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Drying characteristics on physicochemical characteristics of tomato powder

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Abstract
The purpose of this study is investigate the drying characteristics of the tomatoes to prepare tomato powder. The drying characteristics of tomato slices were carried out in this study. The effect of processing parameters such as the drying temperature and drying time required for drying of were studied and final dry weight of the tomato slices were estimated. In this study the drying characteristics i.e the amount of moisture removed for every 1hour by tray dryer at 60, 65 and 70 ℃ and every 3 hour by tray dryer is calculated for the respective samples. From the above study on dehydration of tomato slices in tray drying at 70 ℃ has shown better moisture removal content compared to the other conditions of drying with less time and gives better results in maintaining better quality, appearance, color and texture.

Keywords: Drying characteristics, physicochemical characteristics, tomato powder

1. Introduction
India is one of the largest producers of the fruits and vegetables in the world. Tomatoes originated in western South America. Today tomatoes are one of the most important ingredients available and are especially indispensible in Mediterranean cookery. The common garden tomato is botanically classified as a fruit and it is developed from dry ripened ovary in the base of flower and contains seed(s) of the plant. It can be classified as a berry since it is pulpy and has edible seed. Some plants have a soft part which support the seeds and is also called as a fruit, though it is not developed by ovary like strawberry, which has its seed outside (NHB, 2014) [5].

The chemical composition of fresh tomato fruits depends upon factors such as cultivars, maturity, light, temperature, season, climate, soil fertility, irrigation and cultural practices. The relative concentrations of the chemical constituents of tomato fruit are important in assessing the quality with respect to color, texture, appearance, nutrient value, taste and aroma. The soluble solids of tomatoes are predominantly sugars, which in turn are important contributors to flavor. The starch content of tomato fruit depends upon maturity, cultivar and ripening conditions and varies from 1-1.22% in immature fruit to 0.1-15% in red ripe fruit. The texture of the fruit is satisfactory only when pectase, calcium and pectin are in sufficient quantities.

Tomato fruit is a rich source of ascorbic acid (vitamin C). On the basis of fresh weight, vitamin C content averages about 25 mg/100 g, however, the values vary with the cultivars. Citric and malic acids are organic acids that contribute most to the typical taste of tomato fruit. Other acids such as acetic, formic, trans-aconitic, lactic, fumaric, galacturonic and α-oxo acids have been detected. Tomato fruit contains tomatine, a glycosidic steroidal alkaloid. Traces of solanine were also found. Flavonoids and some other phenolic compounds constitute the total phenolics of tomato fruit. Lipid fraction of tomatoes is composed of triglycerides, diglycerides, sterols, sterol esters, free fatty acids and hydrocarbons (Salunkhe *et al.* 1974) [8].

2. Materials and Methods
The present research work was conducted at the Department of Food Science and Technology, College of Food Technology, Vasanthrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

2.1 Materials
2.1.1 Raw materials
The fully ripened, freshly harvested Vaishali tomato varieties were selected for the study. Sugar, citric acid and other ingredients were purchased from the local market of Parbhani (MS), India.

2.1.2 Chemicals
All the chemicals used in the present investigation were of analytical grade. They were obtained from Department of Food Science and Technology, College of Food Technology, V.N.M.K.V, Parbhani.

2.2 Determination of pH
The p^H was determined with a p^H 700 Digital meter at 25.0±2 °C. The p^H meter was standardized using p^H buffer of 4.0, 7.0 and 10.2 Ranganna S. (1986) [6].

2.3 Determination of Total Soluble Solids (^{0}brix)
TSS was determined by using refractometer (Model Misco®) with a range of 0 to 32 ° Brix and a resolution of 0.2° Brix by placing 1 to 2 drops of clear juice on the prism. Between samples the prism of the refractometer was cleaned with distilled water and dried before use. The refractometer was standardized against distilled water (0° Brix TSS) Ranganna S. (1986) [6].

2.4 Determination of titratable acidity
The titratable acidity was determined by using the method adopted by Ranganna S. (1986) [6].

2.5 Determination of Dehydration ratio
Dehydration ratio was calculated by taking the weights of tomatoes before and after drying Jyothi and John (2014) [3].

2.6 Determination of Rehydration ratio
Rehydration ratio was calculated by taking the weights of tomatoes before and after drying Jyothi and John (2014) [3].

3. Results and Discussion
Tomato is an economically important vegetable crop widely grown in India. The nutritional value of tomato is due to its rich organic acids and phenolics which have also been correlated with high biological activity in the human body. Tomatoes are a rich source of lycopene (60-90 mg/kg). However lack of sufficient post-harvest strategies, poor transportation and storage facilities contribute to very high tomato wastage. Tomatoes are mostly used in the preparation of puree, ketchup, soup and paste apart from fresh consumption.

3.1 Proximate composition of tomato *var*. Vaishali
Proximate composition represents the nutritional value of raw tomato which directly influences on nutrient content of prepared products. The obtained results were tabulated in Table 1.

Table 1: Proximate composition of tomato *var*. Vaishali

Parameters	Fresh tomato
Moisture (%)	93.4±5.00
Ascorbic acid (mg/100g)	13.7±1.65
Reducing sugar (g/100g)	0.0075±0.0005
Total sugar (%)	2.27±0.50
Protein (%)	0.79±0.05
Carbohydrate (%)	3.48±0.50

*****Each value is average of three determinations

The chemical composition of tomato revealed its high perishability due to high moisture content (93.4±2.00%). Other constituents like ascorbic acid, total sugar and reducing sugar were 13.7±1.65 mg/100g, 2.27±0.50% and 0.0075±0.0005 g/100g respectively. It was found to be contain poor source of protein (0.79±0.05%) while total carbohydrate content was found to be 3.48±0.50%. The chemical properties of tomatoes found to be in line with results of USDA nutrient database (2014).
The results were similar to the findings of Hanif *et al.* (2006) [2], the moisture content of tomato fruit was found 91.84%. The tomato was found to be contained ascorbic acid (12.2 mg/100g), total sugar (3.85%), reducing sugar (0.0094 g/100g), carbohydrate (3.78%) and protein (1.27%) respectively.

Table 2: Chemical composition of tomato pulp

Parameter	Mean value
Titrable Acidity (%)	0.59
pH	4.54
TSS (ºBx)	5.70
Fibre (%)	0.60

* Each value represents the average of three determinations

The chemical composition of tomato pulp revealed its high perishability. The tomato pulp found to be acidic in nature with the pH range of 4.54 and titratable acidity 0.59 percent respectively. The TSS of tomato pulp has found to be 5.70^{0}Bx. The results obtained in present investigation were in close agreement with the results reported in the scientific literature of Srivastav, (2002) and Lee *et al.* (2002).

3.2 Effect of drying on dehydration and rehydration ratio of prepared tomato powder
Dehydration ratio reported as, ratio of mass of tomato slices before loading into the drier to the mass of dehydrated products. Different pre-drying treatments used in this study could influence the dehydration ratio of the tomato slices. If pre-drying treatment and drying itself would not induce any changes in the material rehydration could be treated as a process reversible of dehydration. In practice most of the changes are irreversible and rehydration cannot be considered simply as a process reversible to dehydration. Rehydration can be considered as a measure of the injury to the material caused by drying and treatment preceding dehydration.

Table 3: Effect of drying on dehydration and rehydration ratio of prepared tomato powder

Parameters	Dehydration ratio	Rehydration ratio
Cabinet dried	20.42	1.54
Foam mat dried	24.84	1.16
Spray dried	27.56	1.02

*Each value represents the average of three determinations

It could be found that from the above table 3, the data pertaining to the dehydration ratio of tomato powder prepared by different drying methods *i.e* cabinet, foam mat and spray drying contained the values were 20.42, 24.84 and 27.56 respectively, whereas the rehydration ratio of cabinet, foam mat and spray dried tomato powder were 1.54,1.16 and 1.02 respectively. Rehydration is the phenomenon that decides the effectiveness of the final product. Similar results were reported by Jyothi and John (2014) [3], who found the dehydration ratio of tomato powder was in the range from 0.68 to 1.51.
Cabinet dried tomato samples attained better rehydration ratio as compared to solar dried samples, probably due to uniform exposure of slices to the drying air condition and better heat transfer, leading to less textural changes during dehydration which subsequently offered higher rehydration ratio of the

final product. Foam mat drier could not maintain the constant rate of drying due to changes in air temperature, though drying carried out in lower temperature. Slight shrinkage and case hardening caused less reconstitution properties of the dehydrated samples (Sagar and Suresh kumar, 2010) [7].

3.3 Drying kinetics of tomato powder

The variation of moisture ratio versus drying time for the various air temperatures of 50, 60, 70, and 80 ºC. The drying followed a falling rate period and the increase in temperature accelerated the drying process. As hot-air temperature increased, moisture removal also increased and ultimately resulted in the reduction in drying time. Drying time reduced as the air temperature increased from 50 to 80 ºC. This means that there was significant savings in time as hot-air temperature increased.

Table 4: Drying kinetics of tomato powder

Sample	Initial weight (g) (W)	Reading for every 3 hour of time duration					Moisture content (%)= (a-b)*100 / W
		0	3	6	9	12	
T_1	100 g	18	15	13.5	5.5	2.5	6.26
T_2	100 g	18	16.5	14	6	3.5	5.4
T_3	100 g	18	13.5	10.5	5.5	2.5	4.8

* Each value represents the average of three determinations

From Table 4, it was observed that the moisture content was affected by the tray drying method. The total moisture content in fresh tomato was found to be 95.98 percent which were reduced in cabinet drying. The sample T_1 contained 6.26 percent and whereas sample T_2 had 5.4 followed by sample T_3 34.8 respectively. It was concluded that, the moisture content were found decreasing trends. Similar results were reported by Abano *et al*. (2011) [1].

4. Conclusion

In this study the drying characteristics i.e the amount of moisture removed for every 1hour by tray dryer at 60, 65 and 70 ℃ and every 3 hour by tray dryer is calculated for the respective samples. From the above study on dehydration of tomato slices in tray drying at 70 ℃ has shown better moisture removal content compared to the other conditions of drying with less time and gives better results in maintaining better quality, appearance, color and texture .

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