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Effect of Sulphite in Drying characteristics and Nutritional Aspects of Sun, Solar and Tray dried Tomato Slices

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ABSTRACT: Tomato being a climacteric fruit has short storage life under ambient storage conditions. Processing into other forms not only ensures efficient product utilization, but also ensures product availability year round. Drying is a cheap and one of the prime methods of processing, where the dried tomato is converted into powder and further incorporated in various cuisines, seasonings and in the dehydrated form along with other vegetables. Sun and solar drying has shown negative effect on the final dried product by undesirable blackening effect and microbial infestation. Besides these, the availability of sunlight had a huge impact in sun and solar drying process. Unpredictability in weather and non-uniform drying led to the use of mechanical dryers. Mechanical dryers like tray driers can not only provide faster drying rates but also reduce the chances of contamination. Use of pre-treatments like sulphiting not only inhibits the growth of microbiota, but also prevents oxidation and maintains color and flavor of the dried product. Care was taken that should the sulphite level do not exceed the given limit as prescribed by FSSAI. The effect of sulphite pre-treatment in drying rate, colour retention and nutritional retention is the main idea behind this study. In this research, a comparison of untreated and sulphite pre-treated samples of tomato slices by sun, solar and tray drying was studied and concurrently drying characteristics and nutritional analysis were performed.

Keywords: Tomato slices, Drying, Drying characteristics, Sulphite, Nutritional analysis.

INTRODUCTION

Tomato is one of the prominent vegetables across the globe. As per FAOSTAT (2010), tomato is the world's second most produced vegetable, with yearly output surpassing 100 million tons (Farag *et al.*, 2016).Tomato is the second most widely grown horticulture product, and the top in terms of industrialized volume (Filho *et al*., 1996; Bashir *et al*., 2014). Tomatoes are abundant in minerals, vitamins C and E, lycopene, phenolic flavonoids, and carotenoids, along with other nutrients and phytochemical constituents (Giovanelli and Paradiso 2002; Kalogeropoulos *et al*., 2012; Maiman *et al.,* 2021). Being a perishable commodity, tomato can be processed further to extend shelf life and make it available year round.

One of the most popular techniques for prolonging the shelf life of perishable wet products, lowering transportation and storage costs, and limiting quality loss is to dry those (Nazghelichi *et al.,* 2010). Drying diminishes moisture content as well as water activity, limiting microbiological growth (bacteria, yeasts, and molds) and oxidative and enzymatic reactions begetting product with safe storage and improved product shelf life (Sokhansanj and Jayas 1995; Sagar and Suresh 2010; Fernandes *et al.,* 2011; Beuchat *et al.*, 2013; Maiman *et al.,* 2021). When sun drying was utilized to dry tomatoes, resulting in lower-quality goods. The fruit tissue dries, darkens and develops a distinct flavor (Gupta and Nath 1984; Bashir *et al.,* 2014). Various chemicals have been employed as pre-treatments for drying of tomatoes, namely sodium chloride, potassium meta-bisulphite (KMS), calcium chloride, and sucrose (Lewicki *et al.,* 2002; Davoodi *et al.,* 2007; Souza *et al.,* 2007; Marfil *et al*., 2008; Farag *et al.,* 2016). Solar dryers have emerged to save energy and retain product quality. Solar dryers also employ a non-conventional and sustainable energy source of energy (Belessiotis and Delyannis, 2011; Maiman *et al*., 2021). To meet the demands of consumer, a solar dryer can not only dry a product quickly and uniformly but can also perform these under hygienic conditions (Condorı *et a*l., 2001). The influence of solar tunnel drying on the antioxidant and physicochemical characteristics of tropical fruits mango, banana, and papaya was investigated, and it was shown that solar tunnel drying enhanced the fruit's physicochemical and antioxidant properties while slightly lowering the vitamin C content (Abrol *et al.,* 2014; Maiman *et al.,* 2021). Mechanical dryers like tray dryers (convective dryers) are extensively used for the purpose of drying fruits (Nijhuis *et al*., 1998). This method is superior to solar drying since it uses a confined environment with controlled airflow and temperature. It is also a very efficient and simple process, although it is energetically ineffective (Radojčin *et al*., 2021).

This study focuses on drying characteristics and nutritional aspects of untreated and pre-treated (0.2% KMS) sun dried, solar dried and tray dried tomato slices.

MATERIALS AND METHODS

A. Materials

Fresh, whole, ripe tomatoes of almost similar size were purchased from a local market in Coimbatore, Tamil Nadu. Food grade KMS of Baker's brand was purchased for the experiment. Rust-less sharp stainless steel knives and potable water were used for slicing and soaking the tomatoes for pre-treatment.

B. Methods

The purchased tomatoes of hybrid variety were washed under running tap water to remove adhering dirt on the surface. It was sliced manually to uniform thickness of 10 mm using rust-less stainless steel knife, followed by soaking in 0.2% KMS solution for 10 minute. One set of samples were sliced without pre-treatment and kept aside for sun and solar drying.

Drying methods

Hot Air Oven. Hot air oven was used for estimating the initial moisture of tomato. 5 g of fresh tomato was kept in hot air oven at 105±1°C in a petri dish and reduction in weight was noted for every hour interval. This process was continued until constant weight was obtained.

Sun drying. Sliced tomatoes with and without pre-treatments were spread uniformly over aluminium trays and placed with maximum exposure of sun light. This experiment was performed during the month of December, from 9 am to 5 pm. The average temperature and relative humidity during the study was 29ºC and 52.2%. The drop in weight was noted for every one hour interval. The samples were dried until constant weight was obtained.

Solar drying. Compound parabolic collector (CPC) based solar dryer available in Renewable Energy Department of Tamil Nadu Agricultural University was used in this study. The temperature and relative humidity throughout the drying process varied based on the solar intensity. Temperature and relative humidity was noted using a digital hygrometer. The lowest and the highest temperature were 23.64ºC and 61.33ºC. The lowest and the highest relative humidity were 19.07% and 29.51%.Reduction in weight for both samples with and without pre-treatments was noted for every hour interval. The samples were dried until constant weight was obtained.

Tray drying. Trays of the tray dryer were loaded and the slices were equally spaced for better air circulation. The temperature was set to 60ºC and the blower fan was switched on for uniform distribution of hot air throughout the chamber. Fresh samples and pre-treated slices of tomato were dried and the experiment was performed for every 15 minute interval until constant weight of tomatoes was obtained.

C. Nutritive analysis

The prescribed AOAC (2005) methods for nutritive analysis of dehydrated vegetables have been used in this experiment.

RESULTS AND DISCUSSION

A. Drying rate curves

To understand the effect of sulphited pre-treatment on various drying methods, drying rate curves were studied. The drying rate curves of sun drying, solar drying and tray drying are illustrated in Fig. 1, 2 and 3 respectively. From the figures, it can be seen that pre-treated samples had faster drying rates compared to the untreated samples in all three methods of drying. Tray drying had the least drying time of about 3 hour, followed by solar drying which took nearly 400 minute (6.6 hour) and the most time consuming drying process being sun drying consuming 7 hour.

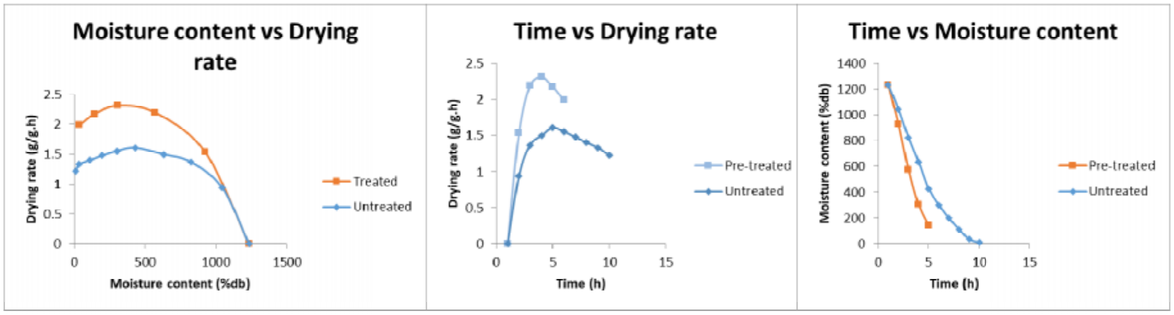

Fig. 1. Sun drying of untreated and pre-treated tomato slices.

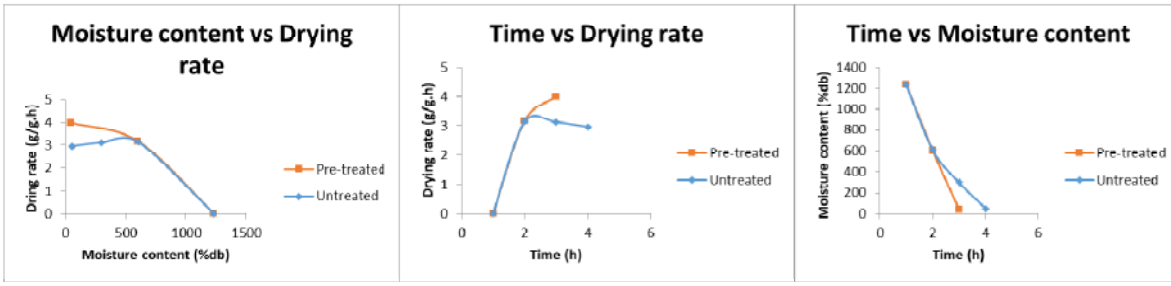

Fig. 2. Tray drying of untreated and pre-treated tomato slices.

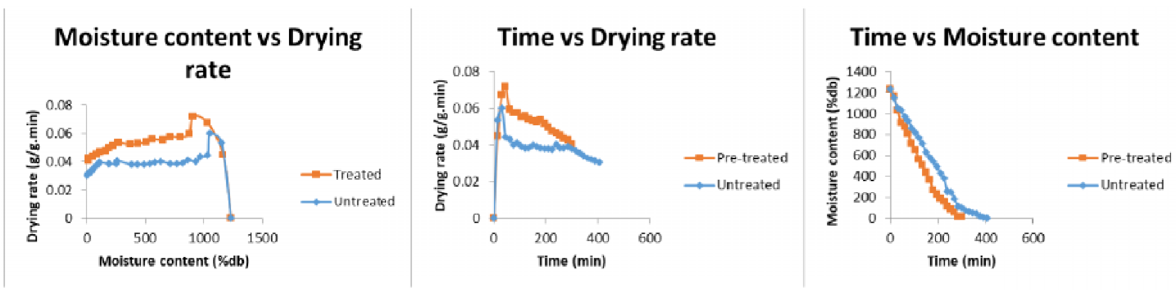

Fig. 3. Solar drying of untreated and pre-treated tomato slices.

B. Nutritional aspects

All the pre-treated samples were subjected to nutritive analysis following AOAC (2005) procedures and were compared to fresh sample. The results of the analysis are tabulated in Table 1.

Table 1: Nutritive analysis of samples.

Samples	Moisture (g/100 g)	Carbohydrate (g/100 g)	Protein (g/100 g)	Dietary fiber (g/100 g)	Calcium (mg/100 g)	Iron (mg/100 g)	Phosphorus (mg/100 g)	Lycopene (µg/100 g)	Ascorbic acid (mg/100 g)
Fresh	92.50	3.20	0.76	1.58	10.17	0.30	18.77	2481	25.27
Sundried sample									
Untreated	5.00	2.75	0.57	1.39	9.81	0.19	17.64	1939	2.16
Pre-treated	5.30	3.05	0.69	1.41	9.94	0.21	18.47	2000	3.20
Solar dried sample									
Untreated	6.40	3.09	0.71	1.48	10.07	0.23	18.61	2096	8.00
Pre-treated	6.80	3.13	0.72	1.56	10.11	0.26	18.69	2119	8.93
Tray dried sample									
Untreated	8.00	3.11	0.70	1.53	10.12	0.26	18.70	2134	11.00
Pre-treated	8.30	3.15	0.73	1.57	10.14	0.27	18.73	2157	11.30

From the analysis, it was inferred that tray dried tomato slices had better nutrient retention in comparison to sun and solar drying. In an overall view, there has been a nutrient depletion, with the least degradation in sulphited tray dried samples of tomato.

In the context of moisture content, the pre-treated samples had negligible moisture retention than the control samples. Prior to drying, the tomato's initial moisture level was found to be 93.2% wet basis (Idah *et al.,* 2010). The moisture content for the fresh tomato was determined to be 92.5 percent, and after solar drying, it was significantly reduced to 3.95 percent (Maiman *et al*., 2021).

There has been a decrease in lycopene content in dried samples compared to the fresh tomato slices. Isomerization and oxidation (auto-oxidation) while processing are the main factors of lycopene degradation in tomatoes (Tan *et al.,* 2021). Exposure to oxygen and heat had resulted in lycopene destruction (Shi *et al.,* 1999). There was about 87% retention of lycopene in the sulphited tray dried sample and the least retention of lycopene was observed in untreated sun dried sample at 78%.

Ascorbic acid had significant reduction and this may be contributed to the fact this is a heat-labile vitamin. Due to the high heat sensitivity of vitamin C, the combination of drying temperature and duration influences how far the vitamin C is retained (Santos and Silva 2008). The action of sulphur dioxide, which inhibits endogenous enzymes such ascorbic acid oxidase, cytochrome oxidase, and peroxidase, may be the cause of the increased maintenance of vitamin C in KMS pretreatment samples compared to the control sample (Chapagain *et al.,* 2018). Poor retention of vitamin C was obtained as done in previous studies, with the highest contribution of vitamin C contributed to solar dried sample having 44.7% as compared to the fresh sample.

A negligible change in carbohydrate, protein, dietary fiber, calcium, iron and phosphorus content are observed for all the samples. Undesirable blackening effect and chances of microbial infestation are high in sun and solar drying due to the inability to maintain temperature and relative humidity throughout the drying process.

CONCLUSION

Sulphite pre-treatment had a positive impact in color of the dried slices and had maintained the nutritional value up to certain extent. Among the three drying methods, tray drying came out to be the best in contrast to solar and sun drying. In tray drying, the sulphited tomato slices was comparable to untreated sample. Pre-treatment with 0.2% potassium meta- bisulphite for 10 minute followed by tray drying can provide good quality dehydrated tomato slices. As a result, sulphite pre-treated tomato slices subjected to tray drying can be a good solution to obtain a quality dried product. However, the level of sulphite added should be kept keen as it has potential health hazards, especially for people with asthma and respiratory issues.

FUTURE SCOPE

The uses of reducing agents like sulphites do have a noticeable effect on the visual appeal and nutritional value of dried products. In spite of these, care should be taken not to cause any side effects on consumption. Instead, use of hydrogen gas in the drying atmosphere which has similar reducing property as that of reducing agents can be tried. This novel idea has been given and put forth into action by Alwazeer and Betu (2019) in drying of apricots. This could even be the future scope in drying industries where reducing agents are replaced due to health consciousness of the consumers.

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Conflict of Interest. None.

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