



PM Formalisation of Micro Food Processing Enterprises Scheme

Processing of Tomato Powder



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CHAPTER 1

INTRODUCTION

1.1. Status and Market Size

Tomato (*Lycopersicon esculentum*) is grown in our country in abundance; both in summer and winter seasons, but those grown in winter are superior in quality because they contain more total solids. They are a good source of vitamin C. Fresh tomatoes are very refreshing and appetizing but cannot be stored for a long period. It is estimated that a loss of about 25% of the produce occurs due to lack of post-harvest handling operations in India. Under this situation, production, storage/transport of an intermediate product would help in reducing the huge post-harvest losses and would be highly beneficial to the development of processing industry. But, sophisticated technology for bulk storage of tomato pulp, has limited application in Indian, due to higher costs involved. The intermediate products which would help the farmer to get more profit from the crop. Often they are sold at distress prices during the peak harvest season and huge percentage of the produce is spoiled due to mishandling. Such losses can be avoided by converting tomatoes in to delicious products.

Botanically, a tomato is a fruit—a berry, consisting of the ovary, together with its seeds, of a flowering plant. However, the tomato is considered a "culinary vegetable" because it has a much lower sugar content than culinary fruits; it is typically served as part of a salad or main course of a meal, rather than as a dessert. Tomatoes are not the only food source with this ambiguity; bell peppers, cucumbers, green beans, eggplants, avocados, and squashes of all kinds (such as zucchini and pumpkins) are all botanically fruit, yet cooked as vegetables.

1.1.1. Socioeconomic importance

Tomato fits easily into different cropping systems, has high economic value and fruits can be processed, dried, canned and bottled. Moreover, tomatoes contribute to a healthy,

well balanced diet. Tomatoes are rich in potassium, magnesium, phosphorus and small amounts of calcium. Tomatoes contain a lot of vitamin A, vitamin C and vitamin B3. They have small amounts of other B vitamins, and vitamin E. Tomatoes are mostly grown by a large number of small holder farmers with holdings of between 1-3 acres of land. The southern and central states constitute much of India's production including the states of Andhra Pradesh, Telangana, Karnataka and Maharashtra. Tomato production is growing worldwide because consumers demanding a wider range of innovative, value-added products. Tomatoes are an important crop for both the farmer and the consumer in India. It grows in almost every state of the country. Due to increasing standards of living in the cities and the rapid urbanization taking place in the rural areas, consumption of tomato based products is expected to go up steadily. The major institutional customers of tomato paste are restaurants. At present, the market of ketchup/puree, especially in the urban areas, is dominated by brands likes MEGGI and KISSAN. Some medium and small companies are also engaged in its production. However, because of poor post-harvest infrastructure and value addition, a huge quantity of tomato get wasted in the supply chain. Therefore, processing of tomato can not only minimize wastage but also offers huge scope for entrepreneurship development at micro or small scale level through government schemes such as PM-Formalization of Micro Food Processing Enterprises Scheme of MoFPI, Government of India.

1.1.2. Commercially grown varieties

The main varieties of tomato grown in the country are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Arka Alok, Pant Bahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Arka Vardan, Rashmi etc.

1) Vaishali:

This is a determinate hybrid variety of tomato which produces medium sized (100g) quality fruits. The variety is suitable for growing in hot and humid weather conditions. Suitable for tomato juice preparation.

2) Roma:

This is a variety of IARI, New Delhi. Fruits are elliptical in shape with yellow and thick stem end. Suitable for processing.

3) Pusa Ruby:

This is an early maturing variety developed by IARI, New Delhi; derived through selection from the cross Sioux x Improved Meeruthi. Plants are indeterminate (80- 85 cm), spreading and hardy with fewer branches. Fruits are flattish round, small-medium, uniform red, slightly lobed (4-5 locules) and acidic; suitable for processing; suitable for cultivation during autumn, winter and spring summer seasons; gives an average yield of 30 t/ha.

4) Pusa-120:

Plants are semi determinate, spreading, late maturing with dark green foliage. Fruits are flattish round, attractive, medium to large, uniform red, less acidic, less seeded, resistant to nematode and suitable for winter and summer seasons. Average yield is 300- 320 q/ha.

5) Pusa Sheetal:

Plants are determinate, fruit set successfully under low night temperature (up to 80 C) and suitable for early spring season, fruits are flattish round with yellow stem end, smooth, attractive, medium sized, red colour and uniform ripening. Harvesting starts from early march. Average yield is 350 q/ha.

6) Arka Vikas:

Fruits are medium large (80-90g), oblate with light green shoulder, which develop deep red color on ripening. Suitable for fresh market. Adapted to both rain fed and irrigated conditions. Average yield is 350 q/ha.

7) Arka Abha:

Fruits are oblate with light green shoulder. Develops deep red colour on ripening.

Average fruit weight is 75g. Resistant to bacterial wilt caused by *Ralstonia solanacearum*. Suitable for fresh market. Average yield is 430 q/ha.

8) Arka Saurabh:

Fruits are medium large (70-80 g), round with light green shoulder, deep red in colour, firm with nipple tip, Suitable for both fresh market and processing. Average yield is 300-350q/ha.

9) Arka Alok:

Fruits are square round on lower cluster, large in size, firm with green shoulder, resistant to bacterial wilt. Suitable for fresh market. Average yield is 460 q/ha.

10) Kashi Vishesh (DVRT-2):

Plants are determinate, dark green, fruits are red, spherical, medium to large sized. First harvest at 70-75 days after transplanting, Resistant to TLCV. Average yield is 400-450 q/ha.

11) Kashi Sharad:

Plants are indeterminate, leaves are broad, fruits are attractive red, slightly oval, firm with thick pericarp, longer shelf life, and avg. fruit weight is 90-95 g. Average yield is 400-500q/ha.

12) HS-101:

Plants are determinate, multi branched, fruits develop in clusters of 2-3, round, small to medium sized, red at ripening and suitable for winter season cultivation. Average yield is 250-275 q/ha.

13) Pant Bahar:

The plants are bushy and profusely branched. Fruits are flattish round, medium in size

with 5-6 locules, slightly ridged and uniform red at maturity. First picking starts in 75-80 days after transplanting. Average yield is 250 q/ha.

14) Pant T-3:

The fruit weight is about 70 g. Fruits become uniform red at maturity. Suitable for processing. Average yield is 300 q/ha.

15) Pusa Early Dwarf:

It is an early ripening selection from the cross between 'Improved Meeruti' and 'Red Cloud'-a typical dwarf type with medium large fruits of uniform colour. It has been observed to do well in both the seasons, and yields 395 q/ha.

16) Hisar Arun (Sel-7):

It is an early maturing variety developed by CCSHAU, Hisar; derived through modified pedigree method from the cross Pusa Early Dwarf x K-1. Plants are determinate dwarf, erect, with cut leave and synchronized clustered flowers, bear 15-20 fruits. Fruits are round, red, medium size (65-70 g), 4-6 locules with deep red flesh. First picking starts in 60-65 days after transplanting; gives an average of 150q/ha and 287 q/ha early and total yield respectively in 80-85 days of crop duration.

17) Hisar Lalit:

It is a nematode resistant variety developed by CCSHAU, Hisar. It is derived from the cross HS101 x Resistant Bangalore. Plants are determinate and early maturing. Fruits are round and medium to large in size. It is suitable for cultivation in nematode infested areas.

18) Punjab Chhuhara:

The plants are dwarf, bushy, determinate with dense and luxuriant foliage. Its dense foliage protects the fruit from sunburn. The fruits are pear shaped, small to medium sized,

firm fleshy, less seedy and uniformly red at maturity. Yield: 350- 400 q/ha.

19) Marglobe:

Indeterminate in nature, fruits large, round with green stem end, smooth and juicy. It is late in maturity. Yield: 280-300 q/ha.

1.1.3. Cultivation Scenario

Tomato plants are vines, initially decumbent, typically growing 180 cm (6 ft) or more above the ground if supported, although erect bush varieties have been bred, generally 100 cm (3 ft 3 in) tall or shorter. Indeterminate types are "tender" perennials, dying annually in temperate climates (they are originally native to tropical highlands), although they can live up to three years in a greenhouse in some cases. Determinate types are annual in all climate.

Tomato plants are dicots, and grow as a series of branching stems, with a terminal bud at the tip that does the actual growing. When that tip eventually stops growing, whether because of pruning or flowering, lateral buds take over and grow into other, fully functional, vines.

Tomato vines are typically pubescent, meaning covered with fine short hairs. These hairs facilitate the vining process, turning into roots wherever the plant is in contact with the ground and moisture, especially if the vine's connection to its original root has been damaged or severed.

Most tomato plants have compound leaves, and are called regular leaf (RL) plants, but some cultivars have simple leaves known as potato leaf (PL) style because of their resemblance to that particular relative. Of RL plants, there are variations, such as rugose leaves, which are deeply grooved, and variegated, angora leaves, which have additional colors where a genetic mutation causes chlorophyll to be excluded from some portions of the leaves.

The leaves are 10–25 cm (4–10 in) long, odd pinnate, with five to nine leaflets on petioles, each leaflet up to 8 cm (3 in) long, with a serrated margin; both the stem and leaves are densely glandular-hairy

Their flowers, appearing on the apical meristem, have the anthers

fused along the edges, forming a column surrounding the pistil's style. Flowers in domestic cultivars can be self-fertilizing. The flowers are 1–2 cm (1/2–3/4 in) across, yellow, with five pointed lobes on the corolla; they are borne in a cyme of three to 12 together.

Although in culinary terms, tomato is regarded as a vegetable, its fruit is classified botanically as a berry. As a true fruit, it develops from the ovary of the plant after fertilization, its flesh comprising the pericarp walls. The fruit contains hollow spaces full of seeds and moisture, called locular cavities. These vary, among cultivated species, according to type. Some smaller varieties have two cavities, globe-shaped varieties typically have three to five, beefsteak tomatoes have a great number of smaller cavities, while paste tomatoes have very few, very small cavities.

Cultivation and Bearing:-

Tomato plantation is done in well pulverized and leveled soil. Land is ploughed for 4-5 times to bring soil to fine tilth, then planking is done to make soil level. At time of last ploughing well decomposed cow dung and Carbofuron@5kg or Neem cake@8kg per acre should be applied. Transplantation of tomato is done on raised bed of 80-90cm width. To destroy harmful soil borne pathogen, pest and organism, soil solarization is carried out. It can be done by using transparent plastic film as mulch. This sheet absorbs radiation and thus increases soil temperature and kills pathogen.

Solarization for one month before sowing is done. Tomato seeds are sown on raised beds of 80-90 cm width and of convenient length. After sowing, bed covered with mulch and irrigation of bed must be done with Rose-Can daily in morning. To protect crop from virus attack nursery bed is covered with fine nylon net. To make plants healthier and stronger and to harden seedling against transplanting shock, spray of Lihocin@1ml/Ltr water at 20 days after sowing is good. Damping off damages crop to great extent, to prevent crop from it, overcrowding of seedlings is avoided and soil is kept wet. If wilting is observed, drenching of Metalaxyl@2.5gm/Ltr water is done 2-3 times till plants are ready for transplantation. Seedling is ready for transplantation 25 to 30 days after sowing with 3-4 leaves. In case if seedlings age is more than 30 days transplantation must be done after de-topping. Watering of seedling beds is done 24 hours

before transplanting so that seedlings can be easily uprooted and be turgid at transplanting time. To protect crop from bacterial wilt, seedlings are dip in 100 ppm Streptocycline solution for 5 minutes before transplanting.

For northern state, tomato cultivation for spring season is done in late November and transplanted in second fortnight of January. For autumn crop, sowing is done in July – August and transplanted in August - September. In hilly areas sowing is done in March- April and transplantation is done in April -May. Depending upon variety and its growth habit, spacing of 60x30cm or 75x60cm or 75x75cm is good.

Plant starts yielding generally by 70 days after transplantation. Harvesting is done depending upon purpose like for fresh market, long distance transport etc. Mature green tomatoes, 1/4th fruits portion gives pink color are harvested for long distance markets. Almost all fruits turn into pink or red color but having firm flesh are harvested for local markets. For processing and seed extraction purpose, fully ripe fruits with soft flesh are used.

Post-harvest management: -

There are some fruit handling management after harvesting to avoid post-harvest losses. Following are Post-harvesting handling practices:

- Fruits are graded according to their size and color. All the diseased, deformed, bruised and unripe fruits are sorted out.
- Do not leave harvested fruit out in the hot sun;
- Providing shade for fresh tomatoes or other produce after harvest helps to reduce the pulp temperature and extend shelf life.
- There are more simple tools that can be used to harvest horticultural produce with less damage/bruises, like harvesting clippers, hand-held pruners, a picking basket on a long pole, harvesting bags that can be worn during picking, and color charts for visual determination of proper maturity for tomatoes and various other fruits and vegetable crops.

- Use of improved containers and packages for handling harvested produce, like wooden crates and plastic crates can be used to reduce postharvest loss. Adding a liner (such as paper or plant materials) to a rough container can help to reduce abrasion damage.
- Evaporative cooling can be provided with a few simple tools, including a solar-powered fan, a fiber pad (aspen wood fiber, straw or poly-cellulose fiber) and a digital temperature probe or wall thermometer. Air is cooled by pulling or pushing it through a wet pad, and then the cooled air is used to reduce the temperature of the packed produce.
- Zero Energy Cool Chambers (ZECC), this technology is made of materials that are easy to find, like low-cost bricks and sand to make an evaporative cooling chamber and includes 6 medium-sized plastic crates to hold stored fresh produce and a thatched shade cover on wooden poles to protect the ZECC from direct sun and reduce heat gain from solar radiation.

Packaging as a postharvest handling practice in tomato production is essential in putting the produce into sizeable portions for easy handling. However, using unsuitable packaging can cause fruit damage resulting in losses. Some common packaging materials used in most developing countries include wooden crates, cardboard boxes, woven palm baskets, plastic crates, nylon sacks, jute sacks, and polythene bags.

1.1.4. Production status of Tomato

Table 1: Area, production and productivity of Tomato in India

Years	Area (In ' 000 hectare)	Production (In ' 000 MT)	Productivity (In MT/ hectare)
1991-92	289.1	4243.4	14.7
2001-02	458.1	7462.3	16.3
2002-03	478.8	7616.7	15.9
2003-04	502.8	8125.6	16.2
2004-05	505.4	8825.4	17.5
2005-06	546.1	9820.4	18.0

2006-07	596.0	10022.0	16.8
2007-08	566.0	10303.0	18.2
2008-09	599.0	11149.0	18.6
2009-10	634.4	12433.2	19.6
2010-11	865.0	16826.0	19.5
2011-12	907.1	18653.3	20.6
2012-13	879.6	18226.6	20.7
2013-14	882.0	18736.0	21.2
2014-15	767.3	16385.0	21.3
2015-16	773.9	18732.0	24.2
2016-17	808.5	19696.9	24.4

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

Table 2: State-wise share in area and production

State	Production ('000 Tonnes)	Percent share (%)
Andhra Pradesh	3146.96	16.22
Madhya Pradesh	2511.89	12.95
Karnataka	1775.79	9.16
Gujarat	1366.57	7.05
Orissa	1305.31	6.73
West Bengal	1268.12	6.54
Chhattisgarh	1133.09	5.84
Bihar	955.57	4.93
Telangana	901.53	4.65
Tamil Nadu	845.91	4.36
Uttar Pradesh	844.01	4.35

Maharashtra	805.90	4.15
Haryana	650.63	3.35
Himachal Pradesh	502.42	2.59
Assam	417.86	2.15
Jharkhand	270.00	1.39
Punjab	231.45	1.19
Others	463.70	2.38
Total	19396.71	100.00

1.1.6. Composition & Nutritive Value of Tomato

Table 3: Composition of Tomato (100 g edible portion), fresh weight basis

Nutrients	Quantity per 100g
Water	94 g
Energy	18 kCal
Protein	0.88 g
Fat	0.2 g
Carbohydrate	3.89 g
Phosphorous	24 mg
Calcium	10 mg
Magnesium	11 mg
Potassium	237 mg
Vitamin C	13.7 mg
Choline	6.7 mg
Niacin	0.594 mg
Vitamin E	0.54 mg

Tomato fruit is consumed in diverse ways, including raw as an ingredient in many dishes, sauces and in drinks, while it is botanically a fruit and is considered as a vegetable in culinary, carotene, anthocyanin and other natural antioxidants.

- **Anti-oxidant:** Tomatoes contain a lot of vitamins A and C, mostly because of beta-carotene, and these vitamins act as an anti-oxidant, working to neutralize dangerous free radicals in the blood stream.
- **Vitamin A:** Because of all that vitamin A, tomatoes are also an excellent food to help improve your vision. This also means tomatoes can help your eyes be better about night blindness.
- **Calcium:** Tomatoes have a fair amount of vitamin K and calcium, both of which help to strengthen and possibly repair in minor ways bones and bone tissue.

1.1.7. Health benefits of Tomato

Health benefits:

- **Good for the Skin and Hair:** Given the rising levels of pollution, our skin and hair end up bearing a lot of brunt. Incorporating tomatoes in your regular diet actually helps to battle the wear and tear our skin goes through. Tomatoes contain lycopene, which is also used for facial cleansers. And apart from eating them as salad, you can also peel the tomatoes, and use the skin as a mask on your face. It cleanses and refreshes your skin. And the Vitamin A in tomatoes protects your hair from external damages as well.
- **It's Anti-Carcinogenic:** The Lycopene in tomatoes is reported to control the growth of cancer cells, especially prostate, stomach, and colorectal cancer. If you cook tomatoes, the production of lycopene actually increases, so you can curry it as much as you like.
- **Antioxidant power:** Though most of the phytonutrients and vitamins in tomatoes have potent antioxidant properties, lycopene is a standout. In a test tube study published in Archives of Biochemistry and Biophysics, researchers found that lycopene was most effective at deactivating singlet oxygen (a harmful free radical) of all the carotenoids. This could be because lycopene has a unique molecule shape that is highly effective in deactivating free radicals.

- **Strong bones:** Lycopene may promote bone health and help prevent the development of osteoporosis. A study published in the Journal of Bone and Mineral Research found that participants with higher levels of lycopene in their blood were less likely to experience hip or nonvertebral fracture. Furthermore, a study published in Osteoporosis International found that postmenopausal women who added lycopene to their diets for four months saw decreased bone resorption (breakdown of bones).
- **Eyesight:** Tomatoes contain both vitamin A and beta-carotene, which can turn into vitamin A when digested. Vitamin A is known to be necessary for vision. It is required to keep the retina working correctly and for low-light and color vision, according to the Linus Pauling Institute at Oregon State University. It also plays a role in eye development.

1.2 Indian Market Outlook

The tomato based value added products such as puree, paste sauce and ketchup are extensively used in daily consumption pattern both in rural and urban India. Due to increasing standards of living in the cities and the rapid urbanization taking place in the rural areas, consumption of tomato based products is expected to go up steadily. A large part of the world tomato crop is processed into tomato paste/puree, which is subsequently used as an ingredient in many food products, mainly soups, sauces and ketchup. India has been exporting processed tomato in the form of tomato paste and ketchup. Tomato sauce is being used with snacks like rolls, cutlets, samosas, chops, soup, chowmin and other continental as well as chinese dishes. Bright mixture made from tomato is used as important items with all modern food/snacks. The only ketchup and sauce market in India is pegged at Rs 1,000 crore and growing at around 20% year-on-year. Therefore, there is a big market for the processed tomato products. Tomato products are one of the chief ingredients in ready-to-eat or fast food products. The major institutional customers of tomato paste are restaurants. At present, the market of ketchup/puree, especially in the urban areas, is dominated by brands likes MEGGI and KISSAN. However, the existing market can still accommodate micro or small scale

units on their own or under other's brand.

Across the globe, tomatoes are measured as an important agricultural crop and an essential part of the human diet. Although tomatoes are freshly consumed, 80% of total tomato consumption comes from products such as powder, sauces, juice, and ketchup. Tomato powder is produced by dehydrating natural tomato to create a fine powder of tomato. Tomato powder is the most proficient way of storing the dehydrated tomatoes. Tomato powder is an amazing replacement of tomato juice; tomato sauce and tomato paste and add flavors to dishes. Owing to its property of rich flavoring characteristic tomato powder has vast applications in the food & beverage industry. Rising demand for healthy and natural ingredients in the food industry has resulted in products such as tomato powder, which amplifies a high level of vitamins A, C and K, increase in demand as an ingredient in packaged food products.

With an increasing number of teenagers and youngsters who have high spending power along with raising the working population especially women, the demand for fast food products is propelling worldwide. Tomato powder is one of the most important ingredients in fast food products. Tomato powder usage is increasing in these products as a tastemaker and flavoring ingredient. Change in the food consumption pattern in the last one decade has resulted in the increased per capita intake of fast foods which include pizza, sandwiches, burgers, hotdogs and others. In all classes of food products, tomato powder is being used as a key ingredient for enhancing flavor. Rising demand for non-GMO products is further increasing demand for tomato powder market. Key manufacturer such as Harmony house foods is offering non-GMO tomato powder, which fulfills the consumer demand for non-modified ingredients. However, FDA regulation does not intend the use of tomato fruit powder in infant formula under the jurisdiction of USDA in its notice GRN No.748. This might restrict the growth of the tomato powder market.

Tomato is considered one of the nutrient-rich foods with the most edible ingredient in the world. According to FAOSTAT, tomato is 4th most popular grown vegetable. China and India are among the top ten producers of the tomato. Many key players in the market of tomato powder exist in the Asia-Pacific. Tomato powder gets longer shelf life due to dehydration processes much further generates an immense opportunity for its usage in preserved food products. Tomato powder reveals numerous features which enable its use as flavoring, coloring, aromatic ingredient. The rising

trend of organic product consumption in the food industry is providing a new prospect for market players to strengthen their product offerings by adding organic tomato powder in their product line.

1.3 Value added products from tomato

Tomato production is a growing worldwide as consumers demanding a wider range of innovative, value-added products. Some of the Tomato Value Added Products of tomatoes are Tomato Puree, Tomato Juice, Mixtures of Vegetable Juice, Tomato Ketchup, Tomato Jam, Tomato Powder, Tomato Sauce, Tomato Pickle, Tomato Chutney, Tomato Ketchup, Tomato Soup, Tomato Paste etc.

This results in high demand on mixing technology for production and processing. Tomato processing industry is huge. A large part of the world tomato crop is processed into tomato paste/puree, which is subsequently used as an ingredient in many food products, mainly soups, sauces and ketchup. India has been exporting processed tomato in the form of tomato paste and ketchup. Tomato sauce is being used with snacks like rolls, cutlets, samosas, chops, soup, chowmin and other continental as well as chinese dishes. Bright mixture made from tomato is used as important items with all modern food/snacks. The only ketchup and sauce market in India is pegged at Rs 1,000 crore and growing at around 20% year-on-year. There is a big market for the processed tomato products. Tomato products are one of the chief ingredients in ready-to-eat or fast food products.

Sun-drying is an ancient method used in Indian households to dry fruits and vegetables. The removal of moisture from any substance is called dehydration. If the moisture in fruits and vegetables is reduced to a certain level by drying method, the shelf life can be increased. It is found to be one of the ways to provide antioxidant product at low price to the community. Hence, tomato was dried and developed the various products using dried tomato and dried peel.

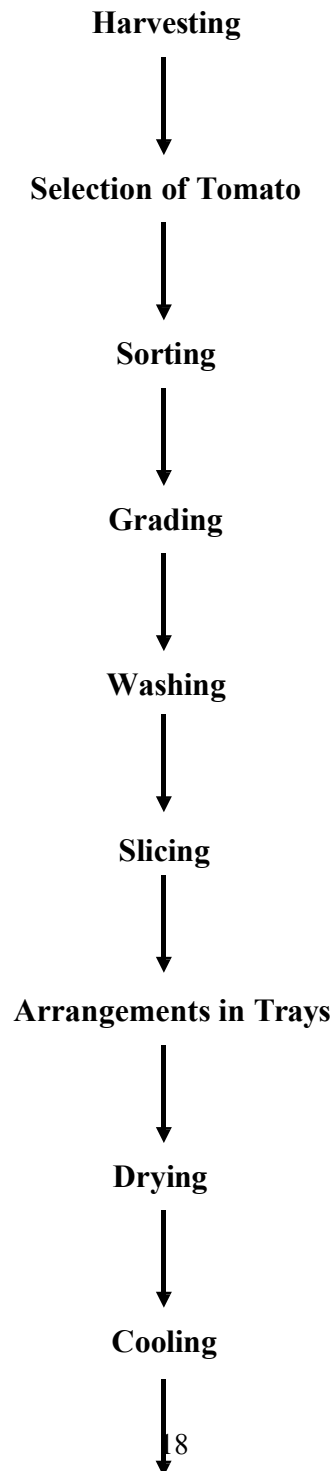
Drying of tomato: The variety of tomato selected for the powdering was country tomato (Namdhaari) which is available in the selected area. Tomato was washed well, deseeded and dried in the sunlight. The dried tomatoes were powdered. Tomato products were developed and standardized using the dried tomato powder. Products like sago tomato

vadagam, rice tomato vadagam and tomato ribbon chips were developed using the tomato powder.

CHAPTER 2

Processing of Tomato Powder

2.1. Process Flow chart for Production of Tomato Powder



Pulverizing



Packaging



Sealing

2.2. Selection of Tomato

Mature tomato with bright color and characteristic flavor are selected. The variety and maturity of fruit influence the flavor and keeping quality of its powder. The fruits are plucked when they mature turns green to yellow-red. All Tomatoes soften extremely quickly, making them vulnerable to bruising and subsequent rotting. So gently pick the ripened fruits from the tree. The fruits should be harvested in the morning hours.

2.3. Sorting

Sorting is the process of grouping according to size, shape, color and weight. Sorting covers two main separate processing operations:

- a. Removal of damaged fruit and any foreign bodies (which might have been left behind after washing).
- b. Qualitative sorting based on organoleptic criteria and maturity stage. Mechanical sorting for size is usually not done at the preliminary stage. The most important initial sorting is for variety and maturity.

Clean and bright colored tomatoes should be preferred. Ruptured or bruised skin with bacterial or fungal infected tomatoes are not recommended.

After sorting, Tomato fruits should be graded into four grades.

Super A, Super, Fancy and Commercial.

2.4. Washing

Washing and sanitizing the fruits is required to remove the pesticide residues, plant debris and other possible contamination as well as microorganisms responsible for quality loss and decay. Generally immersed in tap water whereas sanitizing agents are added to process water to effectively reduce the microbial loads on the fruit surface. Tomatoes are seldom washed. Washing with water must be accompanied with brushing, rubbing, and forcing the water against the fruit and into crevices. Detergents are frequently used in the wash or rinse water. Dirt and microorganisms are removed by washing with Sodium hypochlorite water. Rinsed with Sodium bicarbonate (2%) solution and again rinsed with water in fruit washing tank. Fluming in cold water reduces contact with the air and reduces bruising of soft fruit and is a retardant to oxidation if an antioxidant is used.

2.5. Slicing

The tomatoes 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 slices of tomato without spoiling the appearance of the product). The tomatoes 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 120 kg tomatoes per hour.

Slicing of Tomatoes can be done manually or mechanically. In manual process, it should be done with hands using a serrated knife. Mechanically, it can be done using a

Vegetable slicer machine.

2.6. Drying

Tradition Drying Method: Sun Drying

Drying of tomatoes takes place by utilizing the heat energy radiated by sun. The sliced tomatoes are spread on any available space and allowed under sun until it is completely dried.

The sliced tomatoes are dried until they have a final moisture content of not more than 6 %. Traditionally the sliced tomatoes 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 thickness of tomato slices. It is important that the tomato slices are not placed in direct sunlight as this will cause the color to fade.

Using a mechanical drier will result in a better color and a higher quality product. There are several different types of mechanical drier that are suitable for drying tomato. These include the tray drier, cross flow air tunnels, solar driers, cabinet driers and osmotic drying methods.

2.7. Pulverizing

Pulverizing is also known as grinding / milling. The main aim is to obtain smaller particle size with good product quality in terms of flavor and color. Different grinding methods are available for this process such as hammer mill, attrition mill, pin mill and plate mill. Two to three rounds of proper grinding will give fine powders. Dried fruits and their application in powder form have gained interest in the food industry. Drying and grinding conditions during powder processing greatly influence the quality attributes of biological materials. It implies not only nutritional changes but also physical, textural, sensorial and functional changes.

2.8. Packaging

The tomato powder can be packed using the form fill sealer in plastic or foil bags. It can also be packed in tins and glass containers.

CHAPTER 3

Packaging of Tomato Powder

3.1. Deteriorating factors

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

3.1.1. Moisture Content

Tomato 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 tomato powder

3.1.2. Loss of Aroma / Flavor

Tomato powder contains volatile aroma/flavors, which impart the characteristic aroma/flavor to the product. Losses in the volatile flavor content or oxidation of some aromatic compounds result in aroma and flavor loss.

3.1.3. Discoloration

Tomato powders contain natural pigments named as Lycopene. Light can affect the pigments resulting in loss or fading of color and deterioration.

3.1.4. Insect Infestation

Tomato 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 Tomato powder

3.2.1 Packaging

Packaging ensures safe delivery of the product to the ultimate consumer in good condition at minimal overall cost. Packaging can be defined as a method to protect and contain foods with the aim of minimizing the environmental impact of our consumption.

In order to maintain the quality of the tomato 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.

3.2.2 Functions of packaging

It is important to understand the functions of Tomato Powder packaging to effectively select, design, and utilize noodle packaging systems. The functions of noodle packaging can generally be described as:

1. Promoting and Selling the Product
2. Defining Product Identity
3. Providing Information
4. Expressing Customer Needs
5. Ensure Safe Use
6. Protecting the Product

3.2.3 Components of Tomato Powder packaging

Like most food packages, tomato powder packaging is usually composed of three components:

A primary package is defined as a package that is directly in contact with the

tomato Powder product. It is mainly used to form a sealed microenvironment to protect and isolate the tomato Powder content from an unwanted environment (e.g., high humidity, oxygen, microbial) and other contamination from dust and undesired human contact.

Secondary package is the package that contains one or more primary packages. A secondary package can also be used to provide convenience in handling.

A tertiary package incorporates the secondary package in the final shipping and distribution. The purpose is to consolidate secondary packages and to assist in storage and handling and to provide an additional layer of protection. Examples are corrugated boxes, pallets, and stretch plastic films.



3.2.4 Requirements for effective food packaging

The packaging requirements for tomato 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 vapor and oxygen barriers.

- The packaging material should have a high barrier property to prevent aroma/flavor losses and ingress of external odor.
- 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.
- Be nontoxic
- Protect against contamination from microorganisms
- Act as a barrier to moisture loss or gain and oxygen ingress
- Protect against ingress of odors or environmental toxicants
- Filter out harmful UV light
- Provide resistance to physical damage
- Be transparent - be tamper – resistant or tamper – evident
- Be easy to open
- Have dispensing and resealing features
- Be disposed of easily
- Meet size, shape and weight requirements
- Have appearance, printability features
- Be low cost
- Be compatible with food
- Have special features such as utilizing groups of product together.

3.3. Packaging materials for Tomato powder

3.3.1. Bulk packaging

Bulk packing is the process or act of placing larger quantities of similar items into a larger single box/container to aid in the movement of product, create less refuse, and to prevent damage or pilferage to the smaller cartons or boxes. The jute bags may be provided with a loose liner bag of polyethylene or may be without a liner. The double gunny bag is provided with an inner polyethylene liner.

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 mechanized, less labor 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 packaging means the institutional consumer like transportation, Airways, Railways, Hotels, Hospitals or any other service institutions who buy packaged commodities directly from the manufacturer for use by that institution

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 gusseted and have window and micro perforation.

3.3.3. Consumer Packages

The options available to the traders/exporters of tomato 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, discoloration etc. (this is more critical in case of powdered tomato 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/metallized polyester/LDPE
- BOPP/LDPE
- BOPP/metallized polyester/LDPE
- Polyester/Al foil/LDPE

3 ply laminates such as 12 μ PET/ Print/ 12 μ 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 12 μ thick. 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, flavor and taste retention. The very high mechanical strength (tear, puncture, burst and flex) minimizes 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 odor 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 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

4.1 FSSAI

FSSAI stands for Food Safety and Standards Authority of India which is an organization that monitors and governs the food business in India. It is an autonomous body which is established under the Ministry of Health & Family Welfare, Government of India. The FSSAI has been established under the Food Safety and Standards Act, 2006 (FSS Act) which is a consolidating statute related to food safety and regulation in India.

Functions of FSSAI

1. Framing of regulations to lay down food safety standards
2. Laying down guidelines for accreditation of laboratories for food testing
3. Providing scientific advice and technical support to the Central Government
4. Contributing to the development of international technical standards in food
5. Collecting and collating data regarding food consumption, contamination, emerging risks etc.
6. Disseminating information and promoting awareness about food safety and nutrition in India

According to the FSSAI standards mentioned under regulations section 4.2.2.2 DEHYDRATED FRUITS AND VEGETABLES, Products in which the natural water content has been reduced below that critical for growth of microorganisms without affecting the important nutrients. The product may or may not be intended for rehydration prior to consumption. Includes vegetable powders that are obtained from drying the juice, such as tomato powder and beet powder etc. such as dried potato flakes, dehydrated carrots or peas or cabbage or mushroom or spinach leaf or lentil etc.

As Food Safety and Standards (Food Products standards and Food Additives) Regulations, 2011 dehydrated vegetables are given, regulations as per following:

2.3.36.1 Dehydrated Vegetables means the product, prepared from edible portions of suitable variety of sound vegetable, free from insect or fungal infection, free from blemishes, suitably prepared, from which moisture has been removed under controlled conditions of temperature, humidity & airflow, to the extent that the product is preserved.

2.3.36.2 It may be whole, sliced, quarters, pieces, flakes, kibbled granules or powdered. The finished product shall have uniform color and shall be free from discoloration due to scorching or enzymatic reaction. It shall be free from stalks, peels, stems and extraneous matter. When in powder form, it shall be free flowing and free from agglomerates.

2.3.36.3 The product may contain food additives permitted in these regulations including Appendix A. The product shall conform to the microbiological requirements given in Appendix B.

The standards of Tomato powder:

1.	Moisture	Not more than 5.0 % by weight
2.	Total ash on a dry basis	Not more than 5.0% by weight
3.	Ash insoluble in dil.HCL on a dry basis	Not more than 0.5 % by weight
4.	Peroxide Test	Negative

Preservatives permitted in Tomato Powder:

1.	Sulphur dioxide	Not more than 2000 ppm
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Food additives permitted in Tomato powder:

S.No	Name of Additives	Not more than (ppm)
1.	Ascorbyl esters	80
2.	Benzoates	1000
3.	BHA	200
4.	BHT	200
5.	Canthaxanthin	10
6.	EDTA	800
7.	Phosphates	5000
8.	Propyl gallate	50
9.	Sulfites	500

The Microbial standards for tomato powder are as follows:

S.No	Parameter	Limits
1.	Aerobic plate count	Not more than 4×10^4 / g
2.	Yeast and mold	Not more than 100/ g
3.	Enterobacteriaceae	Not more than 100/ g
4.	Staph.aureus	Not more than 100/ g

4.2 Labelling Standards

Labeling requirements for packaged food products as laid down in the Part VII of the Prevention of Food Adulteration (PFA) Rules, 1955, and the Standards of Weights

and Measures (Packaged Commodities) Rules of 1977, require that the labels contain the following information:

1. Name, trade name or description
2. Name of ingredients used in the product in descending order of their composition by weight or volume
3. Name and complete address of manufacturer/packer, importer, country of origin of the imported food (if the food article is manufactured outside India, but packed in India)
4. Nutritional Information
5. Information Relating to Food Additives, Colors and Flavors
6. Instructions for Use
7. Veg or Non-Veg Symbol
8. Net weight, number or volume of contents
9. Distinctive batch, lot or code number
10. Month and year of manufacture and packaging
11. Month and year by which the product is best consumed
12. Maximum retail price

Wherever applicable, the product label also must contain the following:

The purpose of irradiation and license number in case of irradiated food. Extraneous addition of coloring material. Non-vegetarian food – any food which contains whole or part of any animal including birds, fresh water or marine animals, eggs or product of any animal origin as an ingredient, not including milk or milk products – must have a symbol of a brown color- filled circle inside a brown square outline prominently displayed on the package, contrasting against the background on the display label in close proximity to the name or brand name of the food.

Vegetarian food must have a similar symbol of green color-filled circle inside a square with a green outline prominently displayed.

All declarations may be: Printed in English or Hindi on a label securely affixed to the

package, or Made on an additional wrapper containing the imported package, or Printed on the package itself, or May be made on a card or tape affixed firmly to the package and bearing the required information prior to customs clearance.

Exporters should review the Chapter 2 of the “FSS (Packaging and Labeling) Regulation 2011” and the Compendium of Food Safety and Standards (Packaging and Labeling) Regulation before designing labels for products to be exported to India.

According to the FSS Packaging and Labeling Regulation 2011, “prepackaged” or “pre packed food” including multi-piece packages, should carry mandatory information on the label.

4.3 Sanitary and Hygiene Requirements for Food manufacturer/Processor/Handler

The place where food is manufactured, processed or handled shall comply with the following requirements:

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain overall hygienic environment. All new units shall set up away from environmentally polluted areas.
2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain overall hygienic environment.
3. The premises shall be clean, adequately lighted and ventilated and sufficient free space for movement.
4. Floors, Ceilings and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.
5. The floor and skirted walls shall be washed as per requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors and other openings shall be fitted with net or screen, as appropriate to make the premise insect free The water used in the manufacturing shall be potable and if required chemical and bacteriological examination of the water shall be done at regular intervals at any

recognized laboratory.

6. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement for water used in food or washing shall be made.
7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.
8. No vessel, container or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing or storage of food. (Copper or brass vessels shall have proper lining).
9. All equipment's shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.
10. All equipment's shall be placed well away from the walls to allow proper inspection.
11. There should be efficient drainage system and there shall be adequate provisions for disposal of refuse.
12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.
13. Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all time and the person should not be allowed to come in direct contact with food.
14. All food handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work and every time after using toilet. Scratching of body parts, hair shall be avoided during food handling processes.
15. All food handlers should avoid wearing, false nails or other items or loose jewellery that might fall into food and also avoid touching their face or hair.
16. Eating, chewing, smoking, spitting and nose blowing shall be prohibited within the premises especially while handling food.
17. All articles that are stored or are intended for sale shall be fit for consumption and have proper cover to avoid contamination.
18. The vehicles used to transport foods must be maintained in good repair and kept

clean.

19. Foods while in transport in packaged form or in containers shall maintain the required temperature.

20. Insecticides / disinfectants shall be kept and stored separately and `away from food manufacturing / storing/ handling areas.

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; mmmmb@vsnl.com; yusuf@mmmb.in	Packaging and labelling machines
2.	Acufil Machines S. F. No. 120/2, Kalapatty PostOffice 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) Mumbai400015 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



Contact Us

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