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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 2757-2762

www.thepharmajournal.com
Received: 11-09-2021
Accepted: 21-11-2021

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Turmeric production, composition and its non-conventional uses: A review

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Abstract
Turmeric name is thought to have originated in Middle English or Early Modern English as turmeryte or tarmaret. Terra merita could be of Latin origin ("meritorious earth"). Turmeric has been used for centuries in Asia and is an important part of Ayurveda, Siddha medicine, traditional Chinese medicine, Unani, and Austronesian animistic rituals. It was first used as a dye, and then for its supposed medicinal properties as the yellow dye is used to colour the robes of monks and priests, it spread from India to Southeast Asia alongside Hinduism and Buddhism. Turmeric powder contains approximately 60–70% carbohydrates, 6–13% water, 6–8 percent protein, 5–10% fat, 3–7 percent dietary minerals, 3–7 percent essential oils, 2–7 percent dietary fibre, and 1–6 percent curcuminoids. Turmeric's phytochemical components include diarylheptanoids, a class of curcuminoids that includes curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Turmeric contains 34 essential oils, the most important of which are turmerone, germacrone, atlantone, and zingiberene.

As medicine or food, the importance of spices cannot be overemphasized. The medicinal values of turmeric are very well established in treating various ailments too. This article aims to provide an overview of the characteristics of turmeric as well as its non-conventional uses for the food industry, including its properties as a coloring agent, antioxidant, and functional ingredient. This article also highlights the potential of various properties of turmeric and increase the possibilities for the application of its components, such as cellulose and starch, in the development of nanostructures or nanocomposites for food development.

Keywords: Turmeric, production, composition, non-conventional

Introduction

Turmeric, (*Curcuma longa*), perennial herbaceous plant belonging to the ginger family Zingiberaceae, the tuberous rhizomes, or underground stems, of which have been used from antiquity as a condiment, a textile dye, drug, medicine and as an aromatic stimulants in cosmetic in addition to its use in religious ceremonies (Prasad and Aggarwal, 2011, Amalraj *et al*. 2016) [11, 1]. Turmeric have pharmacological or biological activity that can be exploited in pharmaceutical drug discovery and drug design. In both ancient and modern culture, medicines derived from plants have played a pivotal role in the health care of many cultures, (Gurib-Fakim 2006; Newman and Cragg 2007) [3, 8]. Turmeric is native to tropical South Asia. India is a leading producer and exporter of turmeric in the world (Khajehdehi, 2012). Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam are some of the important states cultivating turmeric. Andhra Pradesh alone occupies 38.0% of area and 58.5% of production. Turmeric is known as Because of its brilliant yellow color, turmeric is also known as “Indian saffron” (ICAR, 2015) [15]. Nowadays, turmeric is widely cultivated in the tropics and has many names in various cultures and countries. In North India, turmeric is commonly called “haldi,” a word derived from the Sanskrit word *haridra*, and in the south it is called “manjal,” a word that is frequently used in ancient Tamil literature. Turmeric derives from the Latin word *terra merita* (meritorious earth), referring to the color of ground turmeric, which resembles to a mineral pigment. It is known as *terremerite* in French and simply as “yellow root” in many languages. In many cultures, its name is based on the Latin word *curcuma* (Prasad and Aggarwal, 2011; Paramasivam *et al*. 2009) [11, 10].

Fig 1: Turmeric Plant

Climate and soil

Turmeric require warm and humid climate can be grown in diverse tropical conditions from sea level to1500 m above sea level, with a temperature range of 20-35 ^{0}C and an annual rainfall of 1500 mm or more. It can be grown in under rainfed or irrigated conditions. Though it can be grown on different types of soil types ranging from light black loam, red soils to clay loams and rich loamy soils having natural drainage and irrigation facilities, although the best soil is well-drained sandy or clay loam soils with a ph range of 4.5-7.5 with good organic status. In India, turmeric cultivation season begins in the mid of April that continues up to the first week of July. It can be grown in rotation with sugarcane, chilli, onion, garlic, elephant foot yam, vegetables, pulses, wheat, ragi and maize. In some areas, turmeric is grown as an intercrop with mango, jack and litchi (Randhawa and Mahey 2002) [13].

Varieties

A number of cultivars are available in the country. Many local cultivars of turmeric are available which are known by the name of the cultivated area locality. Some of the popular cultivars are Duggirala, Tekkurpet, Sugandham, Amalapuram, Erode local, Salem, Alleppey, Moovattupuzha and Lakdong (https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric). The cultivated varieties show significant variation in size and color of the rhizomes and curcumin content. The two leading varieties of turmeric predominating in the world market are “Madras” and “Alleppey”. The Patna variety is of deep color. Out of the two types cultivated in Maharashtra i.e. Lokhandi, contains bright colored hard rhizomes while the other has light-colored soft rhizomes. “Duggirala” and “Tekurpeta” are the prominent commercial varieties of turmeric in Andhra Pradesh, which have long, stout, smooth and hard fingers. The other varieties like Kasturi Pasupa” of the Godavari Delta, the “Armoor” type of the Nizamabad area and the “Chaya Pasupa” are other important varieties of Andhra Pradesh. In Orissa, important varieties cultivated are Roma, Suroma, Ranga and Rasmi. (http://iisr.agropedias.iitk.ac.in/). Currently, India is the world’s largest producer, consumer and exporter of turmeric followed by China and several other subcontinent countries (Nisar *et al*. 2015; Parthasarathy and Kandiannan, 2007) [9, 12].

Cultivation practices

a) Preparation of land

The land is prepared with the receipt of early monsoons. The soil is to given about four deep ploughings that brought to it a fine tilth. Hydrated lime @ 500 - 1000 kg/ha has to be applied for laterite soils based on the soil ph and thoroughly ploughed. Immediately with the receipt of pre-monsoon showers, beds of 1.0 m width, 30 cm height and of convenient length are prepared with spacing of 50 cm between beds. Planting is also done by forming ridges and furrows (Alexander *et al*., 2009) [2].

b) Seed material

Whole or split mother and finger rhizomes are used for planting and well developed healthy and disease free rhizomes are to be selected. The seed rhizomes are treated with mancozeb 0.3% (3 g/L of water) for 30 minutes, shade dried for 3-4 hours and planted. A seed rate of 2,500 kg of rhizomes is required for planting one hectare of turmeric (https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric; IISR, 2015) [15].

c) Transplanting

Though transplanting in turmeric is not conventional, it is found profitable. A transplanting technique in turmeric by using single bud sprouts (about 5 g) has been standardized to produce good quality planting material with reduced cost. The technology has been standardized at Horticulture College and Research Institute, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. The technique involves raising transplants from single sprout seed rhizomes in the pro-tray and planted in the field after 30-40 days. The advantages of this technology are production of healthy planting materials andreduction in seed rhizome quantity and eventually reduced cost on seeds (Randhawa and Mahey 2002) [13].

d) Seed/ rhizome

Select healthy turmeric rhizomes for seed purpose and than treat the selected rhizomes with mancozeb (0.3%) and quinalphos (0.075%) for 30 min and store in well ventilated place. One month before planting, the seed rhizomes are cut into single buds with small piece of rhizomes weighing 5-7 g. Treat the single bud sprouts (mancozeb 0.3%) for 30 min before planting and fill the pro-trays (98 well) with nursery medium containing partially decomposed coir pith and vermicompost (75:25), enriched with PGPR/*Trichoderma* 10g/kg of mixture. The turmeric bud sprouts now get planted in pro-trays where we need to maintain the pro-trays under shade net house (50%). Adopt need based irrigation with rose can or by using suitable sprinklers and the seedlings will be ready within 30-35 days for transplanting (https://www.kisansuvidha.com/turmeric).

Fig 2: Turmeric

e) Planting

Generally, conventional turmeric plantation experiences rhizome degeneration after long-term propagation. As a result, propagation through seed offers challenges because of poor flowering and seed setting (Zhao 2002) [17]. In Kerala and other West Coast areas where the rainfall begins early, the crop can be planted during April-May with the receipt of pre-monsoon showers. Small pits are made with a hand hoe on the beds with a spacing of 25 cm x 30 cm. Pits are filled with well decomposed cattle manure or compost; seed rhizomes are placed over it then covered with soil. The optimum spacing in furrows and ridges is 45-60 cm between the rows and 25 cm between the plants (IISR, 2015) [15].

f) Manuring and fertilizer application

Farmyard manure (FYM) or compost @ 30-40 t/ha is applied by broadcasting and ploughing at the time of preparation of land or as basal dressing by spreading over the beds or in to the pits at the time of planting. Organic manures like oil cakes can also be applied @ 2 t/ha. In such case, the dosage of FYM can be reduced. Recommended blanket nutrient dosage for turmeric for Kerala is 60 kg N, 50 kg P2O5 and 120 kg K2O per hectare. Integrated application of coir compost (@ 2.5 t/ha) combined with FYM, biofertilizer (*Azospirillum*) and half recommended.

Dose of NPK is also recommended. As the soil fertility will be varying with the soil type, agro ecological conditions or management systems, site specific nutrient management based on the soil test results for major nutrient is advocated. The recommended dose of nutrients for varying soil test values of N, P and K is given in table 2. The fertilizers are to be applied in 2 - 3 split doses. Full dose of phosphorus is applied as basal at the time of planting. Equal split doses of N and K is top dressed at 45, 90 (and 120) DAP. In zinc deficient soils, basal application of zinc fertilizer up to 5 kg zinc/ha (25 kg of zinc sulphate/ha) gives good yield. Foliar application of micronutrient mixture specific to turmeric is also recommended (dosage @ 5 g/L) twice, 60 and 90 DAP, for higher yield.

g) Mulching

The crop is to be mulched immediately after planting with green leaves @ 12-15 t/ha. Mulching may be repeated @ 7.5 t/ha at 40 and 90 days after planting after weeding, application of fertilizers and earthing up.

h) Weeding and irrigation

Weeding has to be done thrice at 60, 90 and 120 days after planting depending upon weed intensity. In the case of irrigated crop, depending upon the weather and the soil conditions, about 15 to 23 irrigations are to be given in clayey soils and 40 irrigations in sandy loams (IISR, 2015, https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric) [15].

i) Mixed cropping

Turmeric can be grown as an intercrop in coconut and arecanut plantations. It can also be raised as a mixed crop with chillies, colocasia, onion, brinjal and cereals like maize, ragi, etc. It is an important part of agroforestry practices and home gardens with tree plantation.

j) Plant protection

Diseases like leaf blotch (*Taphrina maculans*), leaf spot (*Colletotrichum capsici*), leaf blight (*Rhizoctonia solani*), rhizome rot (*Pythium aphanidermatum*) Root knot nematodes (*Meloidogyne* spp.) And burrowing nematode (*Radopholus similis*) Root lesion nematodes (*Pratylenchus* spp.) Pests, shoot borer (*Conogethes punctiferalis*) and rhizome scale (*Aspidiella hartii*) attack the crop and reduce the production of turmeric (IISR, 2015, https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric) [15].

k) Organic production

For certified organic production, at least 18 months the crop should be under organic management *i.e.* only the second crop of turmeric can be sold as organic. The conversion period may be relaxed if the organic farm is being established on a land where chemicals were not previously used, provided sufficient proof of history of the area is available. It is desirable that organic method of production is followed in the entire farm; but in the case of large extent of area, the transition can be done in a phased manner for which a conversion plan has to be prepared. Turmeric as a best component crop in agri-horti and silvi-horti systems, recycling of farm waste can be effectively done when grown with coconut, arecanut, mango, *Leucaena*, rubber etc. As a mixed crop it can also be grown or rotated with green manure/ legumes crops or trap crops enabling effective nutrient built up and pest or disease control. When grown in a mixed cultivation system, it is essential that all the crops in the field are also subjected to organic methods of production. In order to avoid contamination of organically cultivated plots from Neighboring non-organic farms, a suitable buffer zone with definite border is to be maintained. Crop grown on this isolation belt cannot be treated as organic. In sloppy lands adequate precaution should be taken to avoid the entry of run off water and chemical drift from the Neighboring farms. Proper soil and water conservation measures by making conservation pits in the interspaces of beds across the slope have to be followed to minimize the erosion and runoff. Water stagnation has to be avoided in the low lying fields by taking deep trenches for drainage (IISR, 2015) [15].

l) Management practices

For organic production, traditional varieties adapted to the local soil and climatic conditions that are resistant or tolerant to diseases, pests and nematode infection should be used. All crop residues and farm wastes like green loppings, crop residues, grasses, cow dung slurry, poultry.

Droppings etc. Available on the farm can be recycled through composting, including vermicomposting so that soil fertility is maintained at high level. No synthetic chemical fertilizers, pesticides or fungicides are allowed under organic system. Farmyard manure may be applied @ 40 t/ ha along with vermi compost @ 5-10 t/ha and mulching with green leaves@ 12-15 t ha-1 at 45 days intervals. Based on soil test, application of lime/ dolomite, rock phosphate and wood ash has to be done to get required quantity of phosphorus and potassium. When the deficient conditions of trace elements become yield limiting, restricted use of mineral/chemical sources of micronutrients by soil application or foliar spray are allowed as per the limits of standard setting or certifying organizations. Further, supplementation of oil cakes like neem cake (2 t/ha), composted coir pith (5 t/ha) and suitable microbial cultures of *Azospirillum* and phosphate solubilizing bacteria will improve the fertility and yield. Use of botanicals, biocontrol agents, cultural and phytosanitary measures for the management of insect pests and diseases forms the main strategy under organic system. Spraying Neemgold 0.5% or neemoil 0.5% during July-October (at 21 day intervals) is effective against the shoot borer.

Selection of healthy rhizomes, soil solarization and incorporation of *Trichoderma*, seed treatment and soil application of biocontrol agents like *Trichoderma* or *Pseudomonas* multiplied in suitable carrier media such as coir pith compost, well rotten cow dung or quality neem cake may be done at the time of sowing and at regular intervals to keep the rhizome rot disease in check. To control other foliar diseases spraying of Bordeaux mixture 1% may be done restricting the quantity to 8 kg copper per hectare per annum. Application of quality neem cake mentioned earlier along with the bio agents *Pochonia chlamydosporia* will be useful to check the nematode population.

2. Harvesting and processing

Well managed turmeric crop is ready for harvest in seven to nine months depending on the variety and time of sowing. The crop is generally harvested during January to March. On maturity, the leaves turn dry and are light brown to yellowish in colour.

In Kerala, turmeric is grown in raised beds and harvesting is done either manually or by using a tractor. In case of manual harvesting, the land is ploughed, the clumps are carefully lifted with spade and the rhizomes are gathered by hand picking. Harvesting with a tractor attached to a turmeric harvester is followed when the raised beds are taken using a tractor. The harvested rhizomes are collected manually and all the extraneous matter adhering to them is cleared.

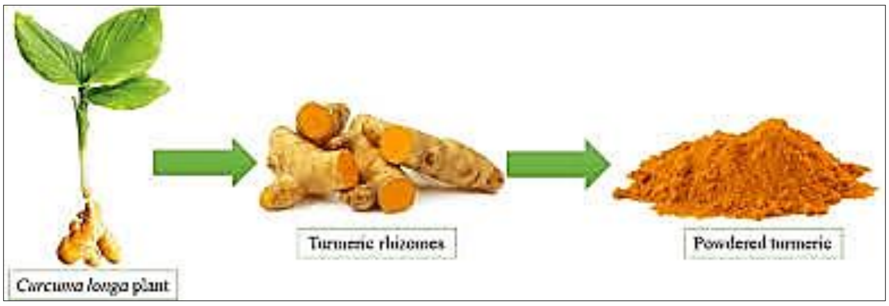

Fig 3: Coversion from turmeric plant to powder

a) Preservation of seed rhizomes

Rhizomes for seed purpose are generally stored by heaping in well ventilated rooms and covered with turmeric leaves. The seed rhizomes can also be stored in pits with saw dust, sand along with leaves of *Strychnos Nux-vomica* (Kanjiram). The pits are to be covered with wooden planks with one or two openings for aeration. The rhizomes are to be dipped in quinalphos (0.075%) solution for 20-30 minutes if scale infestations are observed and in mancozeb (0.3%) to avoid storage losses due to fungi.

b) Post harvest processing

The harvested turmeric rhizomes before entering into the market is converted into a stable commodity through a number of post harvest processing operations like boiling, drying and polishing. Boiling of turmeric is taken up within 3 or 4 days after harvest (IISR, 2015, https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric) [15]. The fingers and Bulbs (or mother rhizomes) are separated and are cured separately, since the latter take a little longer to cook. The dry recovery of the different turmeric varieties vary widely ranging from 19 to 23%.

c) Boiling

Boiling is the first post harvest operation to be performed at the farm level which involves cooking of fresh rhizomes in water until soft before drying. Boiling destroys the vitality of fresh rhizomes, avoids the raw odour, reduces the drying time and yields uniformly coloured product.

In the traditional method, a vessel made of galvanized iron sheet is used for turmeric boiling. Boiling of turmeric rhizomes is carried out till froth forms and white fumes come out of the pan with a characteristic odour. Boiling is considered complete by pressing a pointed stick in to the rhizomes with slight pressure.

The other indications of the completion of boiling process are softness and easy breaking of rhizomes when pressed between the fore finger and thumb and a yellow interior instead of red one.

An effective cooking time of 45 to 60 minutes for fingers and 90 minutes for mother rhizomes is considered essential. Overcooking and under cooking are found to affect the quality of the rhizome. Improved turmeric boiler using steam boiling technique is followed when large quantities of turmeric are to be cured. The TNAU model of Improved steam boiler for turmeric consists of a trough, inner perforated drums and lid. The outer drum is made of 18 SWG thick mild steel to a size of 122 x 122 x 55 cm. A lid is provided with hooks for easy lifting and also provided with an inspection door. For easy draining and cleaning, an outlet is placed at the bottom of the drum. Four numbers of inner drums of 48 x 48 x 45 cm size are provided in the outer drum. The capacity of four inner drum is 100 kg. The inner drums are provided with a leg for a height of 10 cm, so that the rhizomes will not come in contact with water filled for about 6-8 cm depth in the outer drum. The outer drum is placed with more than half of its depth below the ground level by digging a pit, which serves as a furnace. This furnace is provided with two openings, one for feeding the fuel and the other one for removing the ash and unburnt. After placing the turmeric boiler in the furnace, about 75 liters of water is added (6-8 cm depth). About 55 - 70 kg of well washed rhizome is taken in each inner drum and placed in the boiler and the lid is placed in position. Using the available agricultural waste materials, mostly, the turmeric leaves, fire is put in the furnace. During the boiling process, it takes about 25 minutes to produce steam and boil the initial batch of rhizomes and 10 - 15 minutes for the subsequent batches. Through the inspection door, the stage of boiling of the rhizome is assessed by pressing the rhizomes with a hard pin / needle. Using a long pole, the lid is removed and the inner drums are lifted one by one. For the next batch, about 20 litres of water is added to the outer drum, depending on the water lost by evaporation. The next batch of rhizomes is loaded in all the drums and heating is continued. At the end of the boiling process, all the drums need to be cleaned free of mud and soil to avoid damage and enhance the life of the gadget. The capacity of the boiler is about 100 kg per batch and the fuel requirement is 70 – 75 kg of agricultural waste materials (https://vikaspedia.in/agriculture/crop-production/package-of- practices/spices/turmeric; IISR, 2015) [15].

d) Drying

The cooked fingers are dried in the sun by spreading in 5-7 cm thick layers on the drying floor. A thin layer is not desirable, as the colour of the dried product may be adversely affected. During night time, thematerial should be heaped or covered. It may take 10-15 days for the rhizome to become completely dry. The bulbs and fingers are dried separately, the former takes more time to dry. Turmeric should be dried on clean surface to ensure that the product does not get contaminated by extraneous matter. Care should be taken to avoid mould growth on the rhizomes. Rhizomes are turned intermittently to ensure uniformity in drying. The yield of the dry product varies from 20-25% depending upon the variety and the location where the crop is grown. The starch gelatinized during boiling shrink and during the drying process intercellular spaces increase, enhancing water diffusion and reducing the drying time (IISR, 2015, https://vikaspedia.in/agriculture/crop-production/package-of-practices/spices/turmeric) [15].

3. Proximate and Phytochemicals present in Turmeric

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. This implies it could be good source of protein and carbohydrate. Turmeric 67.38% had higher carbohydrate content than Acalypharacemosa (45.26%) and Acalyphamarginata (38.24%) (medicinal plants) but Turmeric (4.60%, 9.40% and 2.85%) was lower in crude fibre, crude protein and ash than Acalypharacemosa (7.20%, 16.19% and 13.14%) and Acalyphamarginata (10.25%, 18.15% and 10.32%) respectively (Iniaghe *et al.*, 2009), which implies that Acalypharacemosa and Acalyphamarginata will have more mineral content than turmeric because of higher ash content. The 2.85% ash content of turmeric shows that turmeric will contain reasonable amount of mineral. The fibre (4.60%) 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. Fibre also adds bulk to the food and prevents the intake of excess starchy food.

Turmeric plant had 0.76% alkaloid, 0.45% saponin, 1.08% tannin 0.03% sterol, 0.82% phytic acid, 0.40% flavonoid and 0.08% phenol. Alkaloid (0.76%) in tumeric plant shows that tumeric could be used in curing headache associated with hypertension, management of cold, chronic catarrh and migraine (Gill, 1992). Tumeric plant could be necessary in the management of inflammation, improve sex hormone, lowering cholesterol, preventing deleterious and cytotoxins and could have antioxidant property as it had saponin (0.45 %) and flavenoid (0.40%). Tannin (1.08%) in tumeric pant shows it could be used as antioxident.

4. Non-Conventional Use of Turmeric

Disposal of the turmeric waste commonly known as turmeric spent oleoresin (TSO) left after separation of curcuminoids has been considered as serious concern and has attracted scientific community at large for its sustainable utilization.

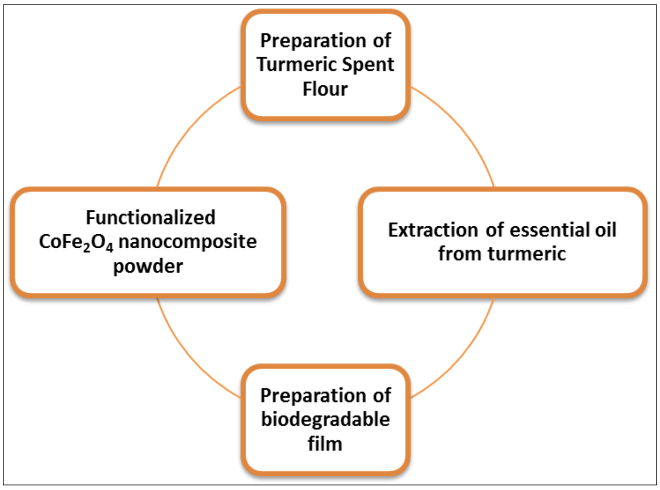

Fig 4: Non-Conventional applications

a) Turmeric starch for the preparation of biodegradable film

After the extraction of turmeric oil and oleoresin, the went through turmeric was found to contain noteworthy sum of add up to dietary fiber (45%), with 43% insoluble fiber and 2% solvent fiber (2%). It is detailed that the turmeric starch having tall water-holding capacity and way better microstructural properties can be utilized as an offbeat source of starch (Kuttigounder *et al.*, 2011) [5].

Substitution of non-degradable manufactured plastics with consumable or biodegradable movies made from biopolymers starting from rural sources is most recent advancement in bundling materials. Right now, investigation of flour from agrarian sources as a modern source is endeavored for the planning of biodegradable movies with moved forward properties. The turmeric went through wealthy in starch division can be utilized as a utilitarian fixing in nourishment businesses and within the planning of biofilms for bundling (Maniglia *et al.*, 2015) [6]. The mechanical and dissolvability properties of turmeric movies are influenced by temperature and pH.

b) Preparation of turmeric functionalized $CoFe_2O_4$ nanocomposite powder

CoFe2O4 magnetic nanocomposite powder were preapred by chemical co-precipitation of CoCl2•4H2O and Fe•Cl3•6H2O by utilizing NaOH solution as a precipitant below its boiling point and continuous stirring upto 1 h (sample 1). Then, turmeric was incorporated into the mixture and stirred for 30 min for sample 2 and 1 h for sample 3. At this step, turmeric-functionalized cobalt ferrite nanocomposite powder were formed in that mixture. Then drying operation was carried out in: sample 1 was dried for about 18 h and sample 2 and sample 3 were dried for about 40 h. Then finally, the samples were powdered in order to produce nanocomposite powder after drying. (Mehran *et al.*, 2016) [7].

c) Preparation of Turmeric Spent Flour

This research was concentrated on utilization of turmeric spent for value addition. Dosa is a popular Indian pan-fried healthy food prepared from raw rice (Oryza Sativa) and black gram (*Vigna mungo* L.). In this study, Turmeric Spent Flour (TSF) was added to dosa batter as a replacement of rice by 10, 25 and 50 percent on weight basis.

Then the dosa batter was left for fermentation at normal temperature and then its microbiological and physicochemical study was carried out. At the time of fermentation, the batter became double in its initial volume at near about 28 °C of temperature. The initial pH was 6.1±0.3 and then after 12hrs it decreased to 9±0.6. The dosa batter have shown, L*, a*, b* and ΔE values 74.6 to 90.7, -4.2 to 2.8, 9.8 to 57.7 and 3.11 to 48.0. Sensory analysis of TSF dosa (up to 25%) further was comparable in sensory characteristics. (Vedashree *et al*., 2016) [14].

d) Extraction of essential oil from turmeric

In this study, fresh rhizomes of turmeric were collected from native markets of Patiala, Chandigarh and Haryana region. The length of the turmeric rhizomes used were of 5-8 cm long and 1-3 cm in diameter. The rhizomes were cut into sizes of 0.2 cm to 1cm.The cut turmeric rhizomes were fed into the the equipment. Then, a packed bed of turmeric rhizomes was obtained from this operation. The modified steam distillation method was done to obtain volatile oil from turmeric rhizomes. This modified steam distillation could be a modification of the Clevenger equipment that is employed to get volatile oil from herbs and plant origins. (Sehgal *et al*., 2016) [4].

Conclusion

Turmeric has a lot of potential as a food ingredient, especially as a colourant, antioxidant, and bioactive. Turmeric's distinctive yellow colour is derived from curcuminoids, including curcumin, making it an important alternative to tartrazine, a contentious synthetic yellow dye being studied for its effects on organism functions.

Turmeric's potential in the food industry is supported by studies that show it can prevent lipid oxidation in a variety of food products by acting as an antioxidant. Furthermore, its consumption can help to stabilise free radicals in the body by acting as an exogenous antioxidant. Although curcumin is the most researched compound of the turmeric rhizome, it accounts for only about 3.5 percent of the dried rhizome, and the residue generated during its extraction contains other compounds of interest to the food industry, such as cellulose and starch.

Nanotechnology could provide a new approach to maximising rhizome utilisation and creating new ingredients for the food industry. The encapsulation of nutritional ingredients such as antioxidants, vitamins and minerals and other bioactives could be the starting point for research on the effect of nanotechnology in food formulations. Additives used in the production of food, particularly those derived from agricultural waste or natural sources like turmeric have a lot of potential for food industry.

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