iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** II **Month of publication:** February 2022

DOI: https://doi.org/10.22214/ijraset.2022.40270

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue II Feb 2022- Available at www.ijraset.com

Composition and Health Benefits of Turmeric (*Curcuma longa*)

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Abstract: ***Turmeric (curcuma longa) belonging to Zingiberaceae family, it is most useful medicinal herb. Turmeric can be found in India other Southeast Asian countries. Turmeric processing steps are washing, boiling, drying, polishing, coloring, grinding/powdering and packing. Turmeric contains more than 100 chemical compounds that contribute to its healing abilities. Curcumin has strong anti-inflammatory and antioxidant properties. Other curcuminoids include bisdemethoxycurcumin and dimethoxycurcumin. Turmeric contains 8.92% moisture, 2.85 % ash, 4.60% crude fibre, 6.85% fat, 9.40% crude protein & 67.38% carbohydrates. Turmeric rhizome contains 0.89% thiamine, 0.16% riboflavin & 2.30% niacin. Turmeric is a spice used for cooking but has gained immense popularity as one of the most powerful herb for fighting various diseases. Turmeric has been shown to be one of the best foods to maintain, protect, and boost immunity, reducing the risk of falling ill. Turmeric has anti-cancer, anti-inflammatory, anti- microbial, anti-viral, and anti-bacterial properties and also fights against COVID-19 virus. Taking high dosage of turmeric does have side effects include headache, stomach upset, nausea, heart burn etc. In some studies received 0.45 to 3.6g/day curcumin for one to four months reported nausea, diarrhea and increase in serum alkaline phosphatase and lactate dehydrogenase contents.In food industry turmeric used for food preservation by increasing shelf life of various food products. Turmeric oil also used in cosmetic sector, perfumes and soap industries. Turmeric is also regarded as a 'rasayana' herb which is a branch of Ayurvedice medicine. Turmeric is used in Ayurveda to balance vata, pitta, and kapha, though in excess, it can aggravate pitta and vata. Turmeric products like turmeric product, essential oil are used for its color and taste in foods, it can be added to beverages and essential oil used as natural food colourant and also used to prevent skin diseases.***

Keywords: Turmeric, Curcuma longa, ayurvedic medicine.

I. INTRODUCTION

Turmeric (Curcumalonga), the ancient and sacred spice of India known as ' Indian saffron' is an important commercial spice crop grown in India. It is used in diversified forms as a condiment, flavoring and coloring agent and as principal ingredient in Indian culinary as curry powder (1). The underground rhizome imparts a distinctive flavor to food but it is also used to provide food with a deep, indelible orange color (2). In the form of this fine, dried, yellow powder, turmeric is mostly sold to customers in developed countries (2). It has anti – cancer and anti – viral activities and hence finds use in the drug industry and cosmetic industry. A type of starch is also being extracted from a particular type of turmeric. The increasing demand for natural products as food additives makes turmeric as ideal produce as a food colorant (1).

II. ORIGIN OF TURMERIC

Turmeric(Curcumalonga L.) is the dried underground rhizome belongs to the family 'Zingiberaceae'. Turmeric is native of India and china. The world turmeric is derived from the French word ' Terre - merite' meaning merit of the earth (3). The genus name curcuma is probably derived from the Persian word 'kurkum' a name also applied to saffron. Turmeric is called as 'Yellow gold ', 'Indian saffron', and ' The golden spice of life.' It is one of the essential spic used as an important ingredient in all over the world(4).It grows to 3-5 ft long having pointed and oblong leaves, funnel – shaped yellow flowers (5). It is still used in rituals of the Hindu religion, and as a dye for holy robes, being natural, unsynthesized and cheap. Turmeric is in fact one of the cheapest spices (4). In India Curcumin longa has different names in different languages as Halda, Haldi, Hardee, Halad, Halede, Halada, Haldar, Aneshta, Bahula, Halud, Indian saffron, Turmeric, Lidar, Mannal, Halja, Manjal, Mancal (5). Its use dates nearly 4000 years, to the Vedic culture in India where it was used as a culinary spice and had some religious significance (4). In past it is used as aromatic stimulant and carminative while currently it is used for cough, rheumatism, sinusitis diabetic wounds, biliary disorders, anorexia and hepatic disorders (5).

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Turmeric (Curcuma longa) has been used for 4000 years to treat a variety of ailments (4). It is used in Hindu religious ceremonies and Hindus also apply a mixture of turmeric and sandalwood powder on their foreheads (6).

Turmeric is widely used as a food coloring and gives Indian curry its distinctive flavor and yellow color (4). Turmeric has been used as a nontoxic drug in Ayurveda for centuries to treat a wide variety of disorders including rheumatism, body ache, skin diseases, intestinal worms, diarrhea, intermittent, fevers, hepatic disorders, biliousness, urinary discharges, dyspepsia, inflammations, constipation, leukoderma, ameorrhea, and colic (6). Antioxidants can neutralize free radicals and may reduce or even help prevent some of the damage they cause.

In addition, curcumin reduces inflammation by lowering levels of two inflammatory enzymes (called COX-2 and LOX) in the body and stops platelets from clumping together to form blood clots.It is a valuable home remedy for bronchial asthma(4). Turmeric has been considered as an emmenagogue, diuretic, and carminative when taken orally, whereas topical application is commonly used to treat bruises, pain, sprains, boils, swellings, sinusitis, and various skin disorders (6). To prepare this milk is poured on a hot ladle with turmeric in it and boiled over a slow fire.

In case of a running cold smoke from burning turmeric can be inhaled. This increases the discharge from the nose and brings quicker relief (4).

Turmeric cultivation does occur in India, China, Indonesia, Iran, Sri Lanka, Peru and Pakistan. India is leading country in the spices scenario and enjoy monopoly in the spices production because of suitable climatic condition (3).

The genus Curcuma L. (Zingiberaceae) contains many taxa of economic, medicinal, ornamental and cultural importance (7). India is the largest producer of turmeric in the world (93.7% of the total world production) and is cultivated in 150,000 hectares in India(7).

III. PROCESSING OF TURMERIC

India is one of the leading countries in production of raw turmeric and other sub products related to turmeric. The demand of turmeric increased all over the world as new ingredients of therapeutic and life saving properties were discovered (8). The postharvest processing of turmeric involves many units operations such as washing, cleaning, curing or blanching, drying, polishing, size reduction and packaging (9).The harvested turmeric rhizomes before entering into the market are converted into a stable commodity through a number of post – harvest processing operations like boiling, drying and polishing (8).Turmeric possesses both primary and secondary rhizomes that are available in various forms such as globular, slightly, conical, hemispherical, and its observable characteristic (10).

Turmeric processing

The Turmeric can be processed in following steps (9, 12)

1) Washing
2) Boiling
3) Drying
4) Polishing
5) Coloring
6) Grinding/ powdering
7) Packing

A. Washing

The Turmeric Rhizomes (Mother, Primary and Secondary fingers) digged out are kept soaked in water throughout night (9). The rhizome plant was sorted to remove unwanted contaminants like sands, dust, straws, stones and other unwanted foreign materials (10).

The cooked Rhizomes are cooled and spread slowly in the yard for drying. It takes 10 to 15 days for sun drying (9). The dried Rhizomes are rubbed against ground to take out hard layer over them and small roots are removed, by this process coloring of Rhizomes becomes bright and shining, machines are also used for polishing (9).

The already drained turmeric rhizome plant was oven dried at temperature of 60°C for 4 to 5 hours. The dried plant sample was passed through sieves to separate the coarse particles from the fine particles (10). The rhizomes after polishing and coloring cut into small pieces and milled to get 60-80 mesh powder (9).

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B. Boiling

Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly colored product. In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling (8). In some other method turmeric processing unit traditional boiling is done with three fourth part of water in metal pots, (pans) covered with leaves and cowdung over the top (9).The Rhizomes are boiled to around 30 to 45 minutes. In another improved method of boiling/cooking, the Rhizomes are treated with 0.1% soda (Sodium Carbonate, sodium bicarbonate or ammonium carbonate) and water solutions and they are boiled in the same way for 30 to 45 minutes (9). Boiling is considered complete by pressing a pointed stick in to the rhizomes with slight pressure (8). Traditional handling method of cooked Rhizomes causes trampling, mudmixing, scorching, leading to quality and quantity loss (9). The duration when boiling is stopped significantly affect the colour and aroma of the final product (11). Over cooking and under cooking are found to affect the quality of the rhizome and spoils the colour of the final product while under – cooking renders the dried product brittle (8,11).

C. Drying

Drying is carried out under sun or using mechanical drying is carried out under sun or using mechanical dryers at a temperature of 60°C (12). Turmeric should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter (8). During night hours the dried fingers are heaped and drying is carried until it is completely dried and it takes 10 – 12 days (12). Care should be taken to avoid mould growth on the rhizomes. Rhizomes are turned intermittently to ensure uniformity it drying (8). As vacuum, freeze and microwave drying need external supply for its working. Therefore it is not feasible for the farmers to use electricity. Solution for this problem was solar drying (8). The processed turmeric rhizome was spread into two metallic stands with two trays made up of mesh wire each having 1.40 m height above the ground and partitioned by 70cm × 50cm tray length and width (11). Solar tunnel drying of turmeric: Solar tunnel drying method is an effective alternative to traditional open sun drying, where retention of curcumin, volatile oil and oleoresin was high, with less drying time (8). The dry product yield will vary from 10 – 15 percent depending on the variety and location where crop is grown up (12). Solar tunnel dryer can be used to process most of the spices, vegetables, fruits and other perishable crops with maximum retention of intrinsic quality and for better shelf life (8).

D. Polishing

Dried turmeric has poor appearance and rough dull outer surface with scales and root bits (8). In traditional method the dried rhizomes are loaded in a bag and beaten on hard surface (12).The appearance is improved by smoothening and polishing the outer surface by manual or mechanical rubbing (8). Polishing is carried out by the action of abrasion of the surface against the mesh and rubbing between the rhizomes (12).In an Improved method, polishing is done by using hand operated barrel or drum mounted on central axis, the sides of which are made of expanded metal screen. When the drum filled with turmeric is rotated, polishing is effected by abrasion of the surface against each other as they roll inside the drum (8). Turmeric rhizomes can be mechanically washed as well as polished in a portable, electric power operated, rotary drum type turmeric washing and polishing machine(8).

E. Coloring

Exporting turmeric is given special color by mixing yellow so that powder andprocessed materials can give better look and quality (8).Thecolor of the processed turmeric will fetch high price in the market. So to get an attractive product, turmeric powder is sprinkled in the last phase of polishing (12). After coloring is complete for one week these are dried. Later on these rhizomes are kept in sacks and closed for exporting (8).

F. Grinding

Grinding can be a method of adding value to a product. The traditional way to grind would be between two stones (8).Grinding is a very simple process that involves cutting and crushing the rhizomes into small particles, then sifting it through a series of screens of different mesh size, to get a fine powder (8).

G. Packaging

Dried rhizomes and rhizome pieces are packed in jute sacks, wooden boxes or lined corrugated cardboard boxes for shipping. Ground turmeric should be packaged in moisture proof, air – tight polyethylene packages (8). The packages should be sealed and labeled with attractive lables. The label needs to contain all relevant product and legal information – the name of the product, brand name (if appropriate), details of the manufacturer (name and address), date of manufacture, expiry date, weight of the contents, added ingredients (if relevant) plus any other information that country of origin and of import may require (8).

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue II Feb 2022- Available at www.ijraset.com

IV. CHEMICAL AND NUTRITIONAL COMPOSITION OF TURMERIC

Curcuma longa is the most chemically investigated species of Curcuma (13).Curcumin also called diferuloylmethane, is the main natural polyphenol found in the rhizome of Curcuma longa (turmeric) and in other Curcuma spp (14).To date, at least 235 compounds and terpenoids have been identified, including diarylheptanoids (including commonly known as curcuminoids), diarylpentanoids, Monoterpenes, Sesquiterpenes, diterpenes, triterpenoids, alkaloid, and sterols, etc (13).Curcumin (diferuloylmethane) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%) (5). Curcumin, demethoxycurcumin and bisdemethoxycurcumin collectively known as curcuminoids (3-6%) are major polyphenolic compounds in turmeric rhizomes (15).

Table: Proximate Composition of Turmeric plant (16, 17)

Parameter	Composition (%) (16,17)	Vitamins	mg/g (17)
Moisture content	8.92 ± 0.02	Vitamin A	3.44
Dry matter	91.00 ± 0.01	Vitamin B1	0.89
Ash content	2.85 ± 0.02	Vitamin B2	1.20
Crude fibre	4.60 ± 0.01	Vitamin B3	0.32
Crude protein	9.40 ± 0.02	Vitamin C	0.84
Fat	6.85 ± 0.00	Vitamin D	0.64
Carbohydrate	67.38 ± 0.01	Vitamin E	0.39
Ether extract	6.64		
Nitrogen free extract	66.76		

Parameter	Composition (%) (16)
Riboflavin	0.59± 0.02
Thiamine	0.16±0.00
Niacin	2.30±0.00
Calcium	0.21±0.01
Phosphorus	0.63±0.02
Potassium	0.46±0.03
Iron	0.045±0.02

Turmeric contains 8.92% moisture, 2.85% ash, 4.60% crude fibre and 6.85% fat. It also contains 9.40% crude protein and 67.38% carbohydrate (16). It also contains the following minerals (ppm): Ca (1.67), Mg (0.92), K (1.29), P (1.07), S (0.73), Cu (0.04), Se (0.04) and Fe (0.06) (17). Turmeric rhizome contains 0.89% thiamine, 0.16% riboflavin and 2.30% niacin (17). The fibre presents in turmeric will help to cleanse the digestive tract of its consumer by removing potential carcinogens from the body and prevents the absorption of excess cholesterol (16). The presence of essential nutrients and minerals in turmeric rhizome powder imply it could be utilized to improve growth performance and health status of poultry (17). Calcium is a major factor sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting and absorption of vitamin B12 potassium and magnesium are known to reduce blood pressure (16).Potassium plays a role in controlling skeletal muscle contraction and nerve impulse transmission. Selenium, vitamins C and E have been found to have antioxidative potentials which by implication may improve performance and product quality of livestock (17).The iron content present in the extract can help in heamoglobin formation and hence recommend for iron deficiency anaemia (16). Various minerals are also co- enzymes in certain biochemical reactions in the body which underscores the important of the plant in metabolic reactions (16).

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V. HEALTH BENEFITS OF TURMERIC

A. *Anti- Cancer Agent*

Cancer is a collection of more than 100 diseases which is uncontrollable and incurable in nature (18).Curcumin has been shown to be a powerful natural agent in cancer treatment (19). Curcumin is a major biological active compound from turmeric or Curcuma longa. This non-toxic natural compound has been reported to possess several biological activities that are therapeutically beneficial to cancer treatment (20).

Curcumin in turmeric plays an important role in treating several types of cancer, including breast cancer, by promoting cancer cell death, minimizing inflammation, and slowing down tumor growth (18). It also contains polyphenol curcumin (Superoxide Dismutase 1 (SOD1)), which has been clinically demonstrated to prevent cancerous cell development in the prostate as well as to inhibit melanoma, chest sickness, brain tumor, pancreatic harm, and leukemia, among many others (18).Curcumin also exhibits anticancer properties through its ability to inhibit cell proliferation and induce apoptosis.

The anti-proliferative effect of curcumin is dependent on its concentration, duration of treatment, and specific cell type (20). At low doses, curcumin causes cell cycle arrest, while at higher doses it induces apoptosis. The use of curcumin as a chemo-sensitizing agent in combination therapy has the potential to overcome chemo-resistance which is common in advance staged cancers and is a major cause of cancer-related death (20).

The anti-carcinogenic effects of turmeric and curcumin have been related to direct antioxidant and free-radical scavenging effects, as well as their ability to indirectly increase glutathione levels, thereby aiding in Hepatic detoxification of mutagens and carcinogens, and inhibiting nitrosamine formation. Curcumin has also been shown to inhibit the mutagenic induction effect of UV rays (22).

Curcumin may be useful in neutralizing chest and prostate cancer developments. These effects are associated with disturbing and diminishing metastatic potential (18). Curcumin plays a positive role in preventing growth before tumors can arise and also in preventing metastasis (18).

B. *Anti- Inflammatory Agent*

Curcumin possesses significant anti-Inflammatory activity in acute as well as in chronic models of inflammation (23).Curcumin is a highly pleiotropic molecule capable of interacting with numerous molecular targets involved in inflammation (21). Curcumin is a potent anti-inflammatory with specific Lipoxygenase- and COX-2- inhibiting properties. In Vitro, and in vivo studies have demonstrated its effects at decreasing both acute and chronic inflammation (22). Cyclooxygenase-2 (COX-2) is a form of prostaglandin H synthase regulated by mitogens, tumor promoters, cytokines, and growth factors. Curcumin exerts Significant Cox-2-inhibiting activity through suppression of NF-rB (24). Lipoxygenases (LOX). The family of lipoxygenases is responsible for several inflammatory processes such as asthma or allergy. Curcumin inhibits the activity of some LOX lisoenzymes and inhibits the release of compounds by LOX which promote inflammatory responses (24).Numerous studies improved the anti-inflammatory activity of curcumin, it can be an effectual constituent in treatment of numerous diseases related to the Inflammation with its capacity as multi-target and high Pharmalogical safety (25).

C. *Anti- Microbial Agent*

Turmeric is believed to have anti-microbial properties. For Centuries it has been used to help heal open wounds and infections (19).Curcumin shows significant antimicrobial properties (26). Turmeric has been inhibit the growth of a variety of bacteria, pathogenic fungi, and parasites (21).Turmeric extracts prepared in n-hexane, water, chloroform and ethanol were applied to meals as preservatives and antibacterial agent.

The samples were assessed microbiologically (total bacterial, total fungal and total coliform counts) and organoleptically (color, odor, taste) at day zero and after 15 days intervals (27).In addition, Curcumin suppressed P. gingivitis homotypic and Streptococcus gordonii biofilm formations in a dose-dependent manner. Bacterial growth was suppressed almost completely at very low concentrations of curcumin(23).

Oil of turmeric cumin and ginger were obtained from Synthetic Industries Ltd., Kerala. Agar well diffusion method was used to determine the antibacterial activity of cumin, turmeric, and ginger oil against Staphylococcus aureus, Streptococcus mutans (Gram +), Enterococcu sp., and Pseudomonas sp. The fresh bacterial suspension was dispersed on the surface of Muller-Hinton agar plates (28).In another animal study, topically application of turmeric oil inhibited dermatophytes and pathogenic fungi in guinea pigs at 7 days post – turmeric application (22). Curcumin has also been found to have moderate activity against Plasmodium falciparum and Leishmania major organisms (22).

D. Anti-Diabetic Agent

Turmeric is an important herb in most Ayurvedic treatments of diabetes as it lowers blood sugar, increases glucose metabolism and Potentate's insulin activity more than three-fold (30). Part of the action might be due to its chromium content. Curcumin prevents galactose-induced cataract formation at very low doses (30). It has been shown that curcumin is useful in preventing glucose-induced oxidative stress in the endothelial cells and in the heart of diabetic animals (24).The of pancreatic cells dedicated to production of insulin as well as reducing insulin resistance in animal models, which are relevant to reduce the risk of developing and manage type2 diabetes (29).

E. Turmeric Helps to Prevent other Diseases

Chronic diseases – including diseases such as Cardiovascular andneurodegenerative conditions, diabetes, stroke, cancers and respiratory diseases (31).Curcumin is thought to be effective on pathogenesis of molecular targets with the purpose of prevention and treatment of diseases (32).Turmeric is considered as a digestive bitter and a carminative. It can be added into foods including rice and bean dishes to improve digestion, reduce gas and bloating (4).A potential risk of gall bladder cancer is gallstone formation. Therefore, the emptying of Gall bladder is a key factor in cancer prevention (24).Turmeric is beneficial for its influence on the liver. In spring more consumption of herbs and foods can strengthen the liver (4). Turmeric shares similar liver protectant compounds that milk thistle and artichoke leaves contain. It is said to shrink engorged hepatic ducts, so it can be useful to treat liver conditions such as hepatitis, cirrhosis, and jaundice (4). Curcumin, when given orally, reported benefit to Patients with proctitis and Crohn's disease or improved symptoms of irritable bowel disease after treatment (24). Rheumatoid arthritis (RA) is a Chronic inflammatory disease that is characterized by hyperplasia of the synovial Fibroblasts (23). Clinical trials on the subject of Curcumin effect to various ophthalmological disorders demonstrated high efficacy of this compound, when either locally or systemically applied, by oral intake It has been reported that 15-day eye drops application containing turmeric can improve symptoms of conjunctivitis, conjunctival Xerosis (dry eye), acute dacryocystitis, degenerative conditions (pterygium or Pinguecula) and of postoperative cataract patients (23). Curcumin may prove to be as effective as corticosteroids in the uveitis (inflammation of the Uvea, the middle layer of the eye between the sclera – white outer coat of the eye and the retina the back of the eye) the type of eye disorder (4).

F. Turmeric Helps to Reduce Wounds

Foot ulcers are one of the most common complications of diabetes affecting up to 25% of patients during their lifetime and frequently resulting in hospitalization (33). Although there are many treatments and medications, including recombinant growth factors and stem cells that are used to treat diabetic ulcers, the optimum drug regimen elusive (34). Several animal and human studies have demonstrated the wound healing potential of curcumin. Curcumin improves collagen deposition in the wound (34). The process of wound healing has 4 stages – homeostasis, inflammation, proliferation, and remodeling. Chronic non – healing wounds could result from the abnormal inflammatory response. There is evidence that abundance of neutrophils, in the wounds can delay the wound healing because of the destructive nature (33). Curcumin and ginger on the abrasion wound healing in rats treated with a corticosteroid, temovate. Rodents were treated topically with 10% curcumin and 3% ginger extract for 21 days. At the end of this period, rodents were treated with Temovate for 15 days. Following this, superficial abrasions were made in the treated skin (34). They showed that curcumin improved collagen deposition (relative level of nearly 2 in rats treated with Temovate alone compared with nearly 36 in rats treated with both temovate and curcumin and nearly 18 in control rats) . Curcumin was also shown to improve the rate of re-epithelialization of wounds (34).Use of turmeric with honey produce faster wound healing, and is cost-effective and safe. However, good wound care practices including early debridement, infection control, and measures to lower direct pressure over the wounds play an important role in healing (33). Raw turmeric (curcuminoid) is slowly absorbed. Refined curcumin combined with honey in the form of gels, collagen films, alginate foams can enhance wound healing (33).

G. Turmeric Role in Prevention COVID – 19.

Severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2) is a respiratory syndrome caused by positive RNA virus resulting in outbreak of corona virus disease 2019 (COVID-19) (35).Coronavirus disease 2019 (COVID-19) is a life-threatening disease which was affected first in China and quickly spread throughout the world (36). According to the WHO data, as of the second week of April 2020, there are 21.5 lakhs peoples in the world affected by COVID-19, out of these more than 1.5 lakhs peoples died. Majority of the severe SARS-CoV2 infected patients develop acute respiratory distress due to the elevated levels of proinflammatory cytokines and other clinical conditions like diarrhoea, when infection is transmitted through food (37).

It mainly enters the human body through the nasal opening, mouth, and eyes, where it goes to the lungs and multiplies themselves using host cellular machinery. In response to virus attack, host cells start secreting the signaling molecules, which may be the critical markers of viral Infection, e.g., difficult breathing (38).The chemical constituents from Curcuma longa (turmeric) and Andrographispaniculata family may be useful against COVID-19 by inhibiting SARS CoV-2 main protease enzyme (36). Nutritional supplements of curcumin with vitamin C andZinc have showed promising results in boosting the naturalImmunity and protective defense against the CoVinfections have been noted in many hospitalized patients inIndian setting. It is also noted that pharmacological formulation of curcumin in nanoemulsion system proved increased solubility and bioavailability and with enhanced antihypertensive effect (37).

H. Reduce Menstrual Problems of Woman

Menstruation is the process of release of the endometrium which causes bloody discharge from the uterus that occurs every 28 days, with average bleeding occurring about 5 days in each cycle (39). Some women experience pain during menstruation known as “menstrual pain” or “dysmenorrhea” (39).The word of Dysmenorrhoea is derived from GREEK & it means difficult menstruation flow or painful menstrual cramps of uterine origin. Dysmenorrhoea is the leading cause of recurrent short term absenteeism; from the school & worker because it is a severe & disabling in above 0-17% of women, it is also responsible for substantial economic losses due to the cast of medication, care & lost productivity (40).Dysmenorrhea can occur in menstruating women with symptoms that are felt during dysmenorrhea, such as nausea, vomiting, diarrhea, swelling of the stomach, breast tension, and headaches (39).Turmeric is an antispasmodic to smooth muscles so it reduces digestive and menstrual cramping. It should reduce the severity of pain, if not ease them completely (4).For women who experience monthly menstrual cramps, try using turmeric extract or bitters twice daily for two weeks prior to expected menstruation (4).

VI. USES OF TURMERIC IN FOOD INDUSTRY AND FOR FOOD PRESERVATION

Currently, people prefer natural food, herbal medicines, natural curing practices and even organic farming i.e. without using chemical fertilizer and pesticides (44, 48). Increasing the shelf life of vegetables, uncooked food and cooked food is a challenge to food technologists and scientists. There is an urgent need to develop strategies in this direction since control of losses due to spoilage of food can change the world food scenario (41). The ever expanding spice processing industries have to concentrate on the utilization of by products and waste generated during processing of spices by turning into value added products (42). Turmeric oil has many applications in cosmetic sector, perfumes and soap industries (41). In the recent years, food supplements containing turmeric have been marketed and widely used by an increasing number of consumers (50).Turmeric is an important tropical spice primarily valued for its color, aroma and antioxidant properties. It is an essential ingredient of several culinary curry powder formulations and extensively used in food, pharmaceutical and cosmetic industries (42).Turmeric is being used since ancient times as a spice, food preservative, coloring agent and cosmetic in traditional systems of medicine (41).

Tomatoes are a major dietary source of lycopene, the red pigment in tomato fruit that is associated with dietary health benefits. Fresh turmeric powder to be used as bio – preservative (41). The bio – preservative potential of turmeric in extending the shelf life of harvested tomato fruits and antimicrobial activity of turmeric against food borne pathogens and food spoilage microorganisms (41).

Idli/Dosa is a popular traditional fermented food, prepared and consumed as a staple food throughout India, particularly in a southern part of India as well as Sri Lanka (42). Streptococcus faecalis and Pediococcus cerevisiae are the major microorganisms involved in the fermentation process (42). Utilization of Tumeric spent flour to improve the overall nutritional status of breakfast foods. Replacement of rice with Turmeric spent flour in dosa to improve the nutritional quality regarding essential minerals and functional compounds such as curcuminoids (42).

Paneer is an important heat and acid coagulated indigenous dairy product. The poor keeping quality of paneer is a major obstacle in its large scale industrial production (43). A great deal of study has been carried out for enhancing the shelf life of paneer employing various preservatives and preservation methods. The addition of turmeric in paneer at the rate 0.6% significantly decreases the sensory score of paneer. Addition of turmeric at the rate of 0.6% extends the shelf life of paneer upto 12 days on storage at 7 ± 1°C (43).

Colour is one of the most important sensory qualities as it helps us to accept or reject particular food items. Colour is used to added or restore colour of a food in order to enhance its visual appeal and to match consumer expectations (44, 48). Turmeric (Curcuma longa) is a spice commonly used to impart yellow colour at household level, mostly for spicy preparation, however its direct use for sweet products is mostly limited due to its typical flavor and taste.

Turmeric or curcumin has high considerable attention over the years according to its using as colouring agents in the food industries (47).Curcumin, the major colouring principal present in turmeric, can be extracted and used as a natural food colour (44).

Antioxidants are used as food additives in order to prevent the oxidative deterioration of fats and oils in processed foods (45). Turmeric powder blended wheat bread was developed and analysed for different physical characteristics, bioactive components and antioxidant activities as affected by different substitution levels of turmeric powder in bread. On the other hand, the incorporation of turmeric powder markedly increased the curcumin, total phenolic contents and antioxidant activities of bread (45).

Yoghurt is a product of the lactic acid fermentation of milk by addition of starter culture containing Streptococcus thermophilus and lactobacillus delbrueckii ssp. bulgaricus(46). Yoghurt is valued for controlling the growth of bacteria and in curing of intestinal disease such as constipation, diarrhea and dysentery, anti – carcinogenic effect and lowering of blood cholesterol. The use of turmeric affected the colour of the yoghurt, changing it from white to yellowish- orange due to the curcumin in the turmeric (46). The different concentrations of turmeric affected the nutritional composition of the yoghurt. pH increased with increase in concentration of the turmeric due to alkalinity of the turmeric. There was a decrease in microbial load of the yoghurt as the concentration of turmeric increase due to the fact that turmeric possesses antimicrobial ability thus increasing the keep quality of the yoghurt (46). The curcumin extract introduced colored stirred yogurt with somewhat good properties than the turmeric extract (47). Using curcumin extract in preparing stirred yoghurt is better than turmeric extract because its slightly affected the growth of lactic acid bacteria and the rate of acidity in resultant yoghurt (47).

Composition of laying hen diets affects pigmentation of egg yolks (49). Some feed additives such as dietary corticosterone dried carrot meal, and canthaxanthin have been used to change the colour of egg yolk. Likewise, turmeric and sumac are used in foods as a coloring and flavoring agent (49).

VII. ROLE OF TURMERIC IN AYURVEDIC MEDICINE

The use of medicinal plants for the treatment of many diseases is associated to folk medicine from different parts of the world (51). In Ayurveda, an ancient system of healing developed in India before 1,000 BC, spices are dealt as wonder foods (52). Sacred ayurvedic texts written, deal the spices as medicines as well Susrutha (500 BC), a well known Ayurvedic physician described the use of 700 drugs derived from spices that were popular in those days (52).They have been used as medicinal plants, due to their anti-inflammatory properties, to treat a wide array of illnesses and conditions, such as arthritis (osteo and rheumatoid), inflammatory bowel disease, cancer, Alzheimer's disease, the common cold, etc (53). Curcumin is the most explored of the so called Curminoids, a family of chemopreventive substances present in the spice turmeric (58). Turmeric is a medicinal herb containing curcuminoids, used as quality markers in dietary supplements (59).Curcuma aromatic Salisb (C. aromatic) is known as " vanaharidra" in Ayurveda wild turmeric in English, "jangli haldi" in Hindi, and "Yu Jin" in Chinese (58). The rhizomes of C. aromatic are used in traditional medicine for eliminating blood stasis, delaying the ageing process, pain relief, and protecting against liver diseases (58).Turmeric (Curcuma longa L.) is a natural compound, usually dehydrated and finely ground into powder, which can be consumed fresh or in dried form (53).Curcumin, a yellow polyphenolic pigment from the Curcuma longa L. (turmeric) rhizome, has been used for centuries for culinary and food coloring purposes, and as an ingredient for various medicinal preparations, widely used in Ayurveda and Chinese medicine (54).

Ayurveda, the science of life, deals with natural methods to treat and prevent diseases and ways to maintain health (55). In the earliest writings of Ayurveda dating several centuries before the common era, the medicinal properties of turmeric have been elucidated in great detail (56). The Caraka Samhita, Susruta Samhita, Bhela Samhita and Kasyapa Samhita make mention of turmeric as an essential dietary ingredient and medicine as well (56).Ayurveda one of the oldest traditional health care oldest traditional health care system, is known for its unique fundamental principles, treatment guidelines, and drugs which are recorded in texts like veda (6000 BC), Samhita (1500 BC – 600 AD) and Sangraha grantha (800 AD -1900 AD) (57). In Ayurvedic medicine, the 5000 year old natural healing system of India, turmeric is used as a cleansing herb for the whole body and as a remedy for minor wounds, poor digestion, arthritis, Jaundice, inflammation, and pain (4).Turmeric has bitter, pungent and astringent qualities, has healing and cooling effect on the body, helps in controlling diabetics, promotes digestion, increase Vata and Pitha if taken in excess and relives kapha (52,55). Kapha stands for functions that build structure, secretions, immunity and like Pitta stands for digestion, metabolism and other biochemical transformations. Vata represents control, movement and regulation of physiological functions (56).Turmeric powder is used to wean the leech away after it is made to suck blood from the body of patients for therapeutic purposes (56). At the same time, it carries a very promising therapeutic value as it is very effective in sprains, bruises, skin diseases, etc. It has also been used as an antidote for snake bites (55).Turmeric powder along with a pinch of asafetida ground together and applied at the place of bite cures poison effect.

Turmeric mixed in juice of Calotropis spp. leaft juice is good cure for skin diseases (52).A very popular combination of turmeric with neem leaves is used widely by the people of India to manage a range of skin eruptions like ringworm, scabies and chicken pox (56). Those infected with small pox, chicken pox and measles in India use hot water boiled with crushed turmeric and neem leaves for bath (52). Turmeric made into a paste in the gooseberry fruits is recommended for regular use in diabetes. Clinical observations suggest that turmeric may prevent microvascular damage in diabetes more effectively than regulating blood sugar levels (56). Haridra (Turmeric) is indicated as a garbhasthapana oushadha (for pregnant women) in charaka Samhitha. Intake of haridra choora along with gomutra (cow's urine) is suggested as a good medicine for chronic skin diseases (55).

Turmeric is an important ingredient in many important formulations in Ayurveda that are widely used in current clinical practice. Lakshadi tailam is an oil with turmeric as an ingredients that is used for prevention of colds and upper respiratoty disorders, especially in children (56). Turmeric and its constituents may be include in modern system of medicine for the development of new dosage forms to treat several diseases with natural herbs with lesser adverse effects in comparison to allopathic system of medicine and improve the health and wellness of society(60).

VIII. SIDE EFFECTS OF CONSUMING TURMERIC

Turmeric has antioxidant, anti – inflammatory, anticancer, antiviral, antibacterial, antimalarial, immune enhancing, anti – allergic effects along with enhancing therapeutic benefits of certain conventional therapeutic therapeutic drugs (61). But there is accumulating evidence that curcumin may not be so effective and safe (62).The use of herbs is a time – honored approach to strengthening the body and treating disease. Herbs, however, contain active substances that can trigger side effects and interact with other herbs, supplements, or medications (4). Taking high dosage of turmeric does have side effects. Side effects include nausea, stomach upset, heartburn, headache etc. It can also lower blood sugar and can worsen condition of people prone to bleeding and kidney stones (61). A relatively high number of reports suggest that curcumin may cause toxicity under specific conditions. In 1976 Good pasture and Arrighi found that turmeric caused a dose and time – dependent induction of chromosome aberrations in several mammalian cell lines; these alterations were observed at concentrations of 10 µg mL (62). Accumulating data have demonstrated since then that curcumin can induce DNA damage and chromosomal alterations both in vitro and invivo at concentrations similar to those reported to excert beneficial effect.For instance, curcumin concentrations of 2.5 and 5µg mL were shown to induce DNA damage to both themitochondrial and nuclear genomes in cells (62).Encapsulated turmeric or curcumin administered in the clinical trials was well tolerated; side effects were generally similar to placebo (4). In one trial of patients with duodenal ulcers, a burning sensation was reported twice as often in the turmeric group than in the placebo group (13% and 7%, respectively). There are rare cases of allergic contact dermatitis reported (4). In another study, some subjects receiving 0.45 to 3.6g/ day curcumin for one to four months reported nausea and diarrhea and an increases in serum alkaline phosphatase and lactate dehydrogenase contents (63).

IX. STUDIES WITH TURMERIC PRODUCTS

Turmeric is widely used in cosmetics(4). Uses of turmeric as a major source of yellow pigment probably in cave arts in the past and later in preparation of costumes and masks of some folklore and temple art forms would have been the primary cause of its domestication rather than its use as a food material, condiment or medicine (52).

Turmeric powder: Turmeric is a spice that comes from the turmeric plant. It is commonly used in Asian food (64). As a powder, turmeric has been used as a spice in vegetable and meat preparations in many Asian countries for centuries. It is used for its color and taste in foods, and as a fresh root, it can be added to beverages such as tea for its medicinal effects (65). Turmeric is regarded as a substance of purity in Hindu culture. The paste made out of fresh rhizomes of turmeric if anointed on the newly born baby and washed during the auspicious occasion in the months of November – December so as to increase the longevity of the baby (52). In India, for centuries, turmeric was used to dye cloth yellow. In fact, yellow color of the cloth was considered sacred and purifying, as it was yellow/orange like fire, an element symbolic of eradicating impurities (19). A variety of diaryl azo dyes, including Mentanil Yellow and Sudan dyes have been reported as colorant adulterants in turmeric powders (66). Turmeric not only brings a golden glow to skin but also keeps skin healthy and beautiful by reducing inflammation, smoothening and treating and preventing skin ailments like pimples rashes, acne, blackheads and blemishes (4).

Turmeric essential oil: Curcuma longa L. (Zingiberaceae) is an annual herb, the dried rhizomes of which are the commercial turmeric (67). It is widely used as a natural food colourant. The medicinal properties of rhizomes are related to the diarly heptanoids and essential oil (67). Rhizomes harvested from each accession were hydrodistilled for their essential oil (70). The essential oil from leaves and flowers are dominated by monoterpenes while those from roots and rhizomes primarily contained sesquiterpenes. The major volatile principles of the rhizome oil are α – and β –turmerone and ar- turmerone (72).

The contents of curcuminoids and essential oils in turmeric rhizomes vary often with genotypes, varieties, geographical locations, sources, cultivation conditions, environment, harvest methods and seasons, drying process, and storage conditions etc (68). Essential oils may be alternative to use of synthetic fungicides for the control of fungi involved in agricultural product deterioration (69). The essential oil obtained by the hydrodistillation of turmeric powder was orange coloured slightly viscous liquid with characteristic spicy odour(68). The oil content of rhizomes varied between 0.16% and 1.94% on a fresh weight basis (71).In Thailand, the essential oil (rhizomes)of Curcuma longa have been used to treat fevers, peptic ulcers, dyspepsia and skin diseases (70).

X. CONCLUSION

Turmeric has been recognized as flavorful, colorful condiment and used for cooking to enrich the color, flavor and taste of the food.Turmeric and its major compound like curcumin proved that it will prevent various diseases like cancer, liver diseases, diabetics, irritable bowel diseases and heart diseases. Turmeric is a traditional remedy in India to treat cold, cough, asthma, and covid-19. Turmeric is given orally for many other conditions including menstrual problems, pain, respiratory tract infections, diarrhea and jaundice. In Ayurvedic medicine, turmeric is used for various respiratory conditions such as asthma, bronchial hyperactivity, diabetic wounds, runny nose, and cough etc. In food industry turmeric used for various purposes for example: increases the shelf life of the some food products. Turmeric products like turmeric powder used for cooking to improve the color and taste in food and reduce skin ailments like pimples, rashes, acne etc. Essential oils acts as anti-fungal agent, used to control of fungi in agriculture products and it is also used to cure the various diseases like fever, asthma, cold and cough etc.

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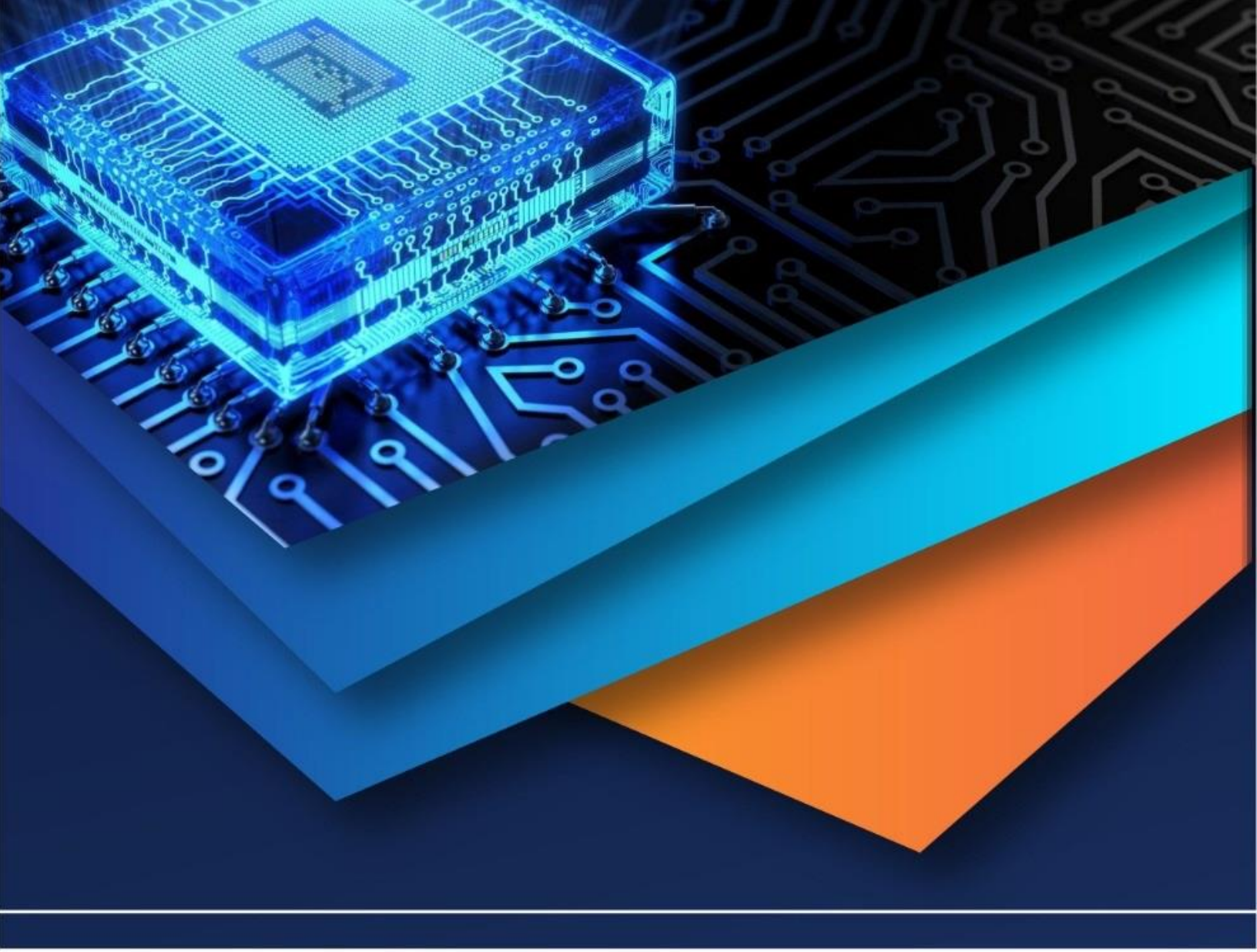
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