PM Formalisation of

Micro Food Processing Enterprises (PM-FME) Scheme

HANDBOOK OF

PROCESSING OF TURMERIC POWDER

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CHAPTER 1

INTRODUCTION

1.1. Status and Market Size

Turmeric (*Curcuma longa* L.) is one of the oldest cultivated crops which has been grown in India and China since several thousand years. Turmeric the main turmeric powder in the Indian dish curry, is argued by many to be the most powerful herb on the planet at fighting and potentially reversing disease. Turmeric is an erect perennial crop, but it is grown as an annual crop. The leafy shoot rarely exceeds one meter in height. The primary tuber at the base of the aerial stem bears rhizome which is the economic portion called as bulb and fingers. The turmeric is traditionally well known for its culinary and medicinal properties. It is one of the multiuse products which have many valuable properties and uses. It is extensively used in food, textile, medicine and cosmetic industries. Turmeric can be grown in the tropical and subtropical countries. It is grown throughout the world particularly in the tropical countries. Though it is grown in many countries, yet it is not commercially exploited in most of the countries. It is widely cultivated in the countries such as India, Pakistan, Bangladesh and China, which form the important producing countries in the world. Turmeric was cultivated over an area of 1.94 lakh ha in India with a production of 10.51 lakh tonnes during 2016-17.

India is the leading producer and supplier of turmeric in the world. During 2000-01 the export of turmeric was 44,627 tonnes and was increased to 51500 tonnes in 2006-07. However export earnings have increased from Rs. 11558 Lakhs in 2000-01 to Rs.16480 Lakhs in 2006-07. The UAE, Bangladesh, Srilanka, USA and Japan are the major markets for Indian turmeric. India enjoys a monopoly position with a share of 90 percent in the International trade for turmeric. However China, Peru and Thailand are emerging as stiff competitors in the recent years.

1.1.1. Socioeconomic importance

Curcuma longa and several other species of the curcuma genus grow wild in the forests of Southern Asia including India, Indonesia, Indochina, nearby Asian countries, and some Pacific Islands including Hawaii. All of these areas have traditional culinary and medicinal uses going back to pre-history. In the Indian

Ayurveda system of herbal medicine, turmeric is known as strengthening and warming to the whole body. Traditional uses in India include to improve digestion, to improve intestinal flora, to eliminate worms, to relieve gas, to cleanse and strengthen the liver and gallbladder, to normalize menstruation, for relief of arthritis and swelling, as a blood purifier, to warm and promote proper metabolism correcting both excesses and deficiencies, for local application on sprains, burns, cuts, bruises, insect bites and itches, for soothing action in cough and asthma, as antibacterial and anti-fungus, and in any condition of weakness or debility.

Turmeric is eaten as a food both raw and cooked throughout Asia. While turmeric root look much like ginger root, it is less fibrous and is more chewable, crunchy, and succulent. The fresh root has a somewhat sweet and nutty flavour mixed with its bitter flavour. As a result, it is not unpleasant to eat and not difficult to chew. It is sometimes chewed plain or chopped up and put in salads raw. Traditional use includes mashing/ grinding it in a mortar to make a paste to mix with other spice powders for flavouring in curries. In modern times, the most common use is of the dried root powder as the base of most curries in India and other nearby countries.

Besides flavouring food, turmeric has healing properties, to purify the blood and skin conditions remedy is probably the most common use of Turmeric in Ayurveda. The main organs that turmeric treats are the skin, heart, liver and lungs. Turmeric is used for epilepsy and bleeding disorders, skin diseases, to purify the body-mind, and to help the lungs expel Kapha. Activities of Turmeric include: Alterative, analgesic, antibacterial, anti-inflammatory, anti-tumor, anti-allergic, antioxidant, antiseptic, antispasmodic, appetizer, astringent, cardiovascular, carminative, cholagogue, digestive, diuretic, stimulant, and vulnerary. Therapeutic uses of Turmeric include treatment of Anemia, cancer, diabetes, digestion, food poisoning, gallstones, indigestion, IBS, parasites, poor circulation, staph infections, and wounds.

1.1.2. Commercially grown varieties

There are about 30 turmeric varieties grown in India. Among them Alleppey and Madras (Perianadan) are of great commercial importance. Some of the improved varieties are: CO-11983, BSR-11986, Krishna, Roma, Suroma, Ranga, Rasmi, Megha Turmeric-1, Suguna, Sudarshana, Suranjana, Duggirala, Kodur, Suvarna,

Varna, IISR Prabha, IISR Pratibha, Rajendra Sonia etc. Description of some of the varieties is given below:

Table 1: Some of the commercial and improved varieties	
Alleppey	Highly coloured variety.It is grown in Kerala and is marketed as Alleppey turmeric.
Duggirala	A long duration type (9 months), major variety of Andhra Pradesh. Rhizomes are bright yellow in colour. Grown mostly in Guntur district. Yield of raw material 25 tons./ha.
Armoor	Mostly grown in Nizamabad district of Andhra Pradesh. Medium duration type. Yield of raw material 25-30 tons/ha.
Suvarna	This is a high yielding type released by IISR, Calicut. It has yield potential of 43 tons/ha. It has also high curcumin content of 8.7%

Table 2: Yield characteristics of improved turmeric varieties

Sl. No	Variety	Mean yield (fresh) (t/ha)	Crop duration (days)	Dry recovery (%)	Curcumin (%)	Oleoresin (%)	Essential oil (%)
1	Suvarna	17.4	200	20.0	4.3	13.5	7.0
2	Suguna	29.3	190	12.0	7.3	13.5	6.0
3	Sudarsana	28.8	190	12.0	5.3	15.0	7.0
4	IISR Prabha	37.5	195	19.5	6.5	15.0	6.5
5	IISR Prathibha	39.1	188	6.2	6.5	16.2	6.2
6	Co-1	30.0	285	19.5	3.2	6.7	3.2
7	BSR-1	30.7	285	20.5	4.2	4.0	3.7
8	Krishna	9.2	240	16.4	2.8	3.8	2.0
9	Sugandham	15.0	210	23.3	3.1	11.0	2.7

10	Roma	20.7	250	31.0	9.3	13.2	4.2
11	Suroma	20.0	255	26.0	9.3	13.1	4.4
12	Ranga	29.0	250	24.8	6.3	13.5	4.4
13	Rasmi	31.3	240	23.0	6.4	13.4	4.4
14	Rajendra Sonia	42.0	225	18.0	8.4	-	5.0
15	Supreme	35.4	210	19.3	6.0	16.0	4.0
16	IISR Kedaram	34.5	210	18.9	5.5	13.6	3.0

1.1.3. Cultivation Scenario

The area under turmeric cultivation increased from 1.05 lakh ha during 1979-80 to 1.56 lakh ha during 1998-99. The growth rate for this period was 2.07 per cent per annum. The total output of turmeric had increased from 2.35 lakh tonnes during 1979-80 to 5.98 lakh tonnes during 1998-99, recording a growth rate of 6.59 per cent per annum. The productivity of turmeric per hectare had also increased from 2,242 kg in 1979-80 to 3,841 kg during 1998-99, recording a compound growth rate of 3.78 per cent per annum.

India is the largest producer, consumer and exporter of turmeric in the world. Other major producers are Thailand, other Southeast Asian countries, Central and Latin America and Taiwan. The global production of turmeric is around 11 lakh tonnes per annum. India dominates the world production scenario contributing 78 % followed by China (8%), Myanmar (4%) and Nigeria and Bangladesh together contributing to 6% of the global production.. Turmeric is also produced in the Caribbean and Latin America: Jamaica, Haiti, Costa Rica, Peru, and Brazil.

India is virtually a monopoly supplier to the world with a share of about 76 per cent of the total global output and 90 per cent of the global trade. Favourable weather conditions prevailing in major turmeric growing areas (Andhra Pradesh, Tamil Nadu, Orissa, Karnataka and West Bengal) and the important steps taken by the Turmeric powders Board including educational programmes for growers on improved methods which lead to increase in productivity of turmeric. Besides this, high yielding varieties released over the years had their own contribution.

1.1.4. Production status of Turmeric

Table 3: Area, production and productivity of Turmeric in India

Years	Area (In ' 000 hectare)	Production (In ' 000 MT)	Productivity (In MT/ hectare)
1997-98	139.7	549.2	3.9
1998-99	160.7	598.3	3.7
1999-2000	176.3	646.2	3.7
2000-01	187.4	719.6	3.8
2001-02	163	552.3	3.4
2002-03	149.4	528	3.5
2003-04	153.4	587.1	3.8
2004-05	164.1	751.9	4.6
2005-06	173.7	870.1	5
2006-07	178.5	786.8	4.4
2007-08	175.3	794.4	4.5
2008-09	190.7	877.2	4.6
2009-10	184.4	918.9	5
2010-11	222.9	1237.4	5.6
2011-12	218.7	1166.8	5.3
2012-13	194.2	986.8	5.1
2013-14	232.7	1189.9	5.1
2014-15	184.4	830.4	4.5
2015-16	186	943	5.1
2016-17	222	1132	5

1.1.5. Production and yield of Turmeric in major states in India

Table 4: State-wise share in area and production

State	Area	Percent share	Production	Percent share
Tamil Nadu	29306	15.15	112590	10.71
Telangana	50000	25.85	255000	24.67
Andhra Pradesh	16570	8.57	134122	12.76
Karnataka	14994	7.75	76490	7.28
Gujarat	4100	2.12	65500	6.23
West Bengal	18000	9.31	45500	4.33
Orissa	3233	1.67	35759	3.40
Mizoram	7204	3.73	27816	2.65
Assam	17059	8.82	17025	1.62
Hariyana	1500	0.78	22000	2.09
Others	31429	16.25	259358	24.26
Total	193395	100.00	1051160	100.00

1.1.6. Composition & Nutritive Value of Turmeric

Table 5: Composition of Turmeric (100 g edible portion), fresh weight basis

Principle	Nutrient Value	Percentage of RDA
Energy	354 Kcal	17%
Carbohydrates	64.9 g	50%
Protein	7.83 g	14%
Total Fat	9.88 g	33%
Cholesterol	0 mg	0%
Dietary Fiber	21 g	52.5%
Vitamins		
Folates	39 µg	10%
Niacin	5.140 mg	32%

Pyridoxine	1.80 mg	138%
Riboflavin	0.233 mg	18%
Vitamin A	0 IU	0%
Vitamin C	25.9 mg	43%
Vitamin E	3.10 mg	21%
Vitamin K	13.4 µg	11%
Electrolytes		
Sodium	38 mg	2.5%
Potassium	2525 mg	54%
Minerals		
Calcium	183 mg	18%
Copper	603 µg	67%
Iron	41.42 mg	517%
Magnesium	193 mg	48%
Manganese	7.83 mg	340%
Phosphorus	268 mg	38%
Zinc	4.35 mg	39.5%

Source: USDA National Nutrient Database

1.1.7. Health benefits of Turmeric

1. It is a natural antiseptic and antibacterial agent, useful in disinfecting cuts and burns.
2. When combined with cauliflower, it has shown to prevent prostate cancer and stop the growth of existing prostate cancer.
3. Prevented breast cancer from spreading to the lungs in mice.
4. May prevent melanoma and cause existing melanoma cells to commit suicide.
5. Reduces the risk of childhood leukemia.
6. Is a natural liver detoxifier.
7. May prevent and slow the progression of Alzheimer's disease by removing amyloyd plaque buildup in the brain.
8. May prevent metastases from occurring in many different forms of cancer.
9. It is a potent natural anti-inflammatory that works as well as many anti-inflammatory drugs but without the side effects.
10. Has shown promise in slowing the progression of multiple sclerosis in mice.

11. Is a natural painkiller and cox-2 inhibitor.
12. May aid in fat metabolism and help in weight management.
13. Has long been used in Chinese medicine as a treatment for depression.
14. Because of its anti-inflammatory properties, it is a natural treatment for arthritis and rheumatoid arthritis.
15. Boosts the effects of chemo drug paclitaxel and reduces its side effects.
16. Promising studies are underway on the effects of turmeric on pancreatic cancer.
17. Studies are ongoing in the positive effects of turmeric on multiple myeloma.
18. Has been shown to stop the growth of new blood vessels in tumors.
19. Speeds up wound healing and assist in remodeling of damaged skin.
20. May help in the treatment of psoriasis and other inflammatory skin conditions.

1.1.8. Medicinal properties of Turmeric

Turmeric has long been used to heal many health disorders like liver problems, digestive disorders, treatment for skin diseases and wound healing; it is also used in medicinal field as an anti-inflammatory agent. Curcumin is the active ingredient in turmeric which has been shown to have a wide range of therapeutic effects.

Turmeric is considered as a digestive bitter and a carminative. It is a cholagogue, stimulating bile production in the liver and encouraging excretion of bile via the gallbladder. This improves the body's ability to digest fats. For chronic digestive weakness and/or congestion turmeric is recommended. It can be taken as a single extract or in the form of digestive bitters, which combine turmeric with other bitter and carminative herbs.

Turmeric is beneficial for its influence on the liver.

Scientific research confirm that turmeric can cure host of diseases, also they found that turmeric restrain the growth of various types of cancer. Turmeric is used for the treatment of skin cancer or pre cancerous skin conditions.

Turmeric may helpful in preventing the blockage of arteries that can gradually cause a heart attack or stroke in one of two ways. Turmeric makes cholesterol levels low and inhibited the oxidation of LDL (bad cholesterol). Oxidized LDL deposits in the walls of blood vessels and contributes to the formation of atherosclerotic plaque. Turmeric may also prevent platelet build up along the walls of an injured blood vessel. Platelets collecting at the site of a damaged blood vessel cause blood clots to form and blockage of the artery as well.

Turmeric may help relieve the symptoms of osteoarthritis because of its ability to reduce pain and disability. Turmeric is useful as an external antibiotic in preventing bacterial infection in wounds.

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.

Turmeric decreases congestion and inflammation from stagnant mucous membranes. Turmeric is anti-inflammatory to the mucous membranes, which coat the throat, lungs, stomach and intestines.

Regular use of turmeric can benefit from Colitis, Crohn's disease, diarrhea, and post-giardia or post salmonella conditions. The itching and inflammation that accompanies hemorrhoids and anal fissures can reduce by use of turmeric.

Turmeric can also benefit skin conditions including: eczema, psoriasis and acne, for those it is potent detoxifier.

1.2. Indian Market Outlook

Currently, India is the major producer of turmeric, and it is also the major user of its own production. The increasing global demand for natural products as food additives makes turmeric an ideal candidate as a food colorant, thus increasing demand for it. Additionally, recent medical research demonstrating the anti-cancer and anti-viral activities of turmeric may also increase its demand in Western countries.

Turmeric is an important cash crop that is mostly grown for the anticipated profits it brings, backed by a sentiment. It is considered a good omen crop which despite the high cost of production encourages farmers to cultivate on the smallest patch of land available. However, in recent times the prices have not been encouraging and are well below the heady highs of 2010-11. In recent times concerns have been raised about the decline in acreage and production, though not alarming. Seed material is an important cost and the most vital component in the turmeric cultivation. Traditional crop, as it is, there is lot of diffidence towards adoption of new varieties unless proven. This is also one of the reasons for the continued use of the same seed material over decades.

Primary processing at the farmers' level is becoming cumbersome and adding to the high cost of production, almost 13% of cost of production. Primary processing involving boiling and drying of fresh turmeric also needs interventional support both in terms of technology development and adoption at farmers' end.

1.3. Value added products from turmeric

1.3.1. Primary products

In the world market, only two types of turmeric dominate: 'Madras', and 'Alleppey', both named after the regions of production in India. The orange-yellow flesh Alleppey turmeric is predominantly imported by the United States, where users prefer it as a turmeric powder and a food colorant. Alleppey turmeric contains about 3.5% to 5.5% volatile oils, and 4.0% to 7.0% curcumin. In contrast, the Madras type contains only 2% of volatile oils and 2% of curcumin. The Madras turmeric is preferred by the British and Middle Eastern markets for its more intense, brighter and lighter yellow color, better suited for the mustard paste and curry powder or paste used in oriental dishes. Turmeric produced in the Caribbean, Central and South America has low curcumin and volatile oil contents, and is darker it is not desired by the U.S. importers.

The Bengal type is preferred for use in dyes in India. It is interesting to note that in the United States, turmeric is considered as a turmeric powder by the food industry, whereas it is classified as a food colorant.

a. Dried Rhizome

Turmeric is mostly imported as a whole rhizome, which is then processed into powder or oleoresin by flavour houses and the industrial sector. Rhizomes come as fingers, bulbs and splits. Fingers are the secondary branches from the mother rhizome, the bulb, and splits are the bulbs cut into halves or quarters before curing. The fingers are 2 to 8 cm long and 1 to 2 cm wide, and are easier to grind than the more fibrous bulbs and splits, and therefore command a higher price. Rhizome quality is judged by a clean and smooth skin, uniform skin and flesh colors, and a clean snap (or "metallic twang" as described by the Indian Ministry of Agriculture standards, Agmark) when broken. Turmeric cleanliness specifications for import pertain to whole rhizomes.

b. Turmeric Powder

Ground turmeric is mostly used on the retail market, and by the food processors. Rhizomes are ground to approximately 60-80 mesh particle size. Since curcuminoids, the color constituents of turmeric, deteriorate with light and to a lesser extent, under heat and oxidative conditions, it is important that ground turmeric be packed in a UV protective packaging and appropriately stored. Turmeric powder is a major ingredient in curry powders and pastes. In the food industry, it is mostly used to color and flavour mustard. It is also used in chicken bouillon and soups, sauces, gravies, and dry seasonings. Recently the powder has also been used as a colorant in cereals.

1.3.2. Secondary and derived products

a. Curry powder

Turmeric is such an important ingredient in curry powder that it merits special mention. In its export statistics of turmeric powders, the Indian Turmeric powder Board specifically lists curry powder exports. The turmeric content in curry powder blends ranges from 10-15% to 30%.26 Typical Indian curry powder for meat and fish dishes contains 20-30% turmeric, 22-26% coriander, 12% and 10% cardamom and cumin, respectively, 4% or 10% fenugreek, ginger, cayenne, cloves and fennel in proportions from 1% to 7%. Curry mixes for vegetarian dishes contain less turmeric, in the range of 5 to 10%, because of the bitter flavour it would impart to the dish.

b. Oleoresins

Turmeric extractives, or oleoresins, are obtained by solvent extraction of the powdered or comminutated rhizome. This process yields about 12 % of an orange/red viscous liquid, which, depending on the solvent used for extraction and on the turmeric type and cultivar, contains various proportions of the coloring matter, i.e. the curcuminoids, the volatile oils which impart the flavour to the product, and non-volatile fatty and resinous materials. The compounds of interest in turmeric oleoresin are the curcuminoids (40 to 55%), and the volatile oils (15 to 20%). The curcuminoids, which consist mostly of curcumin (1,7- bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) and also demethoxycurcumin, and bisdemetoxycurcumin, can be further purified to a crystalline material, and will be used preferably in products where the turmeric flavour is undesirable, such as cheese, ice cream, beverages and baked products.

Curcumin has similar color characteristics than the synthetic food colorant tartrazine (FD&C yellow No. 5); however, unlike tartrazine, it is highly sensitive to light and alkaline pH, and is also degraded by heat and chemical oxidants. It is therefore not easy to use in food processes and products destined to long-term storage. It is nevertheless of commercial interest as a natural food colorant, and research is underway to improve its stability. Upon appropriate dilution with a vegetable oil, propylene glycol or polysorbates, the oleoresin gives a bright yellow liquid with the characteristic turmeric aroma, slightly bitter and pungent taste. The oleoresin may also be spray-dried on a sugar matrix such as maltodextrin to a powder, and can be used as a colorant in dry cereals or beverages. The advantage of spray-dried turmeric oleoresin over ground turmeric powder is that it is devoid of starch, the predominant component in dried rhizome, and also proteins and other fibers. Turmeric oleoresin exported from India in 1998 was ranked third, after pepper and paprika oleoresins.

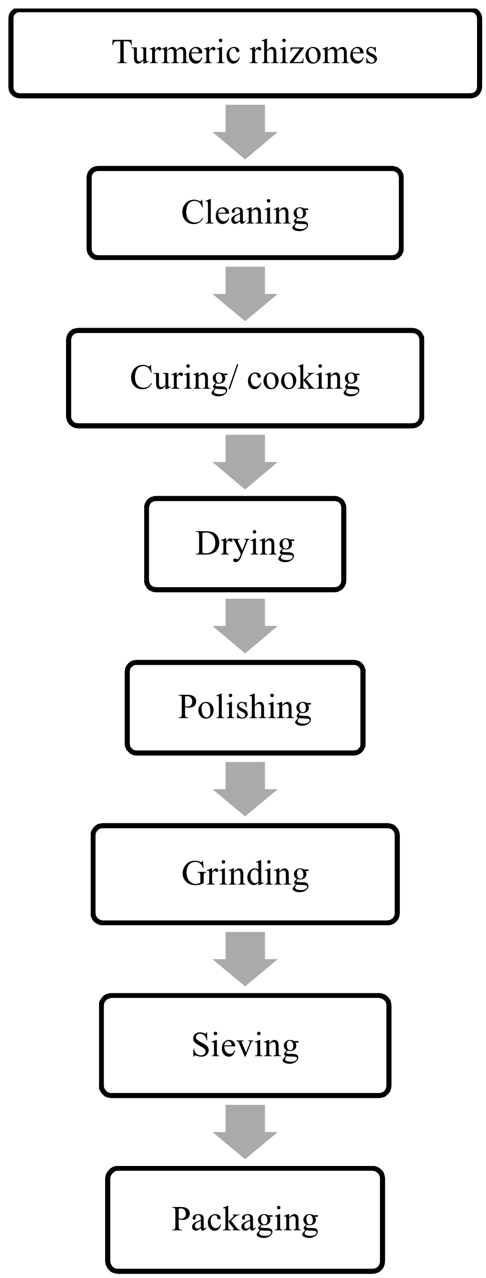
c. **Essential oil**

Turmeric essential oil has little interest in the Western food industry, and it has no commercial value, as opposed to oleoresin. However, there is an increasing literature showing medicinal activities of turmeric, of which some are attributable to compounds present in the volatile fraction. Turmeric essential oil is obtained by distillation, or by supercritical fluid extraction of the powdered rhizome. It is also the product of curcuminoids purification from oleoresins. The latter procedure, which consists in removing the oil with hexane or other lipophilic solvent, tends to alter the oil by loss of higher volatile molecules in the process of solvent evaporation; or, if alcohol is used as the solvent, artifacts are formed by esterification, etherification and acetal formation. The major compounds found in turmeric oil, up to 50-60%, are the sesquiterpene ketones, ß-, and ar-turmerone. The sesquiterpenes zingeberene and ar-curcumene were either not reported, or found at as high as 25% and 35%, respectively. In general, there is a tremendous variation in published compositions of turmeric essential oils, and such variation was also observed in one study, within rhizomes collected from the sub-Himalayan region of the Tarai in India. .

CHAPTER 2

Processing of Turmeric Powder

2.1. Process Flow chart for Production of Turmeric Powder



2.2. Harvesting

Turmeric is harvested when the plants are between 7 and 10 months of age, when the stems and leaves start to dry out and die back. The whole plant is removed from the ground, taking care not to cut or bruise the rhizomes.

2.3. Cleaning and Washing

The leaves are removed from the plant and the roots carefully washed to remove soil. Any leaf scales and long roots are trimmed off. The side (lateral) branches (which are known as the fingers) of the rhizomes are removed from the main central bulb (known as the mother). The mothers and fingers are heaped separately, covered in leaves and left to sweat for one day. The 'mothers' are the preferred material for planting the following year. The separated rhizomes are washed thoroughly with water to remove soil and mud particles.

2.4. Curing

Before drying, the turmeric rhizomes have to be cured. This involves boiling the roots to soften them and remove the raw odour. After curing, the starch is gelatinised, which reduces the drying time required, and the colour is uniformly distributed throughout the rhizome. The specifications for curing turmeric vary from different places. The Indian Institute of Turmeric powder Research and the Agricultural Research Centre recommend boiling in plain water for 45 minutes until froth appears at the surface and the typical turmeric aroma is released. Using this method, the colour will deteriorate if the rhizomes are boiled for too long. However, if not boiled for long enough, the rhizome will be brittle. The optimum stage is reached when the rhizomes are soft to touch or can be pierced by a blunt piece of wood.

Other researchers recommend boiling the rhizomes in an alkaline solution, made from 0.05% to 1.0% sodium carbonate or lime (calcium carbonate). The alkaline water is thought to improve the final colour of the dried turmeric. Since the fingers and bulbs are of different size and thickness to each other, it is important that they are cured in different batches. The curing time is dependent on the age, variety and size and thickness of the rhizomes and varies from one to four or sometimes six hours. It is also affected by the size of the batch – smaller batches generally produce higher quality dried turmeric as the curing process is easier to control and monitor.

It is recommended to use perforated containers with a capacity of 50-75kg. The perforated containers are immersed in the boiling water for the required cooking time. This method allows the boiling water to be used for more than one batch of turmeric. The best time for curing is two to three days after harvest. If it is delayed after this then the rhizomes may start to deteriorate.

The benefits of curing turmeric include the following:

- Reduction of drying time
- More even colour distribution throughout the rhizome
- A more attractive (not wrinkled) product that is easier to polish
- Sterilisation of the rhizomes before drying.

2.5. Drying

The rhizomes are sliced before drying to reduce the drying time and improve the quality of the final product (it is easier to achieve a lower final moisture content in small pieces of rhizome without spoiling the appearance of the product). The rhizomes are traditionally sliced by hand, but there are small machines available to carry out this process. It is a simple structure that contains a transmission system and two stainless steel circular blades. The machine is easy to build and maintain and can cut up to 120kg turmeric per hour.

The cooked fingers or bulbs are dried until they have a final moisture content of 5-10%. An experienced turmeric processor will know when the rhizome is dry enough as the fingers will snap cleanly with a metallic sound. Traditionally the rhizome pieces are laid on clean concrete floors and dried in the sun. This method can take anything from 10 to 15 days, depending on the climate and the size of the rhizome pieces. It is important that the rhizome pieces are not placed in direct sunlight as this will cause the colour to fade.

Using a mechanical drier will result in a better colour and a higher quality product. There are several different types of mechanical drier that are suitable for drying turmeric. These include the tray drier, cross flow air tunnels, solar driers and cabinet driers. The optimum drying temperature is 60°C temperature higher than this result in a darker coloured product.

2.6. Polishing

After drying the rhizomes are polished to remove the rough surface. This can be done by hand or by shaking the rhizomes in a gunny bag filled with stones. Polishing drums are used in many places. These are very simple, power driven drums that have an abrasive metallic mesh lining. In some places the rhizomes are sprinkled with a solution of ground turmeric in water during the final polishing, to give the rhizomes a good colour.

2.7. Grinding

Grinding is one of the most common operations used to prepare turmeric powder for consumption and resale. The main aim of particular spice grinding is to obtain smaller particle sizes, with good product quality in terms of flavour and color. There are different ambient grinding mills and methods available for this process; such as hammer mill, attrition mill and pin mill. In India, traditionally, plate mills and hammer mills are used for turmeric grinding.

CHAPTER 3
Packaging of Turmeric Powder

3.1. Deteriorating factors

In order to select a suitable packaging material/ type of package for turmeric powders, it is essential to know the factors which affect the quality of turmeric powder.

3.1.1. Moisture Content

Turmeric powder is hygroscopic in nature and picks-up moisture from the atmosphere resulting in sogginess and caking/lumping of the powder. Pick-up of moisture also results in loss of free-flowing nature of the turmeric powder

3.1.2. Loss of Aroma / Flavour

Turmeric powder contains volatile oils, which impart the characteristic aroma/flavour to the product. Losses in the volatile oil content or oxidation of some aromatic compounds result in aroma and flavour loss.

3.1.3. Discolouration

Turmeric powders contain natural pigments. Light can affect the pigments resulting in loss or fading of colour and deterioration.

3.1.4. Insect Infestation

Turmeric powder is prone to spoilage due to insect infestation, which can be further accelerated due to high humidity, heat and oxygen.

3.1.5. Microbial Contamination

In high humidity condition of 65% and above, moisture absorption occurs. Beyond a certain level of moisture content, spoilage due to microbial growth sets in.

3.2. Packaging requirements of Turmeric powder

In order to maintain the quality of the turmeric powder during handling, transportation, storage and distribution, the packaging material to be used is to be selected with care, keeping in mind the functional as well as the marketing requirements.

The packaging requirements for turmeric powder, in general, are listed below:

- To protect the product from spillage and spoilage.
- To provide protection against atmospheric factors such as light, heat, humidity and oxygen. The selected packaging materials should have high water vapour and oxygen barriers.
- The packaging material should have a high barrier property to prevent aroma/flavour losses and ingress of external odour.
- The volatile oil present in the spice product has a tendency to react with the inner/ contact layer of the packaging material, at times leading to a greasy and messy package with smudging of the printed matter. The packaging material should therefore be grease and oil resistant and compatible with the product.
- Besides the above functional requirements, the packaging material should have good machinability, printability and it should be easily available and disposable.

3.3. Packaging materials for Turmeric powder

3.3.1. Bulk packaging

In bulk packaging, the current trend is to use Flexible Intermediate Bulk Containers (FIBCs) commonly known as Jumbo bags. These bags have a capacity of up to 1 tonne. In general these bags are made from cloth, but at present mainly from plastic (PP) fabric, which can be laminated or provided with an inner plastic liner bag. The PP fabric is stabilized against UV degradation. The bags are provided with filling and discharge spouts and slings for hanging during loading/ unloading operations.

The FIBCs offer various advantages such as:

- Bags are flexible, collapsible and durable
- Can be used for packaging of granules, powder, flakes and any free flowing material
- Product wastage / spillage and tampering can be avoided
- Since the handling is mechanised, less labour is required

- Saving in time for loading and unloading
- Bags are light in weight and, therefore, freight costs are reduced

3.3.2. Institutional packages

Institutional packs of capacities ranging from 2kg to 10kg are also used. The traditional materials that were used such as tinplate containers and jute bags are currently being replaced by materials such as Laminated flexible pouches and plastic woven sacks. The sacks are usually BOPP multicolor Printed laminated PP Woven bags. These bags may be gussetted and have window and micro perforation.

3.3.3. Consumer Packages

The options available to the traders/exporters of turmeric powder in the selection of a consumer pack for domestic and export market are quite wide. However, the selection/choice of the packaging material/ system depends upon a number of factors, which are broadly listed below:

- Shelf-life period i.e. the degree of protection required by the product against moisture pick-up, aroma retention, discolouration etc. (this is more critical in case of powdered turmeric powder)
- Climatic conditions during storage, transportation and distribution
- Type/ sector of market
- Consumer preferences
- Printability and aesthetic appeal

The package types generally used as consumer packs are:

- Glass bottles of various sizes and shapes with labels and provided with metal or plastic caps. The plastic caps have added inbuilt features of tamper evidence, dispensing, grinding etc.
- Printed tinplate container with/without dispensing systems
- Composite containers with dispensers

- Plastic containers with plugs and caps with dispensing and tamper evidence features
- Printed flexible pouches – pillow pouch, gusseted pouch, stand-up pouch.
- Lined cartons

The printed flexible pouches have recently become very popular due to their easy availability, excellent printability, light weight, machinability and cost-effectiveness. Also, depending upon the functional and marketing requirements, the laminate/film can be tailor made to serve a specific need.

The printed flexible pouches are generally laminates of various compositions. Some of the commonly used laminates are:

- Polyester/metallised polyester/LDPE
- BOPP/LDPE
- BOPP/metallised polyester/LDPE
- Polyester/Al foil/LDPE

3 ply laminates such as 12μ PET/ Print/ 12μ Met. PET/ PE can avoid delamination and prevents smudging and de-figuring of the print.

Polyester and BOPP based laminates are generally more popular for spice packaging due to certain advantageous characteristics of each of these two films.

Polyester used for lamination is generally 10 or 12μthick. The film is highly transparent with excellent clarity, gloss and printability thus enhancing the sales appeal. The film has very low moisture and gas permeability and, therefore, ensures prolonged shelf life of the contents with aroma, flavour and taste retention. The very high mechanical strength (tear, puncture, burst and flex) minimises damage to the contents during handling and transportation. The film has good machinability as well as printability. The latest printing technologies help in improving sales promotions. The film is free from additives and, therefore, does not impart any odour or taint to the sensitive spice product that is packed.

BOPP films may be heat sealable or non heat sealable. The film has high yields, is stable under climatic changes and has excellent moisture barrier. This film is smooth, glossy, crystal clear and has high mechanical strength and non-contamination property for food contact applications.

The following table show the packaging specifications for flexible packs of ground consumer spices, framed by the Indian Institute of Packaging.

Laminates/Co-extruded films (up to 500 grams capacity)	Laminates/Co-extruded films (up to 1000 grams capacity)
12µ PET / 37.5µ LD-HD (30% HD)	12µ PET/50µ LD-HD (30% HD)
12µ MET PET / 37.5µ LD-HD (30% HD)	12µ MET PET / 50µ LD-HD (30% HD)
12µ PET / 50µ PP	12µ PET / 62.5µ PP
12µ MET PET / 50µ PP	12µ MET PET / 62.5µ PP
10µ PET / 9µ Al. foil / 37.5µ LD-HD (30% HD)	10µ PET / 9µ Al. foil / 50µ LD-HD (30% HD)
12µ Al. foil / 37.5µ LD-HD (30% HD)	12µ Al. foil / 50µ LD-HD (30% HD)
25µ BOPP / 37.5µ LD-HD (30% HD)	25µ BOPP / 50µ LD-HD (30% HD)
25µ MET BOPP / 37.5µ LD-HD (30% HD)	25µ MET BOPP / 50µ LD-HD (30% HD)
35µ BOPP / 25µ BOPP	35µ BOPP / 35µ BOPP
30µ LD – 7.5µ Tie - 25µ PA – 7.5µ Tie - 30µ LD-HD (30% HD)	30µ LD – 7.5µ Tie - 30µ PA – 7.5µ Tie - 40µ LD-HD (30% HD)
The LD or LD-HD layer could also be LLD (outer) or LLD-HD (inner or outer) or EAA layer (outer)	The LD or LD-HD layer could also be LLD (outer) or LLD-HD (inner or outer) or EAA layer (outer)

The types of sealing of pouches from flexible plastic based materials could be variable:

- Centre seal formation
- Three sides seal formation

- Four sides seal formation
- Strip pack formation

The vital link in the performance of the pouch is the seal integrity. The performance of the heat seal layer is very important. Even if the film structure has been designed with exceptional properties, with excellence in interlayer lamination, if the sealing of the pouch fails, the product may get contaminated and in some cases become unfit for consumption.

CHAPTER 4
Food Safety Regulations &Standards

According to the FSSAI standards, Turmeric (Haldi) powder means the powder made by grinding dried rhizomes or bulbous roots of Curcuma Longa L. The powder shall have characteristic odor and flavour of Turmeric.

The standards of Turmeric (Haldi) powder:

1.	Moisture	Not more than 10.0 % by weight
2.	Total ash on a dry basis	Not more than 9.0% by weight
3.	Ash insoluble in dil.HCL on a dry basis	Not more than 1.5 % by weight
4.	Colouring powder expressed as curcuminoid content on a dry basis	Not less than 2.0 % by weight
5.	Total starch	Not more than 60.0 percent by weight.
6.	Test for lead chromate	Negative

Turmeric as a whole or Powder shall be free from mustiness or other foreign odors.

The products must be free from mold, living and dead insects, insect fragments, and rodent contamination.

They shall be free from any added coloring matter including Lead Chromate and morphologically extraneous matter including foreign starch.

The bottom line is the standards will guide the food business operators of Turmeric and maintain the quality of Turmeric available in the market.

The Microbial standards for turmeric powder are as follows:

S.No	Parameter	Requirements
1.	Total Plate Count	-
2.	Coliform Count	-
3.	E.Coli	-
4.	Salmonella	Absent in 25gm
5.	Shigella	-
6.	Staphylococus aureus	-
7.	Yeast and Mould Count	-
8.	Anaerobic Spore Count	-
9.	Listeria monocytogenes	-

Manufacturers List of Food Processing Machineries

S.no	Name of the company	Machineries
1.	MMM Buxabhoy& Co 140 Sarang Street 1st Floor, Near Crawford Market Mumbai India Tel: +91 22 2344 2902 Fax: +91 22 2345 2532 yusufs@vsnl.com; mmmb@vsnl.com; yusuf@mmmb.in	Packaging and labelling machines
2.	Acufil Machines S. F. No. 120/2, Kalapatty Post Office Coimbatore - 641 035 Tamil Nadu India Tel: +91 422 2666108/2669909 Fax: +91 422 2666255 Email : acufilmachines@yahoo.co.in	Dryer; Packaging and labelling machines
3.	Bombay Engineering Works, 1 Navyug Industrial Estate 185 Tokersey Jivraj Road Opposite Swan Mill, Sewree (W) Mumbai 400015 India Tel: +91 22 24137094/24135959 Fax: +91 22 24135828	Dryer
4.	Planters Energy network (PEN) No 5, Power House 3rd Street N R T Nagar Theni 625531 Tamil Nadu India Tel: +91 4546 255272 Fax: +91 4546 25527	Dryer
5.	Premium Engineers Pvt Ltd Plot No 2009, Phase IV, GIDC Vatva, Ahmedabad 382445 India Tel: +91 79 25830836 Fax: +91 79 25830965	Dryer; Milling & grinding machinery
6.	Central Institute of Agricultural Engineering Nabi Bagh Berasia Road Bhopal 462 038 Madhya Pradesh India Tel: +91 755 2737191 Fax: +91 755 2734016	Slicing machinery; Cleaning machinery; Milling & grinding machinery

7.	Eastend Engineering Company 173/1 Gopal Lal Thakur Road Calcutta 700 035 India Tel: +91 33 25536937 Fax: +91 33 23355667	Slicing machinery
8.	Gardners Corporation 158 Golf Links New Delhi 110003 India Tel: +91 11 3344287/3363640 Fax: +91 11 3717179	Slicing machinery; Cleaning machinery; Milling & grinding machinery; Packaging and labelling machines
9.	Rajan Universal Exports Post Bag no 250 162 Linghi Chetty Street Chennai 600 001 India Tel: +91 44 25341711/25340731/25340751 Fax: +91 44 25342323	Cleaning machinery; Milling & grinding machinery
10.	Gurdeep Packaging Machines Harichand Mill compound LBS Marg, Vikhroli Mumbai 400 079 India Tel: +91 22 2578 3521/577 5846/579 5982 Fax: +91 22 2577 2846	Packaging and labelling machines

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