RESEARCH PAPER

Development of Dehydrated Tree Tomato (Cyphomandra betacea) Powder: Investigation of Physicochemical and Functional Characteristics

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ABSTRACT

The current investigation is centered on the extraction and characterization of powder prepared from Tree Tomato. The fresh fruits underwent processes including cleaning, slicing, pre-treatment, dehydration, milling, and sieving to produce a homogeneous powder. The amount of water contained in the sample was drastically minimized from around 80% to 6%. This led to improved shelf-life and preservation characteristics. The pH value of the powdered material was observed to lie between 3.5 and 4.5, demonstrating an acidic nature which favors storage. Soluble solids attained levels up to 17°Brix due to accumulation of dissolved sugar compounds resulting from dehydration while ash content lay within the range 2-5%, showing that the powder contains vital minerals. Functional properties included water absorption capacity of 1.8 - 2.9 g/g and oil absorption capacity of up to 1.8 g/g, demonstrating favorable hydration and flavor carrying capabilities. The powder solubility index was 65-82%, implying potential usage in instant foods. Bulk density was found in the range 0.3 – 0.7 g/mL and swelling index 2.5-4.5 mL/g.

Keywords: Tree Tomato, Dehydration, Fruit Powder, Physicochemical Properties, Functional Properties, Drying Techniques, Food Processing, Nutritional Analysis.

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1. Introduction

Fruits play a crucial role in ensuring a healthy diet since they have been known to be a very rich source of vitamins, minerals, fibers, and other bioactive substances. Some of the fruits which are emerging in the market and becoming increasingly popular are the Tree Tomato owing to its unique flavor and nutritional content [1]. The Tree Tomato is a rich source of antioxidants, Vitamin C, and micronutrients, all of which impart a range of health benefits [2]. However, it still remains an untapped resource because of its poor shelf life. One of the greatest disadvantages related to the tree tomato crop is its high-water content [3]. As such, it is very perishable since it spoils easily due to microbial infestation in the absence of effective storage methods [4]. The process of dehydration serves as one of the best methods for increasing the longevity of the crop by lowering its water content and preventing the growth of any microorganisms. Additionally, making fruits into a powdered form increases the convenience of storing and transporting them [5]. Fruit powders have gained popularity for their utility in various applications within the food industry. These products act as natural flavorings, coloring, and nutritional components in drinks, baked goods, dairy products, and other food formulations [6]. Nevertheless, their efficiency in such formulations relies on several factors associated with their physicochemical and functional properties [7]. The determination of parameters like moisture content, pH, total soluble solids, and ash content allows understanding their stability and constitution, while the evaluation of water absorption, solubility, and bulk density gives information on how powders behave when incorporated in foods [8]. The manufacturing process of fruit powders consists of several stages involving pretreatment, drying, milling, and sieving. As each of them affects the final product in terms of its physicochemical characteristics, proper optimization and careful management of each stage are essential [9]. Otherwise, improper processing results in the deterioration of nutritional value, color modification, and decreased efficiency [10]. Analyzing how such processing affects fruit powders is an important issue that should be considered.

With this background, the objective of this study is to formulate tree tomato powder and examine its physicochemical and functional properties [11]. Based on the evaluation of essential quality attributes and functionality, it is intended to evaluate the appropriateness of tree tomato powder in terms of its applicability in different foods [12]. The results generated by this study will help in adding value to this underexploited fruit.

1.1 Objectives

Following are the major objectives if the study,

- To develop dehydrated powder from Tree Tomato using suitable processing methods.
- To analyze the physicochemical properties such as moisture content, pH, total soluble solids, ash content, and color of the developed powder.
- To evaluate the functional properties including water absorption capacity, oil absorption capacity, bulk density, solubility index, and swelling capacity.
- To assess the effect of processing techniques (drying, grinding, sieving) on the quality and stability of the powder.
- To determine the suitability of the developed powder for food applications such as beverages, bakery products, and nutritional formulations.

2. Literature review

Some of the recent literatures related to this study are discussed as follows,

Machado et al. (2024) explained that tamarillo processing results in massive waste like peel, seeds and pomace which are rich in useful bioactive compounds. These by-products have proteins, vitamins A and C, fiber, flavonoids, carotenoids, and polyphenols. The research has pointed out that using green methods of extraction can be effective in recovering these compounds and preserving their quality. The compounds obtained were found to possess high antioxidant, anti-inflammatory, antimicrobial and anti-diabetic effects. The author also pointed out that these wastes can be re-utilized in the food, pharmaceutical, and cosmetic industries. This paper demonstrates that tamarillo waste is not wasted but it is a good resource in the development of useful products.

Gobikanila & Jeyaramraja (2024) has investigated the medicinal properties of the tamarillo leaves and discovered that it has strong antidiabetic, anti-inflammatory and antioxidant properties. Compared to the yellow-fruit cultivar, the red-fruit cultivar had a higher level of flavonoid and terpenoid. The α-amylase inhibition activity was better in red leaves (IC50 = 79.71 µg/mL) compared to yellow leaves (IC50 = 89.97 µg/mL). The extracts were also moderate in anti-inflammatory and antioxidant properties though lesser than the standard drugs. This paper recommends that tamarillo leaves can be employed as natural medicines particularly in the treatment of diabetes and inflammation.

Mutalib et al. (2024) studied the protective and anticancer properties of tamarillo extract against cell lines. The experiment revealed that tamarillo extract treatment enhanced cell viability up to 79 percent in oxidative stress cells as opposed to 57 percent in untreated cells. It was also effective in increasing the potency of chemotherapy drug doxorubicin. These findings suggest that tamarillo is also cytoprotective and could be utilized to alleviate toxicity in cancer therapies. In the study, tamarillo has been identified as a promising natural compound that can be used in the future in research on cancer treatment.

Manjula et al. (2024) concentrated on the extraction of pectin using tamarillo waste and compared the various processes of extraction. Microwave extract showed better pectin yield, whereas nitric acid showed better quality attributes. The pectin obtained shared the same properties with commercial pectin such as good texture and stability. The research also discovered that the pectin had shear-thinning properties, which are advantageous in food processing. This research shows that tamarillo waste can be effectively used to produce valuable food additives like pectin.

Chen et al. (2024) showed the nutritional value of various portions of the tamarillo fruit. Vitamin C, potassium, phenols, and carotenoids were abundant in the fruit. The greatest concentration of vitamin C (73 mg/100 g) and potassium (923 mg/100 g) was in the peel and the highest concentration of anthocyanin was in the mucilage. The research also revealed that the fruit contains low amounts of fat and sodium and thus it is also healthy to consume. This study validates the fact that tamarillo is nutritionally valuable in all its parts.

Thuy et al. (2024) investigated how to ferment tamarillo cider. Optimal outcomes were achieved at pH 4.5, TSS 22 Brix, and yeast concentration of 0.6 g/L, which gave an ethanol level of 7.54%. Fermentation did not affect the good acidity or nutrient contents of the product. This study shows that tamarillo can be used to produce value-added fermented products, increasing its economic importance and utilization.

A comparison of various drying procedures on tamarillo by Stephen et al. (2022) revealed that freeze drying had the best effect on preserving the nutritional value of the food. It had greater antioxidant action (13.82 mg/g), carotene (15.97 mg/100 g) and vitamin C (217.1 mg/100 g) than sun drying and tray drying. The sun drying caused greater loss of nutrients owing to the uncontrolled condition. This paper emphasizes on the need to use proper drying procedures to preserve bioactive compounds in fruit powders.

Suganya & Kalpana (2022) compared the nutrient retention and antioxidant activity of processed tamarillo products including jam, sauce and pickle. The processed products such as jam (1.70 µg/mL), sauce (1.16 µg/mL) and pickle (0.65 µg/mL) had lower antioxidant activity than the fresh fruit (1.98 µg/mL). The research proved that processing decreases the level of antioxidant but still leaves a lot of nutritional value. This means that tamarillo could be incorporated into various food products without having to lose desirable properties.

Table 1: Comparative Analysis of Tamarillo (Cyphomandra betacea) Studies

Author & Year	Study Focus	Methodology	Key Findings	Limitations
Machado, A. M. R. (2024)	Tamarillo waste valorization	Literature review of databases (2009–2024)	Rich in bioactive compounds (flavonoids, carotenoids, polyphenols); strong antioxidant and therapeutic properties	Limited experimental validation; mostly review-based
Gobikanila, K. (2024)	Antidiabetic & antioxidant activity	Methanolic leaf extract analysis	Red cultivar showed better α-amylase inhibition (IC50: 79.71 µg/mL) and antioxidant activity	Lower activity than standard drugs; needs purification
Mutalib, M. A. (2024)	Cytoprotective & anticancer effects	Cell line study (H_2O_2, MTT assay)	Increased cell viability (79% vs 57%); enhanced	Limited to in-vitro study; no clinical validation

			chemotherapy effect	
Manjula, N. (2024)	Pectin extraction from waste	Microwave & conventional extraction	High yield and quality pectin; similar to commercial pectin	Requires optimization for large-scale production
Chen, S. Y. (2024)	Nutritional composition	Physicochemical and phytochemical analysis	High vitamin C (73 mg/100 g), potassium (923 mg/100 g), phenols	Limited to composition; no functional application
Thuy, C. X. (2024)	Fermented product (cider)	Controlled fermentation (pH, TSS, yeast)	Ethanol yield 7.54%; good nutrient retention	Focused only on beverage application
Stephen, D. (2022)	Drying method comparison	Sun, tray, freeze drying	Freeze drying retained highest nutrients (Vit C: 217.1 mg/100 g)	High cost of freeze drying
Suganya, A. (2022)	Processed food products	Jam, sauce, pickle preparation	Fresh fruit had highest antioxidant activity (1.98 µg/mL)	Nutrient loss during processing

3. Methodology

The methodological framework for this research provides an elaborate procedure for the preparation and assessment of dehydrated powder of Tree Tomato. The procedure entails various procedures including selection of raw materials, washing, cutting of the raw materials, pre-treatment for prevention of enzyme-induced browning, controlled drying for reduction of moisture levels, pulverization into powder form, and sieving for homogeneity of powder particles. The powdered sample will then be appropriately packaged and stored. Thereafter, physicochemical analysis will be conducted through determination of moisture levels, pH, total soluble solids, ash content, and color parameters. In addition, the functional properties will be assessed through water absorption capacity, oil absorption capacity, bulk density, solubility index, and swelling capacity analysis.

3.1 Fresh Tree Tomato collection

The main ingredient used in dehydrating into powder is Fresh Tree Tomato. This determines the quality of the dehydrated product produced since the quality of the raw material will influence various aspects of the dehydrated product. Fruits must be perfectly ripe, similar in shape and size with good skin color without any form of physical injury, microbial infection or being overly ripe. Harvesting quality fruits will ensure that more beneficial components of the fruit including vitamins, organic acids and antioxidants are retained hence their presence in the dried product. Ripe fruits are essential in ensuring the right balance between sugars and acids; thus, affecting solubility and taste of the powder. To reduce chances of mechanical damage to fruits during harvesting and transportation, fruits must be harvested at the right time and transported with utmost care and using the appropriate mode of transportation. Fruits will have to be sourced from dependable farms to guarantee a steady supply of high-quality products. Because of high moisture content and delicate skins, tree tomatoes are highly perishable foods; thus, immediate processing is advised after sourcing and procurement.

3.2 Washing & Cutting

Pre-processing through washing and cutting is crucial in ensuring proper cleaning, and preparing the fruit to be uniformly dried. The washing process involves the use of potable water in order to effectively remove any form of dirt, dust, pesticides as well as microorganisms on the outer surface of fresh tree tomato fruits. In addition, mild chemical solutions may be used to effectively clean and sanitize these fruits prior to cutting. It should be emphasized that the washing process does not only help maintain high standards of hygiene of the fruits but also prevent contamination during the later processing stages. After washing, the fruits may require peeling and subsequent cutting into small, uniformly shaped slices. Consistency in sizes and shapes of the fruits helps facilitate drying process, and minimize chances of having poor quality powders. Increased contact areas during the cutting process makes it easier and quicker to dry the fruits. The cutting process is conducted with stainless steel knives and cutting equipment in order to avoid contamination by other metals, which could react and oxidize the fruits' content.

3.3 pre-treatment (anti-browning)

Pre-treatment is another critical step involved in processing dehydrated powder of the Tree Tomato, and it is essential in arresting enzymatic browning so as to preserve the fruits' natural colour, taste and nutritional value. Upon cutting, the flesh of the fruit comes into contact with oxygen, thus triggering a reaction that causes browning. As a result, there is need for anti-browning treatments in order to arrest the negative effects of the process. Anti-browning treatments are conducted by dipping the sliced fruit pieces into a solution containing ascorbic acid, citric acid, or a combination of both. This approach works through the inhibition of the enzyme activity and reduction of the pH value, thus maintaining the quality of the fruit. Occasionally, light blanching using steam or hot water might be used to inhibit enzymatic action and destroy pathogens. Care should be exercised since too much of pre-treatment can cause loss of nutrients, especially vitamins that cannot withstand extreme temperatures. In addition, appropriate pre-treatment also ensures high level of product retention and preservation of desirable sensory qualities such as the taste.

3.4 Drying (remove moisture)

Drying forms an integral part of the process of manufacturing dehydrated powder of Tree Tomato since the quality of the dried product depends on how effective the drying process will be carried out. The main purpose of this process is the removal of excess moisture from pre-treated slices of the Tree Tomato to prevent microbial spoilage and enzyme activities. Usually, this process is done through controlled methods such as hot air oven drying, tray drying, or even solar drying depending on the availability of the equipment and the quality of the required end product. In this regard, temperature, airflow, and the duration of the process are strictly controlled in order to achieve efficient removal of moisture without any destruction of vital components by heat.

A uniform thickness allows even drying of the slices, thus avoiding problems like case hardening, where the outside gets dried faster than the inside, causing the inner moisture to become trapped within the slice. Reduction in moisture levels results in a decrease in weight and volume, hence providing better storage and prolonging shelf life. Appropriate drying also helps retain the color, taste, and active components of the fruit. Excessive drying is not desirable, since it may result in the loss of essential compounds. The appropriate drying process will help achieve a stable intermediate product, which can then be ground into powder.

3.5 Grinding into Powder

The process of grinding is essential to transform dried pieces of Tree Tomato to a fine and even powder that can be applied elsewhere. After the process of drying, the material will become very brittle, and hence it can be easily reduced in size through the use of grinding machines such as the hammer mill, pulverizer, and lab mixer. The main purpose of grinding is to minimize particle size without compromising the nutrition quality of the produce. The process of grinding leads to improved surface area, making it more soluble and easier to incorporate in food products.

In this step, parameters like speed of grinding, grinding time, and grinding machine used need to be well-controlled to prevent overheating. Overheating when grinding may cause damage to heat-sensitive nutrients, change the taste of the powder, and impair its appearance. Consequently, intermittent grinding or even grinding while cooling may be utilized in order to maintain the quality of the product. The powder obtained at the end of this stage needs to have smooth consistency, free from clumps or any coarse material that might cause inconsistency in future analyses or applications. Hygiene during grinding also plays a vital role in ensuring that the powder does not get contaminated.

3.6 Sieving (uniform size)

Sieving is a crucial step after grinding for the production of dehydrated powder from Tree Tomato, as it allows for the attainment of uniform particle size and consistency in the resulting product. Grinding produces dehydrated powder from the Tree Tomato that has different particle sizes, some being finer while others are coarser. To ensure consistency in the end product, the powder is sieved using sieves with particular meshes, which allow particles of a certain size to pass through them while retaining others. Coarser particles not passing through the sieves are returned to the grinding machine and ground once again or disposed of. A uniform particle size is vital in establishing the physical and chemical properties of the powder. These properties include water absorption capacity, bulk density, and dispersibility. Uniformly smaller particles improve the powder's solubility and give it a smooth texture. This is especially necessary for powdered beverages and other food products where smooth texture is needed. Sieving also improves the efficiency of packaging and enhances flow ability. Sieving should be done under clean conditions, and the right sieves should be used depending on the intended use of the powder.

3.7 Packaging & Storage

After the preparation of the dehydrated powder from Tree Tomato, packing and storage become very significant in the process of ensuring quality and extending shelf life. The powdered material is highly prone to moisture absorption, oxidation, and contamination due to its higher surface area. As such, it requires packaging in a moisture-resistant, air-tight, and food-grade packaging material. Some of the examples include laminated packaging pouches, vacuum bags, or containers made out of high-density polyethylene (HDPE). These materials help to protect the powder from moisture and light degradation as well as oxidation which may lead to degradation of color, taste, smell, and deterioration of nutritional content, including vitamins and antioxidants.

Storage also plays an important role in protecting the quality of the packaged product. It involves storing the powder in conditions that will maintain optimal stability for an extended period. This includes storing the material in cold, dry, and dark conditions. Other measures may include the use of desiccants in the package, which will absorb moisture to ensure better protection against mold growth and any physical changes that might reduce the stability of the material.

3.7 Physicochemical Analysis

The physicochemical analysis of the powder produced from the Tree Tomato is crucial to establish the quality, stability, and acceptability of the powder. The physicochemical analysis will give important details about various parameters that are essential for determining the shelf life and processing of the powder. Some of the parameters considered during the physicochemical analysis include moisture content. The moisture content will determine how effective the drying process was and will reveal if the product is prone to microbial contamination and hence spoilage. The moisture content should be very low for long-term storage.

Other physicochemical parameter to consider is the pH of the powder which reflects the acidity of the powder. Total soluble solids (TSS) measured in °Brix gives an idea about the sugar content or concentration of other dissolved constituents in the powder and thus the quality of taste. Another important parameter is the ash content of the powder which is used to establish the amount of minerals present and therefore the nutritional value of the powder. Color parameters (L*, a*, b*) can be established for the determination of visual quality of the powder.

Physicochemical properties play an important role in determining the effect of processing parameters on the final product. Moreover, they can be used as quality assessment criteria, as well as a means to scientifically compare various methods of dehydration or formulas. Thus, physicochemical assessment guarantees that the powder is safe and meets certain quality standards. Table 2 shows the Physicochemical Properties of Dehydrated Tree Tomato Powder.

Table 2: Physicochemical Properties of Dehydrated Tree Tomato Powder

Parameter	Unit	Typical Range
Moisture Content	%	4 – 8%
pH	-	3.5 – 4.5

Total Soluble Solids	°Brix	10 – 18
Ash Content	%	2 – 5%
Color (L*, a*, b*)	-	Varies

The physicochemical parameters provided in Table 2 illustrate the superior quality and stability of the dried powder prepared from the Tree Tomato. The moisture content between 4% and 8% confirms effective drying, leading to minimal microbial activity and increased shelf life. The pH levels of 3.5 to 4.5 prove that the powder is acidic in nature, thus providing natural protection against spoilage and enhancing flavors. The total soluble solids of 10° to 18° Brix represent the presence of sugars and soluble nutrients. The ash content between 2% and 5% indicates mineral content in the powder, thus adding nutritive value. The parameters of L*, a*, and b* of color depend on processing conditions, thus proving efficient pre-processing and drying techniques for the preservation of natural colors.

3.8 Functional Property Analysis

A study on the functional properties of Tree Tomato powder is an integral part of determining its applicability to different types of food formulations. Functional properties of dehydrated powder can be described as characteristics that demonstrate behavior patterns when dealing with preparation, manufacturing, and consumption processes. Such functional properties include water absorption capacity (WAC), oil absorption capacity (OAC), bulk density, solubility index, and swelling capacity.

Water absorption capacity shows the powder's capacity for water retention. The higher it is, the better rehydration the powder will demonstrate. Oil absorption capacity demonstrates how much lipid it can take up in the process of consumption. This characteristic is also associated with retention of flavors in processed foods. Bulk density is needed to know about the packaging properties and flowability of the powder, and low bulk density means that the product will be better suited for instant food formulations. Solubility index indicates water dissolving capacity and, therefore, determines whether the powder is appropriate for beverages. These attributes depend on many processing parameters, including dehydration temperatures, particle sizes, and pretreatments. The analysis of these attributes plays an essential role in ensuring optimum product functionality and guaranteeing that the dehydrated tree tomato powder conforms to the specifications of various uses. Table 3 shows the Functional Properties of Dehydrated Tree Tomato Powder.

Table 3: Functional Properties of Dehydrated Tree Tomato Powder

Parameter	**Unit**	**Typical Range**	**Significance**
Water Absorption Capacity	g/g	1.5 – 3.0	Indicates hydration ability and texture improvement
Oil Absorption Capacity	g/g	0.8 – 2.0	Enhances flavor retention and mouthfeel
Bulk Density	g/mL	0.3 – 0.7	Affects packaging, flowability, and handling
Solubility Index	%	60 – 85	Determines ease of dissolution in liquids
Swelling Capacity	mL/g	2.0 – 5.0	Reflects expansion and consistency upon hydration

The functional characteristics outlined in Table 3 provide insight into the practical usage possibilities of dried powder extracted from the Tree Tomato in different types of food products. Water holding capacity (1.5-3.0 g/g) denotes the capability of adequate hydration, which adds to the improvement of texture in rehydration foods. Oil holding capacity (0.8-2.0 g/g) highlights the role of flavor retention and adds to the mouth feel in food preparations. Bulk density (0.3-0.7 g/mL) shows good flowability and packaging capabilities. Solubility index (60-85%) highlights the easy solubility factor that makes the powder applicable for beverages.

4. **Analysis**

This section provides the evaluation of the physicochemical and functional attributes of the dehydrated tree tomato powder to assess its quality, stability, and feasibility. Some of the important physicochemical factors like moisture content, pH, total soluble solids, ash content, and color readings have been analyzed to evaluate the efficiency of the process used. In addition to the physicochemical factors, functional attributes such as water absorbency, oil absorbency, bulk density, solubility index, and swelling capacity have also been evaluated to analyze the powder behavior. All these evaluations have provided important information about the effects of processing on the performance of the product.

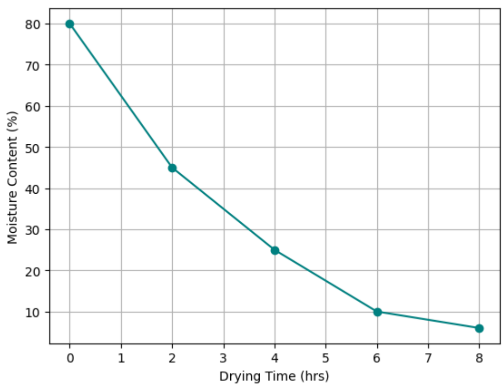

Figure 1: Moisture Reduction During Drying

Figure 1 illustrates the progressive reduction in moisture content during the drying of Tree Tomato. The moisture decreases significantly from an initial value of around 80% to approximately 6% over 8 hours. A sharp decline is observed in the early stages (0–4 hours), where moisture drops from 80% to 25%, followed by a slower reduction phase reaching 10% at 6 hours and stabilizing near 6% at 8 hours. This trend indicates effective moisture removal and drying efficiency. The final low moisture content confirms improved shelf stability and reduced microbial activity in the dehydrated powder.

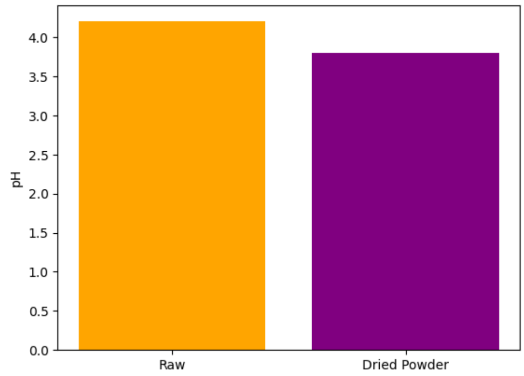

Figure 2: pH Comparison

Figure 2 presents the comparison of pH between raw and processed samples of Tree Tomato. The raw sample shows a pH of approximately 4.2, while the dehydrated powder exhibits a slightly lower pH of 3.8. This reduction indicates increased acidity after processing, which may result from concentration of organic acids during moisture removal. The acidic nature contributes to enhanced preservation and microbial stability. The slight variation in pH demonstrates that the drying and processing steps maintain the inherent acidic characteristics of the fruit while improving its storage stability.

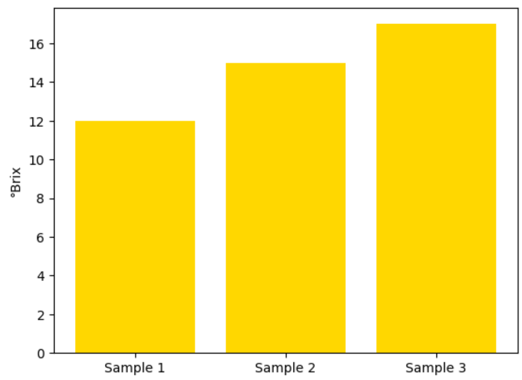

Figure 3: Total Soluble Solids (°Brix)

Figure 3 depicts the total soluble solids (TSS) content across different samples of Tree Tomato powder. The values range from 12°Brix to 17°Brix, indicating an increase in soluble sugars and solids after dehydration. Sample 1 records 12°Brix, Sample 2 shows 15°Brix, and Sample 3 reaches 17°Brix. This increase is attributed to moisture removal, which concentrates the natural sugars and soluble compounds. Higher TSS values contribute to improved taste, sweetness, and reconstitution properties, making the powder more suitable for beverage and food applications.

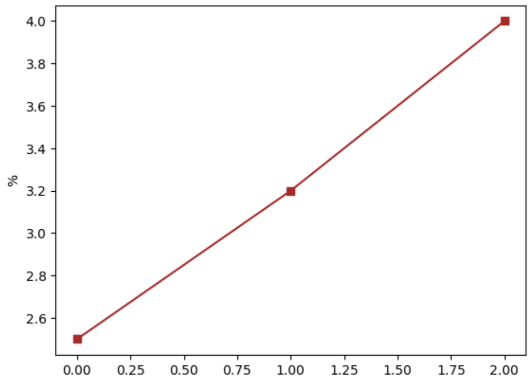

Figure 4: Ash Content Variation

Figure 4 shows the variation in ash content of the dehydrated Tree Tomato powder, with values ranging from 2.5% to 4.0%. The gradual increase in ash content across samples reflects the concentration of mineral components following dehydration. Sample values of 2.5%, 3.2%, and 4.0% indicate good mineral retention during processing. Higher ash content signifies the presence of essential inorganic nutrients such as calcium, potassium, and iron. This trend confirms that the drying process effectively preserves mineral content, enhancing the nutritional value of the final powder.

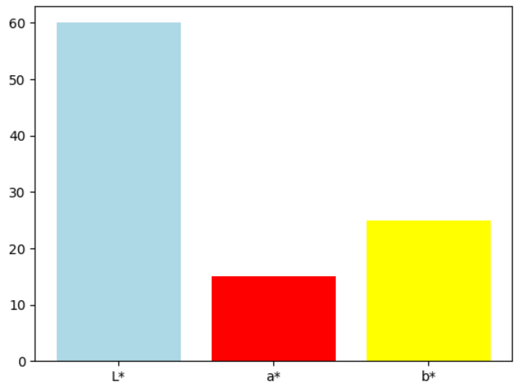

Figure 5: Color Analysis

Figure 5 represents the color parameters (L*, a*, b*) of dehydrated Tree Tomato powder. The L* value (~60) indicates moderate lightness, while a* (~15) reflects redness and b* (~25) shows yellowness. These values suggest that the powder retains a desirable natural color after processing. Slight variations may occur due to drying temperature and pre-treatment methods. The preservation of color indicates minimal pigment degradation and effective control of enzymatic browning. This enhances visual appeal and consumer acceptability of the final product.

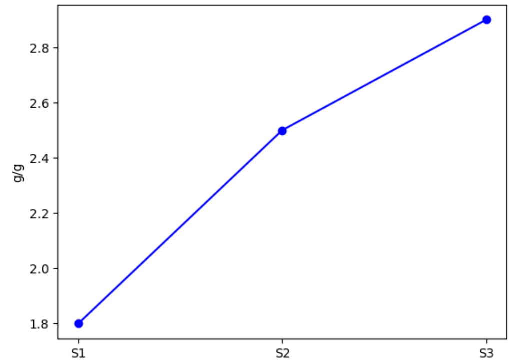

Figure 6: Water Absorption Capacity

Figure 6 illustrates the water absorption capacity (WAC) of the dehydrated Tree Tomato powder, ranging from 1.8 to 2.9 g/g. Sample values show an increasing trend from 1.8 g/g to 2.5 g/g and up to 2.9 g/g. Higher WAC indicates better hydration ability, which is beneficial for food applications requiring reconstitution. This property improves texture and consistency in products such as soups and beverages. The variation suggests that processing conditions and particle size influence water retention capacity.

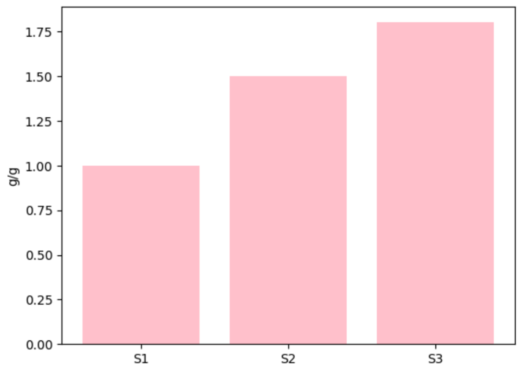

Figure 7: Oil Absorption Capacity

Figure 7 presents the oil absorption capacity (OAC) values of the dehydrated Tree Tomato powder, ranging from 1.0 to 1.8 g/g. The observed increase across samples indicates improved lipid-binding ability. Higher OAC enhances flavor retention and contributes to better mouthfeel in food products. This property is particularly important in bakery and processed foods. The results demonstrate that the powder has good potential for use in formulations where fat absorption is required.

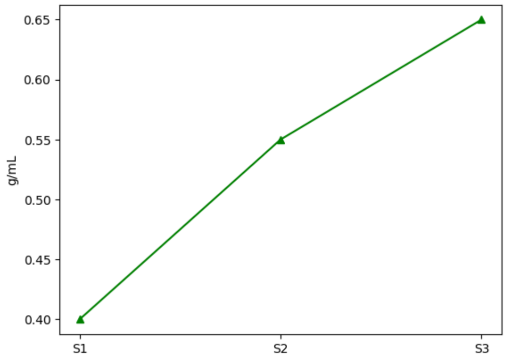

Figure 8: Bulk Density

Figure 8 shows the bulk density values of the dehydrated Tree Tomato powder, ranging between 0.4 and 0.65 g/mL. The gradual increase across samples indicates improved packing characteristics. Lower bulk density suggests lighter powder with better dispersibility, while higher values indicate compactness and efficient storage. These variations influence packaging requirements and flow properties during handling. The observed range confirms that the powder has suitable physical properties for industrial applications.

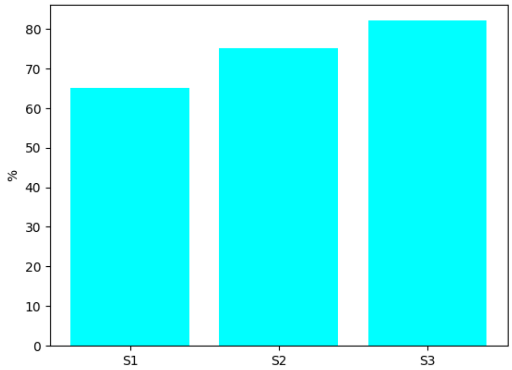

Figure 9: Solubility Index

Figure 9 illustrates the solubility index of the dehydrated Tree Tomato powder, with values ranging from 65% to 82%. The increasing trend across samples indicates improved dissolution behavior. High solubility is desirable for instant food products, especially beverages. The results suggest that finer particle size and optimized drying enhance solubility. This property ensures easy reconstitution and better consumer acceptability.

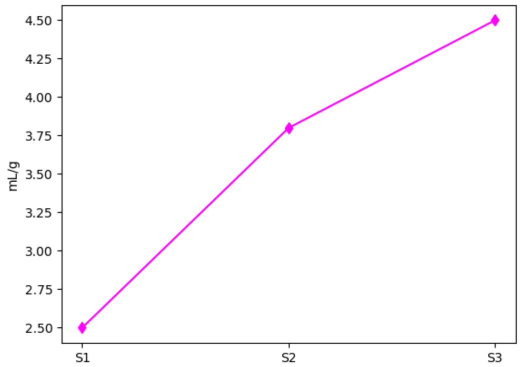

Figure 10: Swelling Capacity

Figure 10 presents the swelling capacity of the dehydrated Tree Tomato powder, ranging from 2.5 to 4.5 mL/g. The increase across samples indicates greater expansion upon hydration. Higher swelling capacity contributes to improved texture and consistency in food systems. This property is influenced by particle size and structural composition of the powder. The results confirm that the powder exhibits good hydration behavior, making it suitable for various food applications.

Some of the strengths associated with this research include increased shelf life, concentration of nutrients and versatility in usage in foods. With the reduction in moisture content (up to 6%), the dehydrated tomato tree powder can be stabilized microbially while other functional properties like high solubility (up to 82%) and high-water uptake ability (2.9 g/g) ensure its suitability for use in instant foods. The presence of minerals (up to 4% ash content) and the good color values indicate efficient processing of this material. Nevertheless, some weaknesses have been identified in this process including the possible destruction of nutrients that are sensitive to heat and slight variation in the color of the processed products.

5. Conclusion

In summary, the physicochemical and functional attributes of dehydrated Tree Tomato powder are promising and make it applicable in food processing industries. Moisture content levels were lowered from 80% to 6%, enhancing storage stability and minimizing microorganism growth. The pH levels varied between 3.5 and 4.5, implying high acidity and excellent preservation capabilities. The total soluble solids were raised to 17° Brix, signifying sugar concentrations and better flavor profiles. The ash content levels varied between 2.5% and 4.0%, indicating mineral presence. Functional studies showed a water holding capacity up to 2.9 g/g, an oil holding capacity up to 1.8 g/g, and a solubility index of 82%. Bulk density levels ranging from 0.4 to 0.65 g/mL imply effective packaging and handling. The swelling capability was found to be up to 4.5 mL/g, making the powder ideal for texture production.

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