

## Value Addition in Tomato (*Solanum lycopersicum* L.)

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### ABSTRACT

The tomato is a significant source of lycopene and the second-largest vegetable crop in the world after potatoes. The tomato is a member of the Solanaceae family, which has more than 3,000 various species. The *Solanum lycopersicum*, the only domesticated species, and the other 12 wild species make up the section of the *Lycopersicon* genus *Solanum* 13 species or subspecies (such as *S. chmielewskii*, *S. habrochaites*, *S. pennellii*, and *S. pimpinellifolium*). In 2016, 133,986,461.00 MT of tomatoes were produced in the world. In 2021-22, India produced 16,089.32 tonnes. Madhya Pradesh is the largest state tomato producer with a production of 2,970 tonnes and a 14.63% market share. They have an abundance of antioxidants with anti-carcinogenic properties. Moreover helps to prevent diabetes, skin issues, and urinary tract infections, and it also improves digestion and vision. Tomatoes contain potassium, and high potassium levels in the blood can weaken kidney functions, and may also cause acid reflux due to their acidic nature. Tomatoes may be stored at ambient temperature for 10-12 days. Tomatoes are the most consumed vegetables in the world, both fresh and processed, primarily as tomato puree, tomato paste, tomato ketchup, tomato soup and juice. Lycopene is one of the most chemicals in tomatoes, in 100 grams of an average tomato containing as much as 3-5 mg. Vitamin C is rich in tomatoes, constituting up to 40% of the recommended daily allowance.

**Keywords:** Tomato, anti-carcinogenic, *Solanum lycopersicum*, lycopene, tomato puree, antioxidant.

### INTRODUCTION

The tomato, or *Solanum lycopersicum*, is one of the most significant vegetables in the world. The tomato is the second-largest vegetable crop in the world after potatoes and a

significant source of lycopene. The Solanaceae family, which has more than 3,000 species, is where the tomato comes from. The fruits of the tomato plant are a significant food source for the whole world's population.

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It is one of the primary sources of minerals, vitamins, and antioxidants due to its widespread use throughout the year (Nour et al., 2015). The wild tomato, *Solanum lycopersicum*, is native from the coastal plain to the foothills of the Andes of South America, centred in Peru and extending north to central Ecuador and South to northern Chile (Peralta et al., 2005), growing between sea level and 3300 meters above sea level (Blanca et al., 2012) in diverse climatic conditions. Indigenous peoples later distributed it into what are now Mexico, Colombia, Bolivia and other South American countries (Rick & Holle et al., 1990).

Tomates (in Spain and France), tomato (in Indonesia), faanke'es (in China), Tomatis (in West Africa), tomatoes (in Nahuatl), automate (in Mexico) and Pomodoro (in Italy) are some of the common names for tomatoes. Tomatoes are a part of a balanced, healthy diet. They are abundant in dietary fibre, carbohydrates, vital amino acids, minerals, and vitamins. Iron, phosphorus, and vitamin B and C are all abundant in tomatoes (Naika et al., 2005). Its high consumption all year round makes it one of the main sources of minerals, vitamins and antioxidants (Adalid et al., 2010). Fresh tomato fruits are used in salads, and cooked tomatoes are used in sauces, soups,

and dishes with meat or fish. They can be processed into juices, sauces, and purees. Tomatoes in cans and in dried form are processed goods with significant commercial value (Naika et al., 2005). Regular tomato and tomato-related product consumption has been linked to a lower risk of developing different cancers and cardiovascular diseases (Borguini & Da Silva Torres et al., 2009).

### MORPHOLOGY

Botanically, Tomato is a fruit, and among fruits, a berry since it is indehiscent (non-shedding), pulpy, and contains one or more seeds that are not stones (Salunkhe et al., 1974). Even though there are biennial and perennial varieties of the tomato, which is a perennial herbaceous plant, it is often grown as an annual crop. These are cultivated in tropical and temperate climates. From germination to flowering stage, it takes roughly 45 days in a warm area with sufficient light for growth, and it takes 90 to 100 days to reach the point at which the fruit is beginning to mature (Nuez, 2001). The plant can develop in a variety of ways, from indeterminate to determinate, and can grow as tall as 3 metres. The angular stem is coated in hairy and glandular trichomes that give it a characteristic smell. All leaves are covered by glandular, hairy trichomes (OECD, 2018).



Figure 1: Tomato Plant



Figure 2: Tomato Leaves

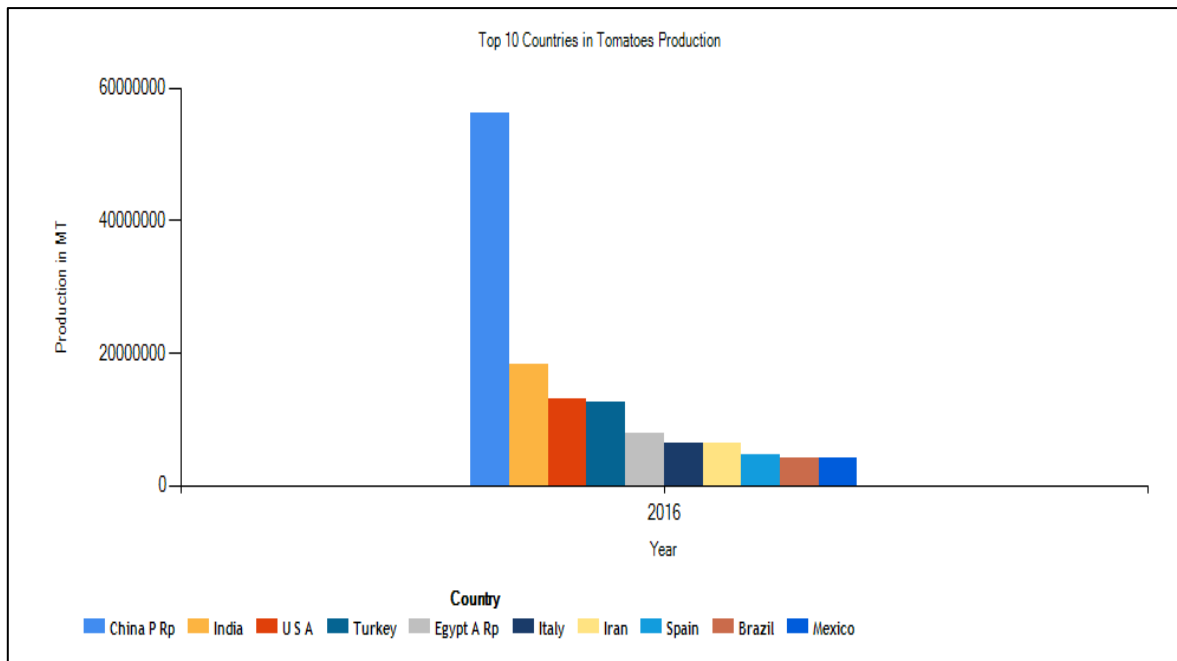


Figure 3: Tomato fruit

**PRODUCTION AND PRODUCTIVITY**

In 2016, the world produced 133,986,461.00 MT tomatoes. China is the first largest producer of tomatoes in the world with 56,308,954.00 MT and shares 31.85%. India is

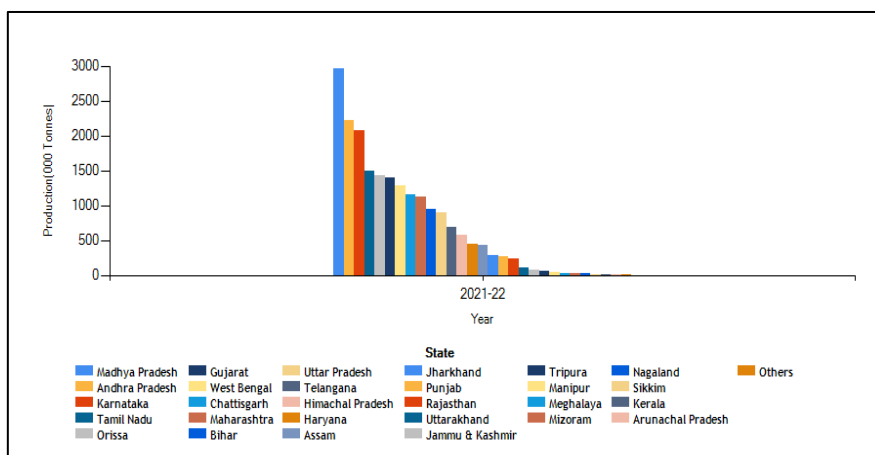
the second largest producer of tomatoes in the world with 18,399,000.00 MT and shares 10.41%. Brazil is the third largest producer of tomato and produces 13,038,410.00 MT and shares 7.37%.



**Figure 4: Graph representing the Production of Tomatoes in 2016**  
(Source: Food & Agricultural Organization (FAO))

In 2021-22, India produced 16,089.32 tonnes. Madhya Pradesh is the largest state producer of tomatoes and produces 2,970 tonnes with a 14.63 % share. Chhattisgarh produces 1,149 tonnes with a 5.66 % share. The major tomato-producing states in the country are Madhya

Pradesh, Andhra Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Maharashtra, Chhattisgarh, Bihar, Telangana, Uttar Pradesh, Haryana and Tamil Nadu. These states account for 91% of the total production of the country.



**Figure 5: Indian Production of Tomato in 2021-22**  
(Source: National Horticulture Board (NHB))

According to data from FAOSTAT, the world produced 186.821 million metric tonnes of tomatoes on 5,051,983 hectares in 2020, achieving an average yield of 37.1 metric tonnes/hectare (mT/ha).

### EXPORT

In 2021–2022, India exported 89,631.40 MT of tomatoes worldwide for a total of Rs. 20,877.99 lacs. India exported 45,49.27 MT of tomatoes to Bangladesh worth Rs. 12,853.12 lacs and 31,949.11 MT of tomatoes to Nepal worth Rs. 3,423.46 lacs in 2021-22.

Source: DGCIS Annual Export

### IMPORT

India imports 10,779.59 MT of tomatoes from all over the world. China exports 6,209 MT of tomatoes to India.

Source: UN Comtrade

### NUTRITIONAL PARAMETERS

The tomato fruit is a fleshy berry that exists in many shapes and colours. The fruit contains more than 90% of water, very little fat or protein, and around 3% of carbohydrates (glucose and fructose) (Collins et al., 2022).

The ripening of red tomato fruits is one of the primary factors influencing the amount of lycopene in tomatoes. Higher levels of lycopene are seen in riper red fruit. Other variables that may affect lycopene content include the time of harvest and the availability of water during the tomato's growth (Dūma, 2022).

On average, tomatoes are composed of macronutrients and micronutrients, with an emphasis on insoluble (cellulose) and soluble (pectin) fibers, as well as organic acids (citric, malic, and ascorbic), sugars, B vitamins, minerals (Ca, K, Mg, and P), and carotenoids (Castro et al., 2021).

**Table 1: Nutritional Parameters of Tomato**

S. No.	Parameters	Values
1.	Energy (kcal/100g)	34.67 ± 18.74
2.	Total protein (g/100g)	17.71 ± 5.40
3.	Lipid (g/100g)	4.96 ± 1.19
4.	Carbohydrates (g/100g)	5.96 ± 1.37
5.	Total Sugar (g/100g)	50.60 ± 3.69
6.	pH	3.83 ± 0.21
7.	Acidity (%)	0.48 ± 0.07
8.	Reducing Sugar (%)	35.84 ± 4.57
9.	Glucose (%)	2.45 ± 0.48
10.	Fructose (%)	2.88 ± 0.49
11.	Sucrose (%)	0.02 ± 0.05
12.	Total Fiber (g/100g)	11.44 ± 9.31
13.	Moisture (g/100g)	91.18 ± 6.83
14.	Ash (%)	8.75 ± 1.69

(Ali et al., 2021)

### Carbohydrates:

A medium tomato has less than 5 grams of carbohydrates, or 4% of the total calories in raw tomatoes (123 grams). Nearly 70% of the carbohydrate content is made up of simple sugars like glucose and fructose (AddaBjarnadottir, 2019).

### Fiber:

An average-sized tomato has 1.5 g of fibre, making tomatoes a healthy source of this nutrient.

Insoluble fibres such as hemicellulose, cellulose, and lignin make up the majority of the tomato's fibres (87%) (AddaBjarnadottir, 2019).

### Vitamins and Minerals:

Tomatoes are a good source of a number of vitamins and minerals:

- a. **Vitamin C**- This vitamin functions as both antioxidant and a necessary nutrient. About 28% of the Reference Daily Intake

(RDI) can be obtained from one medium-sized tomato.

- b. **Vitamin K**- Vitamin K plays an important role in helping blood clotting and bone health. Scientific name is phyloquinone.
- c. **Vitamin B9 (Folate)**- Folate is essential during times of rapid growth, such as during pregnancy and fetal development, as it is needed to form healthy red blood cells.
- d. **Calcium**- A significant amount of calcium can be found in tomatoes, which supports bone health and may even help with minor bone and bone tissue repairs.
- e. **Potassium**- Potassium is a key mineral that lowers blood pressure and prevents heart disease (Adda Bjarnadottir, 2019).

## RECOMMENDED DIETARY ALLOWANCE

Tomatoes contain large amounts of vitamin C, providing 40 per cent of the daily value (DV). Additionally, they have 15 per cent of the Daily Value (DV) for vitamin A, 8 per cent of the DV for potassium, and 7 per cent of the recommended dietary allowance (RDA) for iron for women and 10 per cent RDA for males (Bhowmik et al., 2012).

Tomato juice is an excellent source of ascorbic acid (vitamin C) and a good source of vitamin A as carotene. Eight ounces of food may provide 35 milligrams of ascorbic acid, which is more than half of the National Research Council's recommended daily requirement (RDA) for adults of 60 milligrams and more than 85% of the RDA for children of 40 milligrams (Gerald et al., 1972).

## MEDICINAL IMPORTANCE

Tomato juice, extract, and various tomato plant parts have traditionally been used to treat various health-related issues orally, externally, and directly in several countries (Jafer Dawid, 2016). Tomatoes are known to contain nutritional fibre that relates to diet. In addition to being essential for duodenal health, the fibre can help people and enhance their feeling of fullness in the stomach. Research has shown that tomatoes have anti-inflammatory properties (Ivy Panda, 2020).

## 1. Cancer

Lycopene is a natural antioxidant; it helps slow down cancerous cell growth. Lycopene levels in the blood and tissues were inversely related to the risks of developing breast and prostate cancer. Numerous epidemiological studies have discovered a correlation between a high tomato/tomato product intake and decreased gastrointestinal cancer incidences, as well as a 50% decrease in cancer mortality rates in an elderly US population (Bauman et al., 2015).

## 2. Cardiovascular Health

Lycopene levels higher in adipose tissue have been found to protect against cardiovascular disease (Bauman et al., 2015). According to Peto et al., there is a 3:1 correlation between lower cholesterol levels and lower myocardial infarction risk. It means that a person who frequently consumes lycopene has a 30–40% lower chance of developing cardiovascular disease (Nasir et al., 2015).

## 3. Tomatoes help maintain strong bones

Tomatoes contain a fair amount of calcium and Vitamin K; these are essential nutrients for strengthening and performing minor repairs on the bones and bone tissue (Bhowmik et al., 2012).

## 4. Good for skin

Tomatoes contain a high level of lycopene, a substance used in some of the more pricy facial cleansers. Another ingredient in tomatoes, Vitamin C, supports immunological function. Epidermal and dermal skin cells are known to actively absorb it through sodium-dependent vitamin C transporter isoforms (Collins et al., 2022).

## 5. Diabetes

The valuable mineral chromium can be found in large quantities in tomatoes. It significantly helps diabetics in better managing their blood sugar levels (Bhowmik et al., 2012).

## 6. Anti-aging activity

During the ageing process, it has been observed that the lycopene level in the blood decreases. Due to age-related gastric conditions such as acute and chronic gastritis, irregular gastric acid output, and changes in the intestinal enzyme spectrum, the

gastrointestinal absorption of carotenoids decreases as people grow older (Joshi et al., 2019).

### Side Effects of Tomato:

There are a number of tomato health benefits, and there are also a number of undesirable side effects that are linked with eating tomatoes and tomato-based products. The most common negative effects of tomato consumption and their primary causes are:

- Gastroesophageal reflux disease (heartburn): One of the major causes of GERD is consumption of tomatoes or tomato-related products. Citric and malic acids, two important organic acids found in tomatoes, are thought to be the most effective causes of acid reflux in people who are at risk for it and in people who consume more tomatoes.
- Lycopodermia: A skin disease called lycopodermia affects the skin. This occurs when an excessive amount of lycopene causes skin discolouration. Although lycopene is excellent for your body, consuming more than 75 mg a day can cause lycopodermia.
- Urinary problems: Usually, acidic meals, fruits, vegetables, and drinks like coffee and tea are thought to be potential bladder irritants that could increase the likelihood of urinary incontinence (uncontrolled urine leakage). As a result, eating tomatoes, which are an acidic produce, might irritate the bladder and result in urine incontinence.
- Allergy: One of the recognized allergens, tomatoes can cause a variety of symptoms in those who are sensitive, including sneezing, skin-related issues, red eyebrows and eyelids, throat irritation, and swelling of the mouth and cheeks. (Salehi et al., 2019).

### USES

The tomato is one of the most widely consumed vegetables in the world and has a wide range of uses. Initially cultivated as an ornamental plant, the tomato was not a well-liked food when it was introduced to Europe.

Tomato preparations mixed with other components, such as avocado (*Persea americana*, Lauraceae), honey, yoghurt, or lime (*Citrus x latifolia*, Rutaceae) juice, should be applied to the face or other affected regions, according to folk treatments, despite the paucity of data on tomato's effectiveness for skin disorders like acne or sunburn. As tomato consumption increased throughout Europe and as it became more commonly accepted as a useful food, Italians were motivated to start mass-producing and canning tomatoes (Bauman et al., 2015).

- Tomato juice maintains a strong resistance to disease by keeping the bloodstream alkaline. Potash salts and iron are both abundant in it.
- Only half ripe tomatoes are an excellent cure for any liver issues. Tomatoes are excellent for treating dyspepsia, diarrhoea, and dysentery because they stimulate the torpid liver.
- Tomato skin powder was added to improve the low-quality refined oils to solubilize the carotenoid pigments (Ray et al., 2016). Ketchup's texture qualities are improved by the addition of skin particles during the manufacturing process (Shu et al., 2005).
- The tomato is a nervine tonic. It helps with a variety of nervous system problems.
- Only partially ripe tomatoes will help you avoid heat exhaustion or sunstroke during the hot summer months.
- It is very beneficial in treating scurvy because it is a rich source of vitamin C.

### VALUE ADDITION OF TOMATO

The demand for a greater range of novel, value-added products by consumers has increased tomato production globally. As a result, there is a significant demand for mixing technology in both production and processing. The tomato processing industry is huge. Many food products, primarily soups, sauces, and ketchup, include tomato paste or puree, which is produced from a significant portion of the world's tomato production. India exports processed tomatoes in the form of ketchup and

tomato paste. The only ketchup and sauce market in India is estimated to be worth Rs 1,000 crore and is growing at a rate of about 20% annually (IIFPT). According to the US Department of Agriculture's Economic Research Service, out of all raw tomatoes processed, 35% is processed into sauces, 18% in tomato paste, 17% in canned tomatoes, 15% in juices, and 15% in ketchup (Bauman et al., 2015).

#### Storage and Selection of Tomatoes:

Most ripe tomatoes have their best eating quality for 2 to 3 days if stored at room temperature. Store fruits with the stem scar pointing up and away from direct sunlight to prevent fruit from softening and darkening. Many tomato varieties, such as some large-fruited "vine-ripe" kinds, cluster tomatoes, and many cherry and Roma types, have been bred to improve features that increase the fruit's storage life. They can be kept at room temperature for up to five days (Parnell et al., 2004).

Mature green fruits may be stored at 10°C to 15°C for 30 days and ripe tomatoes at

4.5°C for 10 days under 85-90 per cent relative humidity. For long-distance transportation and packing, wooden boxes and plastic crates of different sized are typically used (IIFPT). For a period of 12 days, tomatoes were kept at two different storage temperatures: 10 °C (95 ±1% relative humidity) and 22 °C (65 ±5% relative humidity). Tomatoes held at ambient temperature for 12 days had significantly more lycopene than tomatoes stored at low storage temperature (Dairi et al., 2021).

#### Tomato Processing:

Tomato can be processed into a number of products:

- a. Tomato puree and pulp
- b. Tomato powder
- c. Tomato soup
- d. Tomato sauces/ketchup
- e. Tomato juice
- f. Tomato chutney

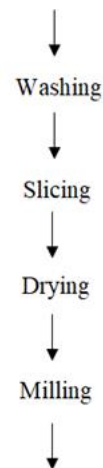
#### 1. Tomato Powder:

Tomato powder is simply dehydrated tomatoes that have been finely ground. It can be used as a spice, seasoning and garnish.



Figure 6: Tomato Powder

Choosing the tomatoes



Packaging and Storage

Process flow diagram for Tomato Powder

**2. Tomato Pulp:**

Tomato pulp is prepared from ripe tomatoes in the same manner as tomato

juice. Cooking for pulp concertation can be done in an open cooker or a vacuum pan.

(a) Boiled Tomatoes

(b) Tomato Pulp

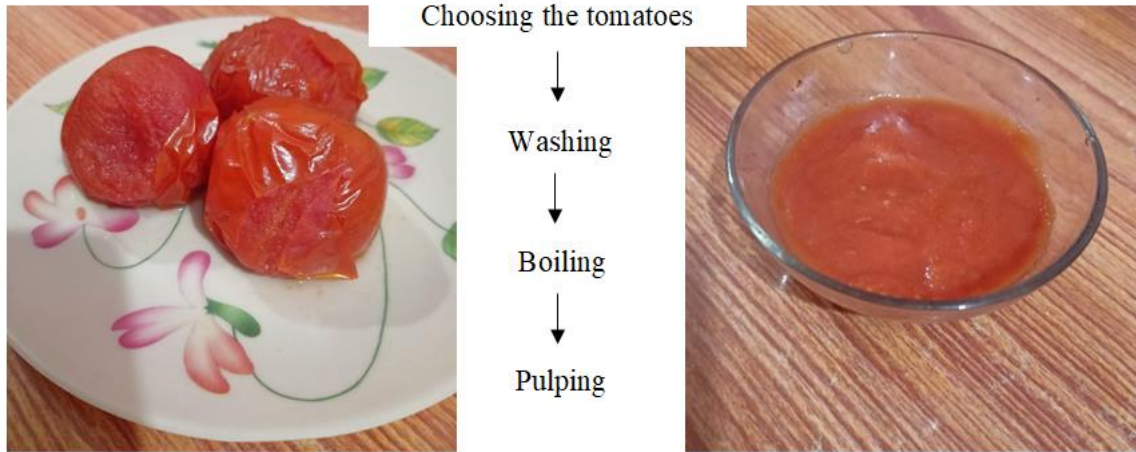


Figure 7: Tomato Pulp

**Process flow diagram for Tomato Pulp**

**3. Tomato Puree:**

Tomato puree can be defined as concentrated tomato juice or pulp without skin and seeds and containing not less than 25 per cent of tomato solids

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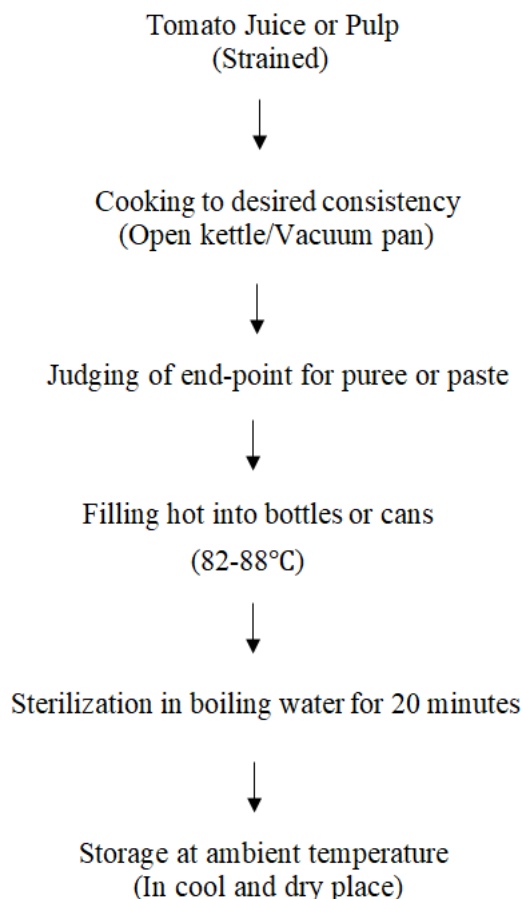
(a) Tomato Pulp



(b) Tomato Puree

Figure 8: Tomato Puree and pulp





### CONCLUSION

Tomato is one of the most researched horticultural crops. The tomato is the second-largest vegetable crop in the world after potatoes and a significant source of lycopene. In the food industry, tomatoes serve multiple applications. Tomatoes are climacteric fruits that contain a lot of compounds that are good for health. The chemical composition of tomatoes varies depending on their variety and the growing season. In addition to being a healthy food with little calories, tomatoes are an excellent source of vitamins and antioxidants. Tomatoes have a 95% water content on average. The remaining 5% is primarily made up of fibre and carbohydrates. A diet high in tomatoes is linked to several health advantages, such as anticancer traits, a lower risk of cardiovascular, neurological, and gastrointestinal illnesses, better skin health, faster recovery after physical activity, and stronger immunological function. An important source of phytochemicals and certain micronutrients are tomatoes and

tomato-based products like tomato juice. Tomatoes, including their skins and seeds, could help greatly to increase the consumption of antioxidants in the average person's diet. Tomatoes are consumed fresh and processed, primarily as tomato puree, paste, ketchup, and juice. The effect of nutrition on fruit quality is likely to be a growing area of interest in future research in the tomato nutrition field.

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### Conflict of Interest:

There is no such evidence of conflict of interest.

### Author Contribution

All authors have participated in critically revising of the entire manuscript and approval of the final manuscript.

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