Turmeric;The Cutting Edge of India'sMerchandise and Global Medicine

Abstract:

Turmeric has served as a potential chemotherapeutic and chemo-preventive drug in Asia forabout four to five thousand years of human civilization.It occupies a significant place in religious rituals, kitchens as food additives, and many ethno-phyto-pharmaceutical safe drugs in Asia andworldwide.India is the top producer (about 80%), and a leading exporter of turmeric, rich in containing curcumin and turmerone oil in the world.The demand for turmeric and its marketing strategy of turmeric has reached its peak as a naturopathic drug of choice during the SARS-02 pandemic from 2020 onwards. The Indian yellow saffron grows as an organic spice to augment the economic, societal, and environmental conditions of tribal in hilly areas in India adding to the value chain.

The existing study envisages the evaluation of the levels of all chemical constituents including heavy/radioactive metals present in turmeric, so that the widely used turmeric may have some refinement to enhance food safety and its standards.MITUTOYO microscope and X-ray fluorescence Spectrometer (XRF) were used for both yellow and black varieties of turmeric specimens from various places like Kandhamal, Koraput, and Khordha districts to examine and compare the chemical contents.

Turmeric, the both black and yellow variety is the rhizome of the Zingiberaceae (ginger) family, mostly grown by using the organic methodology in hilly terrains of India. Iron and few metals and rare earth metals are present in small proportions but zinc which is the potential immune developer in the human body is almost absent in turmeric. The volatile oil, colouring materials, culinary flavoured spices, or common cosmetics extracted from turmeric. They have wide applications in Ayurveda including cardio-protective, Anti-septic, blood level depressant, anti-cancer, antioxidant, antifertility, antidepressant, anti-allergic, anti-inflammatory, neuro/ nephron-protective, immune-modulatory, anti-microbial, and anti-cancer, etc. Despite well-proven drug of choice in naturopathy and Ayurveda, turmeric is not a widely accepted ingredient in pharmacy, the modern allopathic drug structure, which needs attention.

Keywords: Ayurveda, allopathy, curcumin, Covid-19, turmerone oil, turmeric.

Highlights:

1. Turmeric ((Curcuma Longa Linn) is available as a black or yellow variety, that is cultivated by organic method and processed to powdered form yielding curcumin, and turmerone oil.
2. The rhizome contains more water, nonmetalsalkaline earth metals, transition metals, and zinc-deficient but is widely used in developing immunity, during COVID-19.
3. Ayurveda uses turmeric asa cardio-protective, Anti-septic, blood level depressant, anticancer, antioxidant, antifertility, antidepressant, anti-allergic, anti-inflammatory, neuro/ nephron-protective, immune-modulatory, anti-microbial, and anti-dermatophyte drugs of choice. Allopathy the modern pharmacy does not emphasize it. It is high time to think about the efficient use of it that should draw global attention.

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4. Turmeric is an essential product confined to hills that should have commercial claims.

Introduction:

Turmeric is the first option as spice powder in the cuisine of India,China, Pakistan, Vietnam,Myanmar, Nigeria, Bangladesh,and Japan.Turmeric (Curcuma Longa Linn) belongs tothe Zingiberaceae (ginger) group.It is anherbaceous plant, havinga rhizome (root).Turmerichas names in different languages such as Haldi (Hindi), Haridra (Sanskrit), Jianghuang (Chinese), Manjal (South India), andTāmerikkuUkon(Japan). The rhizome C. Longa (turmeric) used in religious ceremonies and rituals and as spices in cooking is native to India, China, and SE Asia. Turmeric is yellow which is due tothe curcumin ingredient that gives its name "Indian Saffron". The rhizome is a phytonutrient plant used as a natural medicine in India for 4K to 5K yearsin history (Prasad et al, 2011[1],Singletary, K. 2020[2], Satpathy et al, 2021(a) [3],)

Turmeric occupies a primary place in Indian kitchens as the cooking medium. It also hasinevitable inclusion in ceremonial, cultural, and religious activities in the Asian subcontinent. It is anethnic-herbal rhizome that helps as an anti-inflammatory herb used against inflammation,total cholesterol (TC) depressant,cirrhosis, colitis, anti-oxidant, healing wounds, reducing pain and abdominal disordersdue to the presence of bioactive curcuminoid polyphenols in both green and dry pastes. With the poor bioavailability of curcuminoid and due to poor absorption, rapid metabolism, and rapid elimination, turmeric can bethe best choice fororal ingestion and has no bio-reactivity. The curcuminoid formulations from turmeric, activated in the presence of black piper may enhance multifold the bioavailability of curcumin. It provides assured potential health efficaciesto treat arthritis, diabetes, sexually transmitted diseases (STDs),and many others and is a staple subject for future research (Hewlings et al., 2017[4], Kocaadam,et al., 2017[5],Singletary, K. 2020[2], Delgado et al, 2021[6], Fuloria et al, 2022[7]). Apart from all its medicinal benefits, turmericis used asa culinary spice, food preservative, and colouring source in India's day-to-day life.

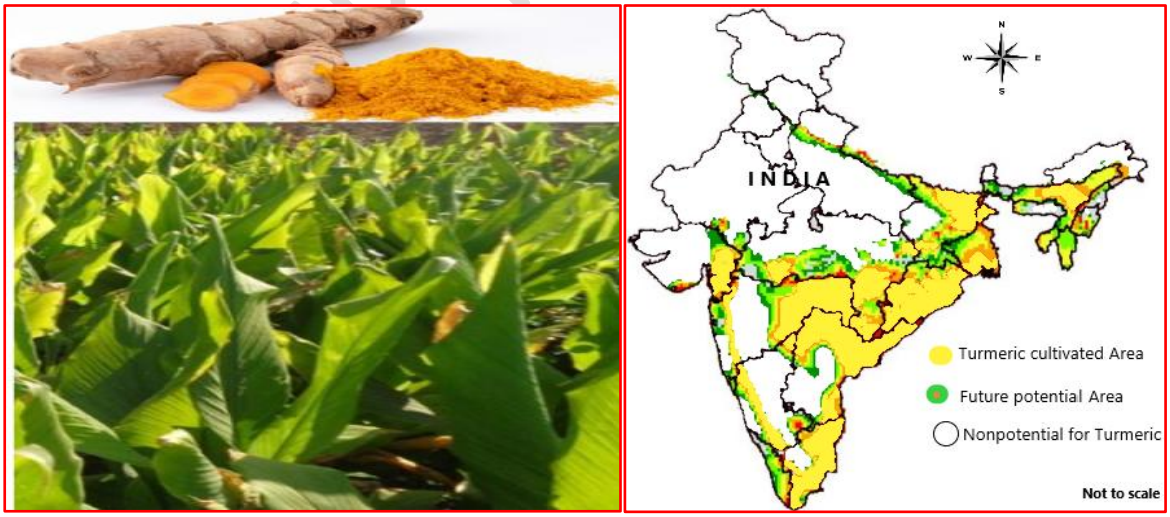

Fig 1: Turmeric; the golden saffron and medicine for all ailments in India

Review of Literature:

The consumption of turmeric (mainly organic) has increased during the outbreak ofsevere acute respiratory syndromessuch as SARS-COVID-2 and some of its mutations during the

recent pandemic from 2019-2021. Curcuminhas effectiveness on virus-cell that leads to inhibition of virus ofinfluenza proliferation, minimizes weakness,andis used as an antidote, (Chabot et al., 2019[8], Vahedian- Azimi et al, 2022[9]).

The ethnobotany domain played a vital role in India's ancient medicines realms of naturopathy, Ayurveda or herbal medicines, and the pharmacology of modern medicines. The roots, leaves, stems, flowers, fruits, or a combination have served the living kingdom or augmented the process of reduction of suffering.In addition to the health care in many cultures, both ancient and modern, the ingredient Curcumin is present,(Butler 2004[10]; Newman et al., 2007[11]Kunnumakkara et al., 2017[12]). Turmeric has gained extensive application in food and herbal medicine as an anti-drug or immunity booster to SARS-2 during the COVID-19 pandemic and its successor OMICRON in eastern India,(Suravajhala et al., 2021[13],Ratis et al., 2021[14], Arjun et al, 2023[15]).

Turmeric is a benign, sustainable,and recognized cytoplasmic stain (Suryavansi et al, 2023[16]), The original Orange-yellow powder/solution turnsin colour brownish-red with alkali and light-yellow with acids and is insoluble in water and ether (O'Neil, 2013[17]). Local turmeric is spicy-like, with a mixed aroma of sweet (ginger + orange),a bitpungent, a little fluorescent, and bitter in flavour, and taste (Fenroli Handbook, 1975[18], Mishra et al., 2020).

The growth rate and instability of turmeric in the 21stcenturyarestudied in the Indian context.The export of turmeric from India in terms of quantity, value in rupees, and value in the dollar was not steady during the reference period, (Jadav et al, 2022[19]).

Thenortheastern region states of India(NER) are recognized as organic states, where various policy measures and initiatives are taken to grow organic Lakadong turmeric variety, by the Government through Self Help Group (SHG) and Farmers Producer Organization (FPO) forachievinghigher growth and productivity, through(https://foodprocessingindia.gov.in/sectors/production_data_spices/Turmeric, Singh et al., 2020[20], Sadony et al, 2023[21]).Kandhamal and Koraputturmericof Odishabased on organic farming has much demand in the global market. Odisha turmeric can capture a larger market share by integrating the local value chain with the global value chain.(Singh Glory, 2019[22], Mishra et al., 2020[23]).

A longitudinal research design was adopted to study the price behaviours of turmeric in major producing states like Odisha, Andhra Pradesh, Karnataka, Telangana, Maharashtra, and Tamil Nadu. The tests like the co-integration and vector error correction model (VCEM), and Granger Causality Test were applied and the study observed that there is a directional movement of prices between Odisha and other producing states, (Prasad et al, 2011[25], Mishra et al, 2018[26], Sahoo et al., 2022[27]).

The present area of study is to find the intrinsic constituents, structure, and practices of cultivation, yield, internal consumption, and external export of Turmeric. The various varieties of turmeric found to be cultivated in India with special importance to Odisha are within the scope as turmeric has less application in modern medicine.

Objectives:

The present study intends to search for

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i. History, religious sanctity, and Ayurveda entity of various types of turmeric (Yellow and black) in Indian culture.

ii. The existing search envisages the evaluation of the levels of alkali, alkaline, metals, and toxic heavy metals present in turmeric so that the widely used turmeric may have some refinement to enhance safety. X-ray fluorescence Spectrometer (XRF) of various turmeric specimens from Kandhamal examined and compared the chemical constituents.

iii. Microscopic study of Turmeric slices heating at a fixed temperature for the divergent period and structural study.

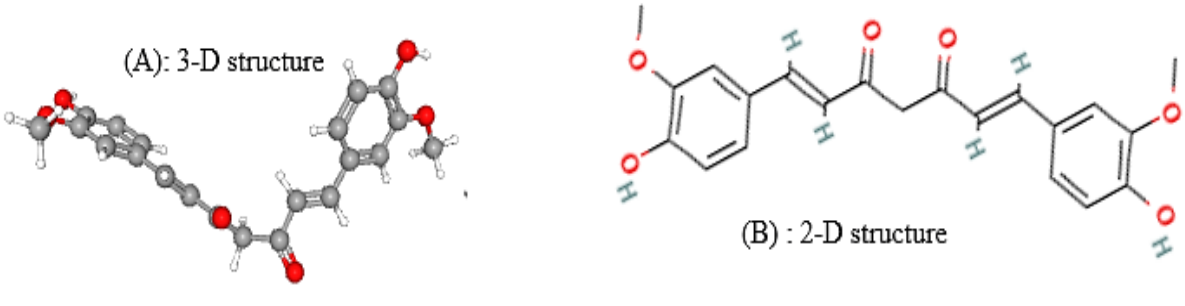
iv. The study of the Product, Price, Promotion, and Place (4P's) of turmeric at various curcumin and turmeric oils produced,and medicinal uses (Ayurveda, naturopathy, pharmaceutical).

History of Turmeric:

Medicines extracted from plants have been used for healing wounds, cosmetics, immune development, and Medicarefrom ancient times to the present day. Turmeric has had wide use for the last four to five milieus (pre-Meghalayan period, Vedic era in Holocene epoch) as spices in the kitchen, medication, religious undertakings, and dietary pieces of stuffdating back to 5,000 years before the present (YBP) in Ayurveda, later during 2,000YBP in Atharva Veda. The C. longaa part of the zinger community contains changedcurcuminoid. Mythology, the Vedic texts, and Puranic sources depict thatturmeric signifiesits purity, auspiciousness,sacredness, divinity,radiance, brilliance, fecundity, and fertility. Itis a part of Hindu religious events. Hindu text tells the legendary story of Shree Ganesh was carved out of the lump of turmeric powder by the divine will of Devi Parvathi the cosmic concert of Adiyogi Mahadev (Sharifi-Rad et al., 2020[28], Prasad et al, 2020[25]).

Chemistry behind Curcumin:

The ingredient Curcumin from turmeric was first isolated in 1815 (Vogel et al, 1815[29]), and later the purified crystalline compound was reported in 1870 by Daube, 1870. The chemical, $C_{21}H_{20}O_6$ with mol. weight(368.38)was structured by Polish scientists in 1910 (Vogel et al., 1815[29], Miłobędzka et al., 1910[30],Priyadarsini et al., 2014[31]).



IUPAC Name:(1E,6E)-1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,6-diene-3,5-dione

Fig 2: The 2-D (B) and 3-D (A) structure of turmeric (Curcumin) as per IUPAC

[Source: https://pubchem.ncbi.nlm.nih.gov/compound/Curcumin]

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The commonly obtainable curcumin (With molecular formulae I) is 1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptane-3,5-dione. The rhizome is available as dyeing stuff in yellow-orange colour, with amolecular weight of 368.39 g/mole, melting temperature of 183°C., and exhibits keto-enol tautomeric.The main extracted constituents from turmeric are either volatile oil orcurcuminoid,or both existing in the rhizome of the turmeric plant.

Fig 3(a): The MITUTOYO microscope and X-Ray Fluorescence Spectrometer (XRF) to take a microscopic view and the elements in Turmeric of various varieties (CUTM Lab, BBSR).

The structure and components

The various constituents in turmeric, the food additive are mainly carbohydrates (69.4%), wetness (13.1%), proteins (6.3%), fats (5.1%), and minerals (3.5%) The other components are Curcumin (2 – 6 %), aromatic Turmerone oil from therhizome and leave extract (11.1%） The aromatic turmerone oil has the properties of neoplasm as an inhibitor or anti-venomous(Leong et al., 2008[32],Bansal et al., 2008[33], Shi S., 2020[34],

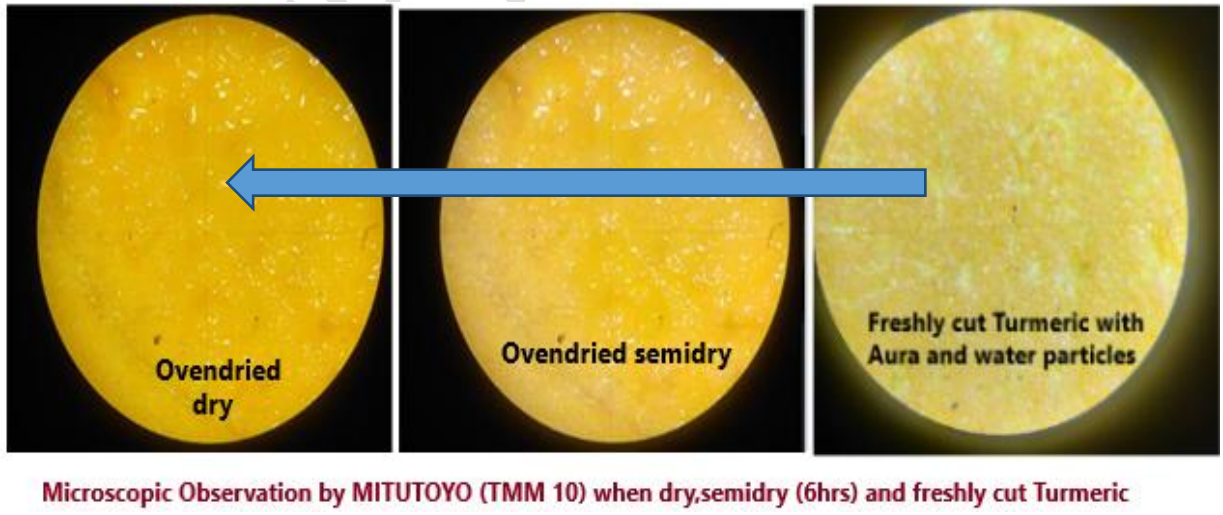

Fig 3.b: The microscopic structureof Turmeric slice oven dried to dry, semidry and freshly

The Turmeric of the Kandhamal variety was ploughed in the study area at the Jatni campus, BBSR, and taken as a specimen. The slices of the specimen were maintained ata constant temp of 50^0C for freshly cut, 8hrs and 24hoursto study microstructure.The level of water

particles is shown in white dots of various sizes (Fig 3.b). , The MITUTUYO micro-scope of model TM-505B is used and found that the water particles with fluorescent oil. On heating, at 50^0 Citis seen that the water Particles are evaporated whereas the oil traces are prominently glazed. **Black Turmeric:**

Black Turmeric is Cucurma caesia, which is a wild tropic and subtropical variety of rare turmeric species of varying size, shape, and colouration, grownwild in India. It is pungent, spicy, and bitter of camphor aroma. It cannot be directly taken as it is a hot, sour, turpentine flavour, with a sharp, and earthy taste. Locally black turmeric is known as kali haldi, Narkachur, and Siyah Haldi. This variety is native to Sikkim, Andhra Pradesh, and Pappi hills of the east and west Godavari districts of India. Tinctures, teas, and pastes are available as traditional medicine applied in India to heal wounds, irritations, snake and insect bites and act as an antibacterial and antifungal, and digestive cure.Fibrosis Oral submucoushave an effective cure by use of black turmeric, (Devi et al., 2015[35], Arya, et al., 2018[36], Bohra 2021[37]),

The elemental constituents

The PAN analytical X-ray fluorescent spectrometer (Das et al., 2019[38]) was used to study the chemical elements present in the turmeric rhizomes and leaf of turmeric plant collected personally as popular of superior quality from Koraput, Kalahandi districts, black variety locally cultivated,Table 1.

Table 1: The nonmetals, metals, lanthanides, RE, etc in Turmeric rhizome and its leaves.

Element	Symb	Sample -i	Sample ii	Sample iii	Sample (leaf)	Sample Vi
		Koraput	Black Haldi	Kandhamal	Local	
Silicon	Si	0.106%	0.214%	541.2ppm	0.517%	Nonmetal
Phosphorous	p	0.192%	0.119%	904.4ppm	646ppm	Nonmetal
Sulpher	S	269.1ppm	316.5ppm	300.4ppm	346.5ppm	Nonmetal
Chlorine	Cl	232.8ppm	284.3ppm	323.2ppm	526.8ppm	Halogen
Potassium	K	0.206%	0.233%	0.120%	0.135%	Alkali metal
Rubidium	Rb	NA	4.5ppm	NA	NA	Alkali metal
Calcium	Ca	232ppm	232.5ppm	228.0ppm	930.1ppm	Alk. earth metal
Manganese	Mn	0.2ppm	19.9ppm	0.0ppm	3.6ppm	Brittle metal
Iron	Fe	31.5ppm	63.8ppm	15.7ppm	40.0ppm	Transition metal
Zinc	Zn	7.8ppm	NA	NA	NA	Brittle metal
Strontium	Sn	50.8ppm	55.4ppm	44.7ppm	NA	Alk. earth metal
Titanium	Ti	NA	16.4ppm	NA	15.2ppm	Transition metal
Europium	Eu	37.9ppm	NA	21.3ppm	20.8ppm	lanthanide
Rhenium	Re	0.8ppm	NA	NA	NA	Trans.metalRare)
Erbium	Er	NA	NA	63.5ppm	39.6ppm	Lanthanide (RE)
Water	H_2o	99.41%	99.334%	99.636%	99.092	
Nor. Factor		1.296	1.315	1.297	1313	

In the study of the turmeric of Local, Koraput, and Kandhamal it is found that Titanium and Erbdium are absent. In the turmeric sample of Korapur, Rhenium is present in the small fragment but absent in other samples. The alkaline metal Rubidium is present only in black turmeric. The superior turmeric of Odisha is the Kandhamal variety and the Koraput type but

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the rarely available transition metal Erbidium in the very small fragment is present in Koraput Turmeric.The aromatic fragrance is obtained in turmeric leave-wrapped country cakes made of rice (Pitha). The rhizome & the leaves are tested for their elements available. The number of nonmetal phosphorous and silicon present in leaves is less than the rhizome and leaves are deficient in zinc and Strontium.As oxides, the black turmeric sample contains bromine and ZrO2 in oxide form in the black turmeric powder.

Compound	SiO2	P2O5	SO3	Cl	K2O	TiO2	MnO	Fe2O3	CuO	ZnO	Br	Rb2O
Conc	4.850	4.737	2.685	1.203	80.010	0.551	1.252	4.469	320.6	782.3	142.7	601.0
Unit	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm

Compound	SrO	ZrO2	Eu2O3	CO2	Re
Conc	279.9	295.6	0.0	0.0	24.5
Unit	ppm	ppm	ppm	ppm	ppm

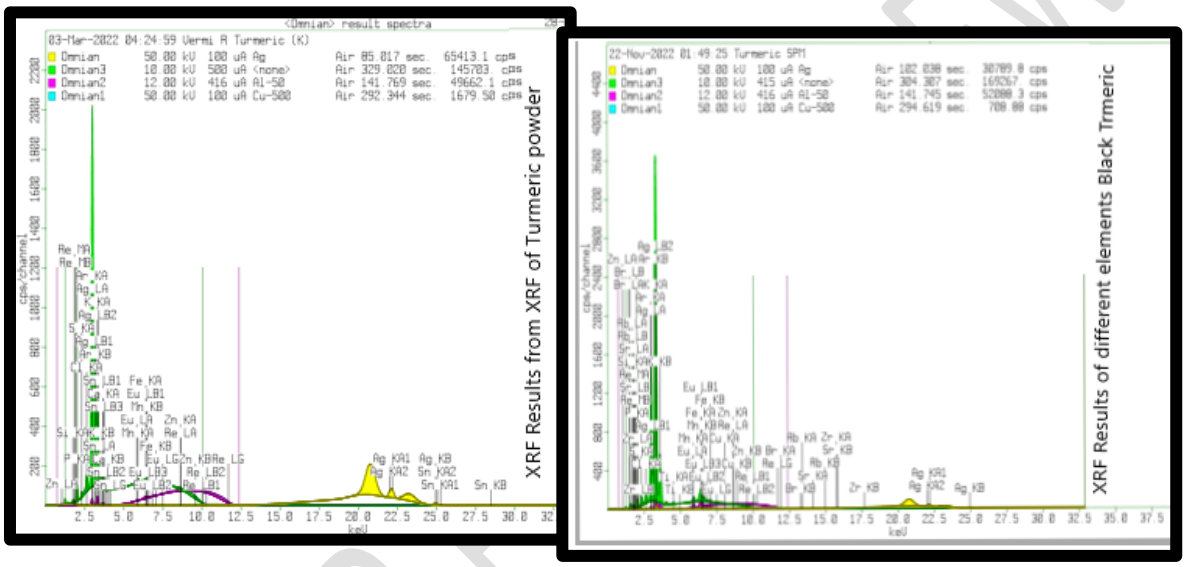

Fig 4: Elements,compounds in yellow /black turmeric tested under X-RF Spectrometer

Health Benefits of Turmeric

Ayurveda prescribes turmeric tobe the antidote of blood, urine, stool, skin, and eye curing all the human systems like nervous, respiratory, endocrine, circulatory, immune, reproductive, cardiovascular, urinary, digestive, excretory, reproductive,skeletal,and many others. Ayurved records turmeric detoxifies the liver, balances cholesterol, fights allergies, stimulates digestion, boosts immunity, and enhances the complexion. Turmeric acts as a natural antiseptic and antibacterial agent and is helpful in disinfecting cuts and burns. Combined with cauliflower it has been shown to prevent and prevent the spread of prostate cancer. Turmeric is a drug against prevents melanoma, cancer, psoriasis, childhood leukemia, pain, metabolism regulation, weight reduction, skin inflammation, and detoxifying the liver, reducing Alzheimer's disease, arthritis, and rheumatoid arthritis.As per Model Detailed Project Report Processing of Turmeric Powder, Indian Institute of Food Processing Technology, Ministry of Food Processing Industries, Government of India, Verma, et al., 2018[39]

The application of turmeric along with other leaves, roots, and herbs available in our backyard for treatment of various diseases has been documented by Late Laxman Mishra in the Odia version of the book titled "Anubhuta Yogamala or Ghara Vaidya: Part One &

Anubhuta Yogamala or Sahaja Chikischa: Part II" based on the natural practices in Northeastern ghats districts of Odisha. Accordingly, the use of turmeric alongwith other applicable ingredients used in the cure of various ailments is quoted with the page numbers as per details (Table 2).

Table 2: The Ayurveda recommendations against diseases cured by Turmeric of Odisha

#	Ailments Details	Page No	#	Ailments Details	Page No
1	Lack of milk inthe post-natal mother	7	14	Allergy skin rashes	107
2	Fever in Small Children	22	15	Kandhamal or Galaganda (Local)	126
3	Chronic Headache	30	16	Jaundice	128
4	Cataract (in the eye)	37	17	Gonorrhea	134
5	Asthma	54	18	Induce sweating during fever	145
6	Cough/Whooping-cough	60	19	Children suffering from fever	159
7	Difficulty in urination	100	20	Smallpox	168,172
8	Skin rashes	134	21	Poison antidote	190
9	Eczema	137	22	Bhagandara (Pistula)	197
10	Prameha	172	23	Blood cleansing	217
11	Gonorrhea	184	24	Snake bites	227
12	Symptoms of Cholera	242	25	Cold bites	229
13	Eczema in hand/palm	246	26	Night pollution	236

Source: Anubhuta Yogamala: Part One and Part II by Laxman Mishra; collected tribal Odisha

Climate and soil:

Therain-fed hilly terrain orplateaus or open forests with irrigation facilities are the best choices for a tropical plant like turmeric. It is native to India with intra-cultural operations like mulching and weeding. Turmeric as a cash crop is cultivated in the Eastern and Western Ghats belt (EGB and WGB hills) and foothills of the Himalayas in India. Growth is favourable in moderately warm and humid climates with an annual rainfall of 1500– 2250mm and a pH range of 4.5-7.5. The shade-tolerant crop grows in well-drained uplands, sandy or clayey loam soil (June to Feb), https://indiaagronet.com/indiaagronet/crop%20info/turmeric.html.

The production in India

Major producers of Turmeric are India, China, Pakistan, Vietnam, Myanmar, Nigeria, and Bangladesh;Globally India is a major producer (80%) and exporter of turmeric. Telangana ranks first in India followed by Maharashtra and Tamil Nadu respectively.Major turmeric and their curcumin level of turmeric-producing states and the districts are in Table 3;

Table 3: The major turmeric-producing states, districts, and varieties,with Curcumin levels

States in India	District	Variety	Curcumin
Telangana	Nizamabad;Adilabad, Karimnagar,Warangal	Madras	3%
Maharashtra	Hingoli;Nanded;Yavatmal	Waigaon	6.12%
Karnataka	Chamaraj Nagar; Alleppey	Sangli&Allepy	3.45 &5%

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Tamil Nadu	Karur Erode, Coimbatore, Salem, Dharmapuri,Krishna Giri, Villupuram	Erode manjal	3.5 to 4.5%
AndhraPradesh	Guntur; Prakasham	Nazimabad	2 to 4%
MadhyaPradesh	Lalitpur;Rewa;Sahadol;Wardha	Waigaon	6.12%
West Bengal	Bongai Gaon	Lakadong	6 to 12%
Odisha	Kandhamal, Korapur, Mayurbhanj	Kandhamal	3.2to 4.2%
Mizoram/Meghalaya	Saiha;Lunglei;MamitKoksibHanhitha	Lakadong	7 to 12%
Gujurat	Mahal, Sabarkantha, Anand, Nadiad	Hybrid	
Assam, seven states	Bongaigaon;Jayantia hills ; Lunglai, Papumpare; Momit; Dibang valley	Lacdong variety	6.8 to 7.5%
Hariyana	Bilaspur	Hybrid	
Hybrid varieties	CIM Pitamber (12.5%); Keshari (1.16%); Suvarna (4.3%); Suguna (7.3%); Sudarsan (5.3); IISR Prabha or prativa (6.5%); rajendra Sonia (8.4%) etc		

Source: http://www.indianspices.com/sites/default/files/majorspicestatewise2021.pdf and https://www.zizira.com/blogs/plants/types-of-turmeric-in-india-turmeric-varieties

The state Maharashtra (367.99TMT) is the largest grower and producer of raw turmeric (35.0% of area and 47.0% of production) in India, India: turmeric production volume by state 2022 – Statista, though Telangana was leading the yield list in quantity (Qty) of turmeric, Table 4.

Table 4: The area (‘000Ha) and Production (‘000MT) from 2017 to 2021 in India

India	2017		2018		2019		2020		2021
State	Area	Qty	Area	Qty	Area	Qty	Area	Qty	Quantity
	Th. Ha	Th. Mt	Th. Ha	Th. Mt	Th. Ha	Th. Mt	Th. Ha	Th. Mt	Th. Mt
Telangana	51.00	294.00	53.10	345.27	55.44	386.6	49.00	313.00	330.26
Maharashtra	10.71	177.85	17.22	38.31	54.25	218.87	57.67	226.71	262.61
Karnataka	14.99	76.49	26.58	153.77	20.74	132.67	21.50	130.93	130.97
TN	29.31	112.59	23.35	92.36	18.43	196.25	20.89	86.51	95.57
AP	19.18	79.73	28.92	69.41	29.72	71.32	30.52	73.24	74.69
MP	10.95	39.05	13.67	47.66	16.27	57.07	17.05	160.10	89.85
WB	18.00	45.50	17737	45.46	17812	45648	17749	45698	45.9
Odisha	27.86	54.50	27869	43.62	27869	43615	27867	43611	43.61
Mizoram	7.20	27.82	7.74	29.82	7.65	29.51	7.65	29.51	29.57
Gujurat	4.10	65.50	4.43	17.39	4570	18181	7653	29510	16.83
Assam	17.11	19.17	15.9	19395	17629	22829	16359	20885	20.88
Haryana	1.50	22.00	0. 92	2195	1753	4061	1331	3009	3.7
Total	221.8	1056.1	261.92	957.13	296.18	1178.75	2945.4	1101.9	

Source: National Horticulture Board (NHB)

Turmeric market in India

Total turmeric stock depleted to 515TMT from 562TMT inclusive carryoverbalance of 29TMT in India during 2021-22.The exports of turmeric have declined to 137TMT from 183TMT and local consumption remainsthe same at 350TMT as usual. The carryover stock

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in FY 2022-23 was 28TMT.The major export markets of Indian turmeric are the USA, Bangladesh, Iran, Malaysia, the UK, Morocco, Germany, and Japan. With the growth of the value of exports, India should cash in on the trend by introducing innovative value-addedproducts and recipes.

India is the topmost producer, consumer, and exporter, followed by other producing,consuming, and exporting countries like Thailand, other SE Asian countries, Central and Latin America, Taiwan, and others. Out of 1100TMT/year turmeric as global production, India ranks in the topmost share of about 78 % followed by China (8%), Myanmar (4%),Africa (Nigeria), and Bangladesh combined shareof 6% of the total global production.The United Arab Emirates imports about (18%), the highest amount of turmeric from India, followed by the USA at 8%. Countries like Bangladesh, Japan, Sri Lanka, the UK, Malaysia, South Africa, Netherlands, and Saudi Arabia amount to 75% of total imports at large from India.

Turmeric in Odisha:

All the thirty districts of Odisha produce organic turmeric cultivated in 27790Ha and the quantity yielded 218165MT of turmeric. The highest area and yield are in the Kandhamal district, followed by Koraput, Keonjhar, and Nayagarh and productivity is more than 7.5MT/ha (Fig-5)

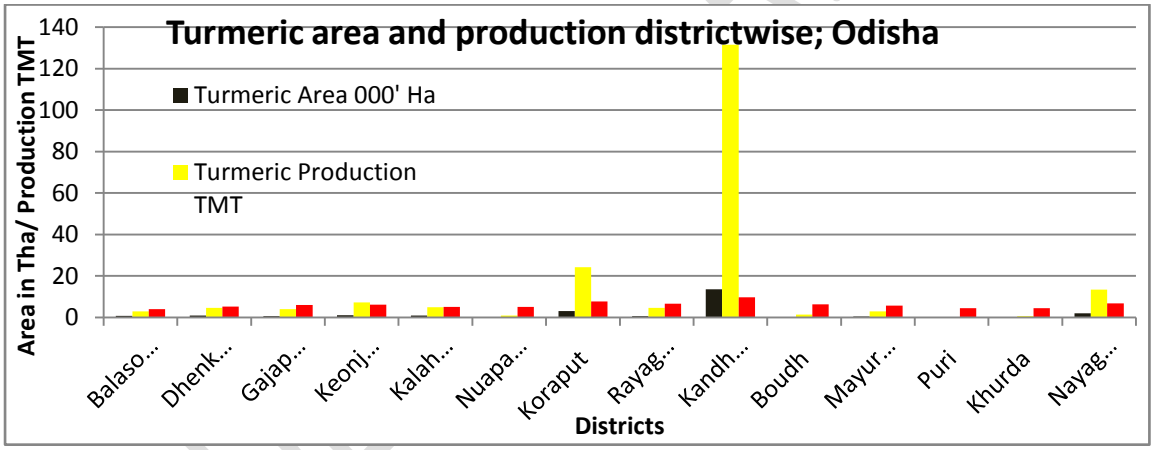

Fig 5: The cultivated area, production, and productivity of major turmeric yielded in Odisha

Odisha's organic Turmeric in Kandhamal and Koraput districtswas acknowledged with the geographical indication (GI) tag upon application of KASAM (Kandhamal Apex Spices Association of Marketing) under class-30type. The blocks popular for Kandhamal turmeric are Baliguda, G-Udayagiri, Raikia, and Tikabali. About 60000 local population of the area in Kandhamal are yielding 40000MT of turmeric annually to augment their socio-economic status and encouraged for cultivation under Pradhan Mantri Fasal Bima Yojana (PMFBY)in the year 2019-20, The constraints of less stress on turmeric cultivation are poor economy, knowledge, training, biotic and anthropogenic constraints, and proper organic market, (Sahoo et al., 2022[40], Odisha Economic Survey 2023[41])Fig-5.

India is the leading producer and exporter of turmeric in the world and the global demand for turmeric is increasing due to its anti-cancer, immune boosting capabilities, and anti-viral properties of turmeric. The study has shown the increased local demand and export figure of

turmeric during the COVID-19 and post-pandemic period is attributable to the three major factors (1) price differential (2) volatility in seasonal yield (3) percentage content of curcumin, dark yellow colour, oleoresins, and essential oil, etc.

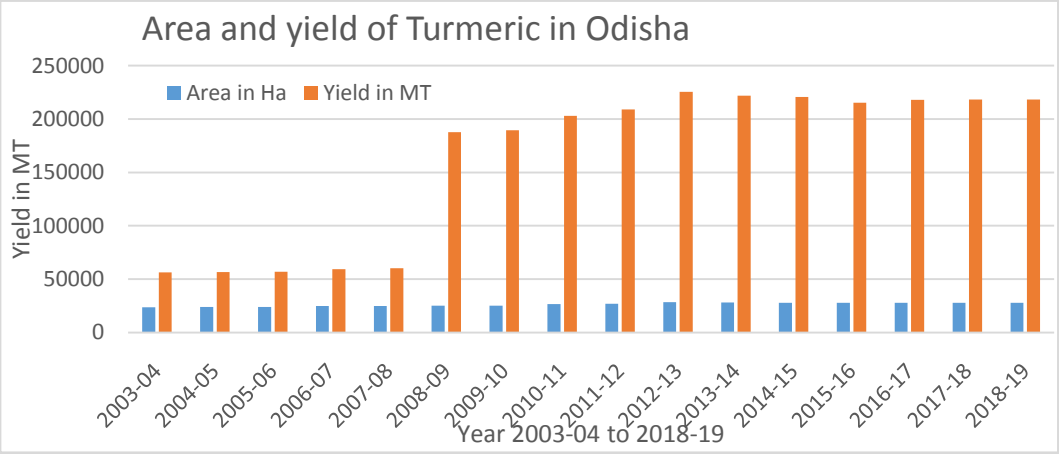

Fig 6: The cultivated area vs. yield of turmeric in Odisha from 2003-04

Since the differential price, physical and chemical quality are interrelated ~~and~~ the Indian origin produces traditionally command premium. Though Indian turmeric has the highest curcumin content and turmeric oil on average, the export is hampered due to non-uniformity in quality. The bulk of the consumption of turmeric is used for extraction, food processing, and blending and these industries import from Indonesia, Ethiopia, Myanmar, and Vietnam taking advantage of the price differential. Recently Vietnam has taken various policy initiatives for the growth of the turmeric industry and eating into Indian market share overseas. The article recommends policy measures in consultation with relevant stakeholders to increase production and productivity with higher curcumin content along with steps to address the issue of price fluctuations,(Negi et al, 1999[42], Patil et al., 2022[43]).

Side effects:

Curcumin in Turmeric is innocuous on oral ingestion or external applicationas per the JECFA /WHO (The Joint United Nations and World Health Organization Expert Committee on Food Additives) when taken in measured quantity. According to European Food Safety Authority (EFCA) reports, the Allowable Daily Intake (ADI) value of curcumin is 0–3 mg/kg body weight.The limitation of curcumin is the least absorption inhumans and prolonged overdosing with curcumin causes diarrhoea, rash,headache, nausea, and manyailments. (Sharma et al., 2004[44], Sharifi-Rad et al., 2021[28]].

Discussion:

Turmeric has been in use as old ethnic Ayurveda drugs to contemporary pharmaceuticals. The curcumin in turmerichas proven biological accomplishments that include cardio-protective, Anti-tumour,blood level depressant, anticancer, antioxidant, antifertility, antidepressant, anti-allergic, anti-inflammatory, neuro, or nephron protective, immunomodulatory, anti-microbial, and anti-dermatophyte, properties. Apart from curcuminoid, Turmeric has various ingredients like volatile oil, colouring, culinary flavoured spices, or common cosmetics, (Qin et. al., 2017[45],Satapathi et al 2021(b)[46])

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Curcumin in Turmeric is unstable and least bioavailability on taking, even cannot reach the circulatory system. Themain curative constituent of turmeric or the extracted oil, curcumin metabolizes fast and is volatile, so it iswobbly and has high bioavailability when present in the blood. Turmeric is a medicine for all in India for many ailmentsand cosmetics, Turmericis still a drug in Ayurveda/ naturopathic drug, but it is yet actively includedin allopathic pharmaceuticals, https://www.nccih.nih.gov/health/turmeric.

Turmeric, its oil, and curcumin content have various biological activities, but challenging as curcumin is unstable with low bioavailability before reaching the bloodstream on oral consumption. Asthe components of turmeric are complex and least explainable, concrete conclusions cannot beachieved aboutits safety, economic, societal, and environmental benefits for use as prolonged cosmetics, and paybacks for health issues.NCCIH is funding to have research on the issue of turmeric's bioactivity.

Safety: Forcurcumin-enhanced bioavailability, many alteredturmeric products are industrialized in the market. Cultivating bioavailability may be unsafe for use. The cases need medically tested against use asfood additives, particularly during pregnancy. Intensive research is essential forthe safe use of turmeric in particular doses normally, during various cancer, pregnancy, and breastfeeding during the neonatal period.

Social benefits: – Collective hike in value-adding chain and selling, farmers socially congregated as a society to help each other by forming societies. The collective efforts of farmers shall enhance their societal bonding in addition to helping inmitigating othersocial problems in society. The accessibility to remote hills and mountain areas has become easy. Theease of accessfor cultivation, demand, high rate of yield, and easy vending, shall encourage farmers to grow turmeric in their fields. **Environmental benefits: –** Obtaining remunerative prices for their turmeric, the tribal or the aboriginals shall put less stress on forest goods,and land. Practicing the culture, and training on organic farming shall reduce environmentalpollutionby chemical fertilizers and pesticide consumption.

Economic benefits: – Present strategy at high price realization by savings in processing, carriage, or shipping with operational cost. Now farmers need not go to the nearest market, collection units, or agents,this saves cost and time. Innovative processing methodologies of the products help the farmers to have attractive prices at an enhanced economy.

Except for Iron, the other micro metals were present ata very low level in turmeric. Iron and Cadmium contents in some brands significantly exceeded the maximum limit recommended by the World Health Organization (WHO).*Astonishingly, zinc is rarely available in turmeric samples. It enhances immunity in human health.*

Value addition benefits

The source of major demand for turmeric comes from extraction and food processing (blending) industries. The factors underlying turmeric demand are the percentage of curcumin, oleoresin content, and relevant price. The import of turmeric in terms of volume and value has steadily increased despite stable and significant domestic production. The domestic producers and the turmeric industry are safeguarded through innovative policy initiatives including increased adoption of scientific cultivation practices, (Patil et al, 2020[43], Puri et al., 2022[47]). There is an increased use of turmeric in poultry feed as a natural ingredient to benefit the poultry in terms of growth, weight gain, feed conversion ratio, and

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liver,(Paucar, et al., 2022[48]).Finally, the moderated Turmeric and its components act as anti-inflammatory, neuroprotective, hepato-protective,anticancer, antioxidant,and cardio-protective possessions. Itsbio-availability, bio-efficacy in natural cosmetics, and safety topographies shall prove turmeric to have a proper place in modern medicine and pharmacology in addition to ayurveda and naturopathy.

In tribal areasof Odishalike Phulbani, Koraput, and Keonjhar,the lack of fully efficient and effectiveagricultural marketing is the main drawback for tribalfarmers. For this adopting the new value addition processand its marketing through innovative marketing methods canhelp the farmers for their livelihood enhancement and security.Collective value addition and marketing helped the farmers ingetting a higher price for their produce and raisingthe living standardofthe farmers. Hence, other farmers of the tribal region shouldadopt such new techniques so that they can also raise theirstandard of living.

Conclusion:

Turmeric with curcumin is one of its important ingredients. Thebioactive, naturallysafe, attractive colour, fragrance, andmultiple medicinal, pharmaceutical, colouring,and bio-technological properties, have made the rhizomea popular and essential spice, and essential commodity in day-to-day life of Hindus, Muslims, and Buddhists in SE Asia. Efforts needto incentivizeto turmerone the producer and processor ~~by~~ marketing more value-added products for higher revenue. Arrangementsare to be made at the appropriate policy level to provide slice/flakes makers, dryers, grinders, hygienic storage space, packing machines, cost-effective certifications, etcto make our producers and other participants in the value chain possess world-class facilities.

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