



Turmeric Cultivation and Medicinal Benefits: Special Reference to Kandhamal District of Odisha, India

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Authors' contributions

This work was carried out in collaboration among all authors. Author HT has done the literature review and written some part of the paper. Author SP contributed in the literature review and writing of the paper. Author BKD contributed for writing the paper and also helped in revising the manuscript. Final revision of the paper was done by author TD. All authors read and approved the final manuscript.

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ABSTRACT

This study delves into the production methods and therapeutic properties of turmeric (*Curcuma longa*), a perennial herbaceous plant widely known for its culinary and medical uses. It covers various aspects including cultivation techniques, bioactive substances responsible for its healing properties and health benefits associated with its consumption. The cultivation section emphasizes optimal agro-climatic conditions, soil preparation, planting techniques, and post-harvest procedures essential for successful turmeric farming. The study also explores the medicinal properties of turmeric, focusing on bioactive compounds like curcumin, known for its anti-inflammatory, antioxidant, and anticancer properties. Additionally, it highlights turmeric's potential in treating

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inflammatory diseases, cardiovascular illnesses, and neurodegenerative conditions like Parkinson's and Alzheimer's. The study also delves into organic and sustainable farming practices to address challenges faced by turmeric producers, emphasizing fair-trade practices and biodiversity preservation for long-term sustainability.

Keywords: Turmeric; *Curcuma longa*; golden spice; medicinal value; anticancer properties.

1. INTRODUCTION

Turmeric (*Curcuma longa*) known as the "golden spice" has long been an essential component of human culture. This perennial herbaceous plant, native to the Indian subcontinent, is highly valued for its profound therapeutic properties in addition to its significant role in culinary traditions [1]. Turmeric's vivid yellow colour, which comes from its rhizomes, has been used to colour innumerable meals and is also highly valued in traditional medical practices all over the world [2]. The goal of this study is to investigate the complex link between the production of turmeric and its medical value, revealing the various facets that contribute to the herb's widespread scientific and cultural relevance. The origins of turmeric may be found in ancient India, where it was highly valued for its therapeutic qualities in addition to its use as a culinary spice [3]. Turmeric has been used for medicinal purposes since at least 500 BCE, as evidenced by its presence in ancient Ayurveda literature, demonstrating its importance in conventional Indian medicine. Turmeric, which represents purity and good fortune, has long been a staple of religious rites and celebrations. The spread of traditional medical knowledge across Asia and ultimately the world may be seen in its voyage from the Indian subcontinent to other regions of Asia. Turmeric, a plant that belongs to the Zingiberaceae family of gingers, is distinguished by its long, lance-shaped leaves and spikes of yellow flowers that resemble cones. But turmeric's secret to its culinary and medicinal powers lies in the rhizomes, which have a unique flavour and earthy scent. Turmeric farming demands a careful balancing act between environmental factors. The plant flourishes on well-drained, loamy soils with a warm and humid climate. Although Southeast Asia, China and portions of Africa and the Caribbean have accepted its production, India continues to be the world's leading producer of turmeric due to its favourable agro climatic conditions. Turmeric cultivation heavily relies on agricultural methods. Soil preparation is the first step in the process when the ground is carefully tilled and altered to generate [4]. The most well-researched and well-

known bioactive component of turmeric is curcumin, which is at the core of the plant's therapeutic properties. Turmeric's distinctive yellow colour, curcumin has drawn notice for its anti-inflammatory, antioxidant, and anticancer qualities. Turmeric also has additional curcuminoids, numerous minerals, and essential oils, including zingiberene and turmerone, that enhance its medicinal profile. Turmeric has several different medical uses that have positive effects on health. It is a natural treatment for ailments, including arthritis and joint discomfort, because of its anti-inflammatory qualities. Curcumin's antioxidant properties help prevent chronic illnesses, lessen oxidative stress, and neutralize free radicals. Due to its ability to control blood pressure and improve lipid profiles, turmeric has demonstrated promise for cardiovascular health [5]. Its medical value is increased by its function in promoting digestive health and reducing gastrointestinal symptoms. Moreover, current studies have explored the neuro protective properties of turmeric, indicating prospective uses for it in the therapy and avoidance of neurodegenerative illnesses including Parkinson's and Alzheimer's [6,7]. Curcumin's relevance in neurological research is highlighted by its capacity to alter multiple molecular pathways and traverse the blood-brain barrier. Although growing turmeric has great potential, there are drawbacks [8]. Diseases, pests and environmental elements that might impact output and quality are common problems faced by farmers. Organic and sustainable agricultural methods are being investigated as potential remedies to lessen these issues [9]. The preservation of biodiversity and the advancement of fair-trade principles are critical factors in ensuring the long-term viability of turmeric farming. To sum up, the goal of this research is to present a comprehensive knowledge of turmeric cultivation and its therapeutic benefits. We set out on a trip spanning century of traditional knowledge and state-of-the-art scientific study as we uncover the historical, botanical and chemical aspects and investigate its myriad health advantages. With its extensive historical use and promise for healing, turmeric is a monument to the complex [10].

2. HISTORY OF TURMERIC

Turmeric's history is primarily based on the Indian subcontinent, where for more than 4,000 years, this golden spice has been an essential component of culinary, medicinal and cultural traditions. *Curcuma longa*, the plant's scientific name, belongs to the Zingiberaceae family of ginger plants. An outline of turmeric's history is provided below:

Ancient use in Ayurveda: The ancient Ayurvedic scriptures, which describe the traditional Indian medical system that dates back to around 500 BCE, contain the first recorded references to turmeric. Turmeric's medicinal qualities were acknowledged by Ayurveda, which used it in a variety of formulas to treat a wide range of illnesses.

Culinary and religious significance: Due to its vivid yellow hue, turmeric is used as a natural dye and is associated with fertility, wealth and purity in Hinduism. It developed into a crucial component of religious rites and ceremonies, frequently being used as an offering or applied to the body. Its warm, bitter flavor made it a popular ingredient in many different recipes, giving Indian food more taste and vibrancy [12].

Spread along ancient trade routes: Turmeric's reach grew along with trade routes. It ultimately made its way to Southeast Asia, where it was incorporated into the cuisines of many other nations after traveling to the Middle East and East Africa. The Silk Road allowed turmeric to be

introduced to areas outside of its home country [13].

Turmeric in traditional medicine systems: Turmeric was important in traditional medical systems other than Ayurveda. It was used to treat pain and inflammatory problems in Traditional Chinese Medicine (TCM). In Indonesia and other Southeast Asian countries, traditional medicinal methods have also included spice [11].

European exploration and adoption: Turmeric and other exotic spices were discovered by European explorers and traders traveling through the Indian subcontinent during the middle Ages. With the growth of the spice trade, turmeric's use in European cuisines increased over time [14].

Scientific exploration and curcumin discovery: Scientists started separating and researching the active ingredients in turmeric in the 19th century. The most well-known bioactive substance, curcumin, was discovered in 1815 by Pierre Joseph Pelletier and Joseph Bienaimé Caventou. This finding made it possible to conduct a more thorough scientific investigation into the therapeutic benefits of turmeric [15].

Modern medicinal and culinary applications: The 20th century saw a rise in scientific studies examining the health advantages of turmeric. Due to its antioxidant and anti-inflammatory qualities, curcumin has attracted a lot of research interest. In the wellness sector, turmeric pills and extracts became more well-liked, and their use in a wider range of products from beverages to skincare grew.



Fig. 1. *Curcuma longa* (a) Plant and (b) Rhizome [11]

Global production and consumption: India continues to be the world's biggest producer and user of turmeric today. Still, the spice is grown in many tropical places, such as Nigeria, Peru, China, and Southeast Asia. Since it can be used for anything from ancient medicine to modern culinary trends, turmeric has become a worldwide product [16].

3. TYPES OF TURMERIC

Turmeric (*Curcuma longa*) comes in a variety of forms, each having special qualities, tastes and applications. The selection of a turmeric variety is frequently influenced by regional preferences, soil quality and climate. Here are a few noteworthy varieties of turmeric:

Alleppey finger (*curcuma longa* 'Alleppey'): Alleppey Finger, which comes from the Indian state of Kerala, is well-known for having a lot of curcumin. This cultivar is well-known for its rich orange-yellow colour and is frequently used medicinally [17].

Salem turmeric (*curcuma longa* 'Salem'): This cultivar, which is grown in Tamil Nadu, India's Salem area, is highly regarded for its fragrant flavor. Salem turmeric adds a unique scent to food and is frequently used in cooking [18].

Erode turmeric (*curcuma longa* 'erode'): This cultivar, which is grown in the Tamil Nadu region of Erode, India, is renowned for both its high curcumin content and vivid yellow colour. Turmeric erode is preferred in traditional medicine and cooking [19].

Nizamabad bulb (*curcuma longa* 'Nizamabad'): This cultivar, which gets its name from the Nizamabad area in Telangana, India, is well-known for its big bulbs. It is used in traditional medicine and cooking and its look makes it a popular choice [20].

Rajaporeturmeric (*curcuma longa* 'Rajapore'): This type, which is grown in Maharashtra, India's Rajapore district, is renowned for its distinct flavor. Turmeric from Rajapore is frequently used in curry recipes and spice combinations.

Madras turmeric (*curcuma longa* 'madras'): This cultivar, which gets its name from the Indian Tamil Nadu city of Madras (now Chennai), is distinguished for its vivid colour. It gives food a deep golden colour when used in South Indian cooking.

Suguna (*curcuma longa* 'Suguna'): A product of agricultural research, this hybrid type has a high yield. Suguna turmeric is known for its production and is grown in many places.

ndira yellow (*curcuma longa* 'Indira yellow'): This cultivar was created by the Indian Institute of Spices Research (IISR) and is distinguished by a high curcumin concentration as well as resistance to specific illnesses. One cultivar that is thought to be both disease-resistant and high-yielding is Indira Yellow.

Local varieties in different regions: Local cultivars are tailored to certain soil types and temperatures in many different places. Regional differences might include distinctive tastes, hues, or scents that are prized in certain areas [21].

4. INTERNATIONAL SCENARIO

Beyond its ancient origins in the Indian subcontinent, turmeric farming has spread to become a worldwide phenomenon in agriculture. Due to its resilience to a variety of soil types and temperatures, turmeric is a versatile spice that is widely adopted across numerous places in the global context of turmeric production. Vietnam, Thailand, and Indonesia are among the Southeast Asian nations that have adopted turmeric farming, greatly augmenting the world supply. Because of its ideal agro climatic conditions, countries in Africa, including Nigeria Ethiopia and Sri Lanka have started growing turmeric [19, 22]. The South American nation of Peru has also become a significant producer, opening up new markets for turmeric worldwide. China has included the growing of turmeric into its broad crop portfolio due to its extensive agricultural landscapes. Growing awareness of turmeric is what's responsible for its recent spike in popularity [23].

5. INDIAN SCENARIO

Turmeric growing has a long history in India, where it is ingrained in the food, medicine and cultural customs of the region. India is the world's biggest producer and user of turmeric and the colorful fields of turmeric add vibrancy to the country's agricultural environment. A wide variety of turmeric types that are appropriate for various agro-climatic conditions are what define the Indian turmeric farming scene, which is mostly concentrated in states like Andhra Pradesh, Karnataka, Odisha, Tamilnadu and Maharashtra [24]. In India, growing turmeric requires careful

methods such as preparing the land, planting rhizomes, and processing the crop after harvest. Generation after generation of traditional agricultural knowledge is integrated into the cultivation of spices. In order to preserve the biological balance of turmeric environments, farmers frequently use organic and sustainable farming practices. Turmeric's importance extends beyond its financial [25].

6. SCENARIO OF ODISHA

Turmeric farming is a thriving agricultural industry in the Indian state of Odisha, greatly enhancing the region's economic and cultural legacy. Odisha's distinct agroclimatic conditions are favorable for growing turmeric, especially in areas like Rayagada, Kandhamal, and Kalahandi. Turmeric is grown by farmers in Odisha as a commercial crop and a staple food for their households. Realizing the value of turmeric, the state government has launched several programmes to help farmers financially and encourage environmentally friendly agricultural methods. Rhizome planting, methodical post-harvest procedures and careful soil preparation are all part of the agricultural process in Odisha. Numerous farmers in the state use organic and traditional farming practices, which guarantee the production of premium turmeric with a unique flavor and scent. In addition to its financial importance [24].

7. SCENARIO OF KANDHAMAL DISTRICT

Turmeric farming in the charming Odisha area of Kandhamal, India, creates a vivid story against the verdant surroundings. Because of its unique agro climatic conditions, Kandhamal is a well-known place to grow turmeric. The region's farmers actively engage in this long-standing practice of cultivating premium turmeric types because of the region's undulating topography and excellent soils. In Kandhamal, growing turmeric is not just a business venture but also a deeply rooted cultural custom that permeates every aspect of daily life. The methodical procedure includes preparing the land, planting rhizomes, and using careful post-harvest methods. Kandhamal's many farmers use sustainable and organic agricultural practices, protecting the area's natural equilibrium. Turmeric is a commercial crop that is essential to the livelihoods of Kandhamal [26].

7.1 Cultivation

The Indian state of Odisha includes the Kandhamal district, which is well-known for its varied farming methods and is becoming more and more well-known for its turmeric cultivation. India is a major producer of turmeric (*Curcuma longa*), a spice valued for its culinary use, medicinal qualities, and vivid colour. As the region's economy has grown, Kandhamal has become a major hub for the production of turmeric in recent years. The climate of Kandhamal district is ideal for growing turmeric. There are three distinct seasons in the region's tropical climate: a scorching summer, a monsoon season, and a chilly winter. Turmeric grows best in warm, humid climates and Kandhamal's temperature and humidity levels are ideal for this. The area has a range of soil types that are ideal for growing turmeric [26]. The region is home to several well-drained loamy and sandy loam soils, which provide the turmeric rhizomes with excellent drainage and aeration. Turmeric grows best in soil that has a pH between that of a mild acid and a neutral. Kandhamal cultivates turmeric using a combination of contemporary and traditional farming methods. Usually, the first step in cultivation is to prepare the ground by leveling and ploughing. To improve soil fertility, farmers frequently add well-decomposed farmyard manure and organic manure. Rhizomes are used to grow turmeric, and planting usually takes place in the monsoon season. To guarantee ideal development, the rhizomes are planted at a particular depth and spacing. Watering the crop on a regular basis is necessary, especially in the early stages of development. Kandhamal farmers also use intercropping techniques, growing turmeric alongside other crops that work well together.

In addition to optimizing land use, this gives farmers access to new revenue sources. Kandhamal is home to several turmeric cultivators; Salem, Erode, and Alleppey are a few of the most well-known types. Varieties are frequently chosen by farmers, taking into account aspects including market demand, disease resistance, and productivity. The total success of turmeric production in the area is greatly dependent on the choice of appropriate types. Although the production of turmeric has grown significantly in Kandhamal, farmers still face difficulties with post-harvest losses, market access, and managing pests and diseases [26-28]. To solve pest-related difficulties, the use of bio pesticides and integrated pest control

approaches is being advocated. Better post-harvest techniques and enhanced market accessibility are also being facilitated for farmers by government programs and assistance from agricultural extension agencies. The farmers of Kandhamal have benefited economically from the growing of turmeric. Due to the strong demand for the spice both locally and abroad, growers are making more money. Beyond the stage of farming, the region has benefited economically from the emergence of value-added product companies and turmeric processing facilities, which have created jobs.

The production of turmeric Fig. 2 in the Kandhamal area is an example of how ancient farming methods and contemporary agricultural technology work together. The success of turmeric growing is attributed to appropriate soil types and favorable weather conditions. Turmeric growing in Kandhamal is expected to make significant contributions to the region's economy as long as farmers maintain their adoption of creative and sustainable farming methods. The production of this golden spice contributes significantly to the district's agricultural diversification and improves the farmers' financial well-being.

7.2 Soil Preparation

Since the quality of the soil directly affects the growth, development, and production of the

turmeric crop, soil preparation is an essential step in the cultivation process. When the soil is prepared properly, the turmeric rhizomes are given the necessary nutrients, aeration, and drainage. Soil preparation in the context of growing turmeric entails several crucial procedures, from choosing the right location to adding organic matter.

7.3 Land Selection

The meticulous selection of the land is the first stage in preparing the soil for the cultivation of turmeric. The ideal piece of land would have well-drained soils that could hold a lot of water. Since turmeric is easily wet, it's important to make sure it drains well. The land's slope should be such that extra water may simply drain out, avoiding circumstances where it gets too wet.

7.4 Soil Testing

Before starting the cultivation process, it is advisable to conduct a soil test. Soil testing helps in understanding the nutrient status of the soil, its pH, and other physical properties. This information guides farmers in making informed decisions about the type and quantity of fertilizers required for optimum turmeric growth. Turmeric generally thrives in slightly acidic to neutral soils, with a pH range of 6.0 to 7.5 [29].



Fig. 2. Turmeric plant [25]



Fig. 3. Ploughing turmeric field



Fig. 4. Turmeric field and harvesting of turmeric [30]

7.5 Ploughing and Levelling

The soil must be levelled and ploughed in the following stage. Breaking up soil clods, increasing aeration, and promoting improved root penetration are all made possible by ploughing. Even water distribution during irrigation is ensured by levelling the soil. Depending on the size of the farm, traditional ploughing techniques with bullocks or contemporary mechanized equipment might be used.

7.6 Addition of Organic Manure

During the preparation stage, organic manure is mixed into the soil to improve soil fertility. Compost or well-decomposed farmyard manure is frequently utilized to enhance the nutritional

content, water retention and soil structure. Organic matter also enhances the activity of beneficial soil microbes, providing a healthier soil environment for turmeric rhizome growth.

7.7 Bed Formation

Raised beds are frequently created in turmeric farming to encourage appropriate drainage a devoid waterlogging. The elevated beds also promote easier harvesting. The kind of soil and the variety of turmeric being grown are two examples of the variables that affect the beds' width and height.

7.8 Irrigation

While preparing the soil, proper irrigation techniques are essential. The soil should have

just enough moisture without being soggy. This guarantees that the soil is ready for the planting of turmeric rhizomes. Based on the crop's water requirements and the climate, subsequent irrigation schedules are determined.

7.9 Harvesting

Turmeric harvesting is the culmination of a carefully planned growing process, during which farmers receive the fruits of months of hard work. With its vivid yellow rhizomes, turmeric (*Curcuma longa*) is a common ingredient in many dishes and is also well-known for its therapeutic qualities. Farmers must grasp the subtleties of the harvesting procedure to guarantee a good crop and preserve the quality of this priceless spice. The crucial chore of figuring out the best time to harvest begins the harvesting phase. Usually taking seven to ten months to reach maturity, the best time to harvest turmeric is in January or March. Farmers keep a close eye on how the leaves and stems change colour since a shift towards yellow signifies that the rhizomes are mature and ready to be harvested. The soil surrounding the turmeric plants is carefully loosened before the actual harvest. The purpose of this preparation procedure is to make rhizome extraction easier without inflicting harm. To loosen the soil around the plants, either mechanized equipment or manual instruments like spades are used, depending on the size of the cultivation. The careful clipping of stems close to the base of the turmeric plants marks the beginning of harvesting. The plants are then pulled up, taking great care to preserve the integrity of the rhizomes in the process. Using hand tools or little gear makes the uprooting process more organized and effective. The turmeric plants are removed and then moved to regions with shade so they may be processed further. The process of carefully separating the rhizomes from the plant entails digging out any superfluous dirt and roots. It is crucial to handle the rhizomes gently at this point to prevent any bruising or damage. The curing procedure is one of the unique aspects of collecting turmeric. After being picked, the rhizomes are partially dried, which usually takes seven to ten days. The rhizomes' outer skin hardens during this crucial curing stage, which enhances flavor, colour and the production of essential oils.

The distinct flavour and scent of properly preserved turmeric are highly valued for both culinary and medicinal purposes. The dried turmeric rhizomes are trimmed to eliminate any

leftover roots and soil sticking after the curing process. Sorting the rhizomes according to size and quality is the next stage. While smaller or broken rhizomes may be destined for processing into powder or other value-added products, larger, well-formed rhizomes are frequently preferred on the market. The meticulous packing of the turmeric rhizomes for sale and distribution marks the end of the harvesting process. Important information, including the variety, harvest date and provenance, is labelled on the packaging. When turmeric is packaged properly, it maintains its quality during storage and transit, arriving at consumers in perfect shape [31].

8. STORAGE

A crucial part of preserving the genetic purity and vigour of this adaptable crop is storing turmeric seeds. Although the main method of propagating turmeric (*Curcuma longa*) is through its rhizomes, it is important to save and store healthy seeds for genetic diversity and scientific objectives. To preserve the agricultural legacy and encourage further cultivation efforts, it is imperative to maintain the longevity and quality of turmeric seeds through appropriate storage conditions. Choosing premium turmeric seeds with care is the first step to optimal preservation. It is best to gather seeds from disease-free, healthy plants with consistent size and shape, among other desired characteristics. The basis for strong and viable seeds for storage is laid by this first selection. Turmeric seeds must be well washed to get rid of any dirt, pulp residue and debris before storing. In addition to improving the seeds' look, thorough washing lowers the possibility of mould growth or fungal illnesses while they are being stored. To ensure that no moisture is left before storage, the cleaned seeds are spread out in a well-ventilated location to dry fully. Since turmeric seeds are moisture-sensitive, too much humidity might cause the seeds to deteriorate and lose their vitality. Turmeric seeds must thus be kept in a low-moisture environment for storage. To absorb any remaining moisture and keep storage containers at the ideal moisture level for long-term viability, add desiccants or silica gel packets. An important factor in seed storage is temperature. To minimize early germination and slow down the aging process, it is recommended to keep turmeric seeds in a cold atmosphere. Generally, it is advised to store turmeric seeds between 40°F (4°C) and 50°F (10°C). Maintaining genetic characteristics and extending seed viability are facilitated by cold, steady temperatures. It is

essential to store turmeric seeds in airtight containers to keep them safe from outside influences like humidity, pests, and pollutants. The seeds are protected from temperature and humidity variations that can jeopardize their integrity by these containers, which aid in the creation of a stable microenvironment. It is best to keep turmeric seeds in low light or complete darkness. Light exposure can cause metabolic processes in seeds, which might lower their viability. Thus, it is best to store the seeds in opaque or dark-coloured containers to protect them from light and preserve their latent condition. There is constant observation of the turmeric seeds that have been preserved. It is important to regularly inspect for mould, discolouration, and strange smells. If degradation is seen, action must be done right once to either improve the storage environment or use the seeds for propagation before their viability is jeopardized. It is advised to conduct regular viability tests on turmeric seeds to guarantee their successful storage in the future. To evaluate a seed's potential to sprout, a sample of the seed can be planted under controlled circumstances. By taking a proactive stance, farmers and researchers can detect any early reduction in seed viability and make the required modifications to storage conditions or replenish seed inventories.

9. CASH CROPS IN KANDHAMAL

The production of turmeric has become a noteworthy cash crop in the Kandhamal district, of Odisha, and has become an important part of the region's economy. The district's general economic growth has benefited from the production and sale of turmeric, which has also increased farmer income. An examination of how turmeric is grown for profit in Kandhamal is provided below. In Kandhamal, the cultivation of turmeric has emerged as a major factor in economic growth. Recognizing the turmeric market, farmers are increasingly turning to its production as a source of revenue. In addition to giving individual farmers a steady stream of income, the sale of turmeric boosts the local economy by bringing in money to support services and businesses. Due to its extensive usage in traditional medicine, the culinary arts, and the cosmetics sector, turmeric has always been in great demand both locally and abroad. Turmeric from Kandhamal, renowned for its excellence and distinct flavour profile, has established itself in the international market. Turmeric's strong demand raises its financial

worth since producers may charge competitive rates for their supply. Jobs related to the cultivation of turmeric have been created at several points in the supply chain. For many people in the area, growing turmeric has become a source of income, from planting and harvesting to processing and packing. Furthermore, as a result of the increasing demand, processing facilities have been established, creating even more jobs and encouraging entrepreneurship. Kandhamal's agricultural diversification has been made easier by the production of turmeric. The area, which was formerly well-known for growing rice, is now more focused on growing valuable commodities like turmeric. In addition to lowering reliance on a single crop, this diversity lowers the risks brought on by volatile commodity prices. Turmeric growing has been encouraged as a cash crop in Kandhamal, thanks in large part to government initiatives and assistance programmes. With the help of training programs, extension services, and subsidies for equipment, seeds, and fertilizer, farmers are now able to implement best practices and raise their production and quality. The emphasis is shifting from raw turmeric rhizomes to value-added products and processing. In addition to adding value to the crop, the construction of processing facilities for oils, turmeric powder, and other value-added goods creates additional opportunities for revenue generating. This pattern corresponds with the rising demand from consumers for packaged and processed turmeric products. In Kandhamal, sustainable farming methods are frequently used in the turmeric-growing process. In response to the growing demand for produce that is sustainably cultivated and organic, more farmers are using organic farming practices. This supports environmental protection initiatives while also making Kandhamal's turmeric more marketable. The progress of the community in Kandhamal has been aided by the success of turmeric growth. Increased income and economic stability for farmers have a good knock-on impact for the community's general well-being. Higher living standards, easier access to healthcare and education, and better infrastructure are some of the advantages seen in areas where turmeric is grown [26].

10. CHEMICAL COMPOSITION

Protein (6.3%), fat (5.1%), carbs (69.4%), minerals (3.5%), and moisture (13.1%) are the components of turmeric. Steam distillation of the rhizomes yielded the necessary oil, which

contains a-phellandrene (1%), cineol (1%), borneol (0.5%), sapine (0.6%), zingiberene (25%), and sesquiterpene (53%). The compound curcumin (3–4%) is primarily composed of curcumin I (96%), which is responsible for the yellow color. It produces radish brown salt with alkali in ethanol, ketone, acetic acid and chloroform; its melting point is between 176 and 177 degrees Celsius [32].

11. TURMERIC AS A SPICE

In Indian households, turmeric holds a revered place not just as a spice but as a key component of daily life. This vibrant yellow powder is ubiquitously used in Indian cooking, adding colour, flavour, and a host of health benefits to dishes ranging from dals and curries to pickles and rice. Known as "haldi" in Hindi, turmeric's acceptance goes beyond the kitchen; it is also used in traditional medicine, beauty routines, and cultural rituals. The widespread use of turmeric in Indian homes underscores its cultural significance and versatile applications, making it an indispensable ingredient in the Indian household [33].

12. BIOLOGICAL FUNCTION OF TURMERIC AND ITS COMPOUNDS

It was discovered that many rhizome extracts, including powdered turmeric, curcumin and its derivatives and others, were bioactive. In rats and rabbits, turmeric powder has the ability to cure both septic and aseptic wounds [34]. Additionally, it has been shown to provide adjuvant chemoprotection in Swiss mice and Syrian golden hamster models of oral and fore stomach cancer [35]. In rabbits, curcumin also boosts mucin secretion. Additionally, in dogs under anesthesia, it enhances bile secretion. Ar-turmerone-containing curcuma long a fraction exhibits strong antivenomic properties.

13. MEDICINAL VALUES OF TURMERIC

Turmeric (*Curcuma longa*) has been extensively studied for its medicinal properties, particularly its role in treating various diseases. Curcumin, the primary bioactive substance in turmeric, exhibits potent anti-inflammatory, antioxidant, and anticancer properties. According to Aggarwal et al. [34] curcumin has been shown to modulate numerous molecular targets, making it a promising candidate for the treatment of inflammatory diseases, cancer and neurodegenerative disorders [35,36].

Additionally, the therapeutic potential of curcumin in the context of chronic illnesses has been investigated, highlighting its ability to influence multiple signaling pathways involved in the pathogenesis of various diseases [37]. These findings underscore the significant promise of turmeric as a multifaceted therapeutic agent.

13.1 Anti-Inflammatory Properties

Turmeric's main ingredient, curcumin, inhibits inflammatory enzymes and pathways and has a strong anti-inflammatory effect. By reducing the chemicals that cause inflammation, it offers relief akin to that of some drugs but with fewer adverse effects. Curcumin is a promising natural treatment for inflammatory illnesses and ailments, including arthritis, because of its capacity to target various inflammatory sites and modify the immune response. Adding turmeric to your food or supplementing with curcumin can help lower inflammation and improve your general health [38].

13.2 Antioxidant Activity

Turmeric, a brilliant yellow spice with a potent antioxidant called curcumin that is essential to the body's defense against oxidative stress, is produced by the *Curcuma longa* plant. Curcumin scavenges harmful free radicals, preventing and neutralizing oxidative damage to tissues and cells. This reduces the risk of acquiring long-term ailments such as heart disease, cancer, and neurological disorders like Alzheimer's. Most curcumin works by encouraging the body's natural oxidant enzymes, which fortify the body's defenses against oxidative stress [39].

13.3 Joint Health

Turmeric's anti-inflammatory qualities may help reduce the discomfort associated with rheumatoid arthritis and osteoarthritis, two illnesses that affect the joints. It may help those who have these diseases move more freely and have less discomfort.

13.4 Digestive Health

The liver produces more bile when turmeric is added, which facilitates digestion. Additionally, it could lessen bloating and digestive problems.

13.5 Cardiovascular Health

By enhancing endothelial function, decreasing inflammation, and lowering the risk of heart disease, curcumin may benefit heart health.

Table 1. Terpenoids from *C. longa*

| Sl.No | Compounds | Sources | References |
|-------|---|---------|------------|
| 1 | (S)- α -turmerone | Rhizome | [40] |
| 2 | Longpene C | Rhizome | [41] |
| 3 | Curlone | Rhizome | [14] |
| 4 | Ar-tumerol | Rhizome | [41] |
| 5 | Curculonone D | Rhizome | [42] |
| 6 | Procurcumenol | Rhizome | [11] |
| 7 | 5 α -Hydroxyl-1 β -bisabolon-9-one | Rhizome | [43] |

Table 2. Curcuminoids from *C. longa*

| Sl. No | Compounds | Sources | References |
|--------|---|---------|------------|
| 1 | Curcumalongin C | Rhizome | [43] |
| 2 | Curcumin | Rhizome | [11] |
| 3 | (4Z,6E)-5-hydroxy-1,7-bis-(4- hydroxyphenyl)-4,6-heptadien-3-one | Rhizome | [11] |
| 4 | Bisdemethoxycurcumin | Rhizome | [37,42] |
| 5 | Demethoxycurcumin | Rhizome | [42] |
| 6 | (4Z,6E)-(+)-1,5dihydroxy-7-(4hydroxy-3-methoxyphenyl)-1-(4-hydroxyphenyl)-4,6-heptadien-3-one | Rhizome | [11] |

13.6 Cancer Prevention

Studies have been conducted on curcumin's possible anticancer effects. By preventing the proliferation of cancer cells and slowing the spread of tumors, it may aid in the prevention or treatment of cancer.

13.7 Antibacterial and Antiviral Properties

Due to its antiviral and antibacterial qualities, turmeric may aid the body's defense against infections.

13.8 Skin Health

For a variety of skin disorders, topically applied turmeric is useful. Its antioxidant and anti-inflammatory qualities may be beneficial for eczema, psoriasis, and acne.

13.9 Anti-depressant Effects

Some studies show that curcumin may have antidepressant benefits by boosting levels of brain-derived neurotrophic factor (BDNF) and promoting neurotransmitter balance.

Here, we give some volatile compounds that are found by Gas Chromatography-Mass Spectrometry (GC-MS) but haven't been isolated from turmeric oil and that are responsible for antimicrobial, anticancer, antioxidative,

neuroprotective activities of turmeric, antidiabetic, etc. Table 1 represents different types of terpenoids found from *Curcuma longa* and Table 2 represents different types of Curcuminoids found from *Curcuma longa*.

14. PHARMACOLOGICAL ACTION OF CURCUMIN

14.1 Stomach

The effects of turmeric powder on the stomach are positive. It may function as a gastro protection against irritants by increasing mucin production in rabbits. Nonetheless, disagreement persists concerning curcumin's antiulcer properties. On the other hand, 0.5% curcumin could not prevent histamine-induced ulcers. In fact, rats develop ulcers when given greater dosages of 50 mg and 100 mg/kg [44]. The induction gastric ulcer has been linked to a decrease in mucin content and an increase in stomach acid or pepsin release, while the exact process is yet unknown. According to recent laboratory research, curcumin can stop rats' stomach ulcers caused by stress, ethanol, and indomethacin. It can also stop rats' acid secretion caused by pylorus ligation. Curcumin scavenges reactive oxygen species to mediate the anti-ulcer action.

14.2 Liver

In cultured rats, rat hepatocytes are protected against tetra chloride, D-galactosamine,

peroxide, and ionophore-induced damage by curcumin and its equivalents.

14.3 Intestine

Have positive effects on the intestines as well. In the ileum of an isolated guinea pig, sodium curcumin was found to have antispasmodic properties. Moreover, curcumin increases the activities of intestinal lipase, sucrose and maltase.

14.4 Pancreas

The synthetic derivative of p-tolylmethyl carbinol, 1-phenyl-1-hydroxy-n-pentane, raises bicarbonate levels and plasma secretion. Moreover, curcumin stimulates the action of chymotrypsin, trypsin, amylase and pancreatic lipase.

14.5 Neurological Disorders

Research on Alzheimer's disease in animals suggests that curcumin directly reduces the Amyloid pathology of AD [45]. Based on the findings of several investigations, curcumin was shown to have a significant effect on the brain. Curcumin may prove to be a useful medication in the future for treating several neurological conditions, including diabetic neuropathy, tardier dyskinesia and severe depression.

15. IMPACT OF TURMERIC IN THE AYURVEDA MEDICINES

Turmeric (*Curcuma longa*) has been a cornerstone in Ayurveda medicine for thousands of years, revered for its broad spectrum of therapeutic properties. Central to its medicinal value is curcumin, a bioactive compound with potent anti-inflammatory and antioxidant effects. In Ayurveda texts, turmeric is frequently cited for its role in enhancing digestion, improving liver function, and purifying the blood. Studies have corroborated these traditional uses, demonstrating turmeric's efficacy in managing conditions such as arthritis, digestive disorders, and skin diseases [40]. Furthermore, turmeric is often included in formulations aimed at boosting immunity and combating infections, reflecting its antimicrobial and immune modulatory properties [34]. Modern research continues to explore and validate these ancient applications, highlighting turmeric's significance in holistic health practices and its potential as a complementary treatment in contemporary medicine.

16. SUGGESTIONS

A project focusing on the growing of turmeric and its therapeutic properties provides an opportunity to investigate agriculture and health from many angles. Take into account the following advice to guarantee a thorough investigation:

Cultivation techniques: Let's start by thoroughly examining the methods used to cultivate turmeric. Talk about appropriate kinds, climate, and soil needs. Incorporate environmentally and human health-promoting sustainable farming techniques, with a focus on organic approaches.

Nutritional analysis: Examine the nutrient makeup of turmeric. Draw attention to the abundance of curcumin, a strong antioxidant with anti-inflammatory qualities. Describe the ways in which these substances improve human health.

Health benefits: Describe in further detail the health benefits of turmeric. Examine its application in both conventional and modern medicine. Examine its potential for treating and preventing a number of illnesses, including digestive problems, arthritis, and inflammation.

Economic viability: Examine the financial implications of growing turmeric. Examine demand, market trends, and prospective profit margins. Talk about the difficulties and prospects facing farmers while highlighting the crop's long-term financial viability.

Community impact: Assess the impact of turmeric farming on local populations. Think about how it affects employment prospects, revenue creation, and the general well-being of the community. Talk about any cultural or societal importance that turmeric may have in the area.

Processing and value addition: Examine value-adding and post-harvest processing strategies. Examine the market potential for items made with turmeric, such as supplements, oils, and powders.

Future prospects and challenges: Finish by talking about the opportunities and difficulties that lie ahead for the cultivation of turmeric. Talk about future developments in science, technology, and consumer needs. Think about the potential effects of global trends and climate change on turmeric farming.

17. CONCLUSION

The Kandhamal district of Odisha is a well-known place to grow turmeric by use of sustainable and organic agricultural practices, protecting the area's natural equilibrium. It is not only for the business purposes but also deeply rooted cultural custom for every aspect of daily life of the farmers of Kandhamal. The *Curcuma longa* has been used since early times to cure a variety of illnesses. With its anti-inflammatory, anti-allergic, anti-hypertensive, anti-septic, anti-oxidant, anti-microbial, anti-ulcer, and wound-healing properties, turmeric has a wide range of medicinal applications. Turmeric's rotating usage in the treatment of human illnesses requires a detailed understanding of its safety, mechanism of action, and appropriate dose. This analysis will give rise to fresh motivation for using turmeric as a preventative and therapeutic approach.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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