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Effect of different pre-treatments and dehydration methods on quality characteristics and storage stability of tomato powder

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Abstract

Dehydration process was carried out for tomato slices of var. Avinash after giving different pre-treatments such as calcium chloride ($CaCl_2$), potassium metabisulphite (KMS), calcium chloride and potassium metabisulphite ($CaCl_2$ + KMS), and sodium chloride (NaCl). Untreated samples served as control. Solar drier and continuous conveyor (tunnel) drier were used for dehydration. Quality characteristics of tomato slices viz. moisture content, sugar, titratable acidity, lycopene content, dehydration ratio, rehydration ratio and non-enzymatic browning (NEB) as affected by dehydration process were studied. Storage study was also carried out for a period of 6 months for tomato powder packed into different types of packaging materials viz. metalized polyester (MP) film and low density polyethylene. Changes in lycopene content and NEB were estimated during storage at room temperature. Pre-treatment of 5 mm thickness of tomato slices with $CaCl_2$ in combination with KMS and drying using a tunnel drier with subsequent storage of product in MP bags was selected as the best process.

Keywords: Drying pre-treatments; Solar drying; Tunnel drying; Tomato powder

1. Introduction

The preservation of fruits and vegetables by dehydration offers a unique challenge. Due to the structural configuration of these products, the removal of moisture must be accomplished in a manner that will be least detrimental to the product quality. Tomato has a limited shelf life at ambient conditions and is highly perishable. It creates glut during production season and becomes scanty during off-season. Short shelf life coupled with inadequate processing facilities results in heavy revenue loss to the country. The demand for dehydrated tomato is increasing rapidly both in domestic and in international market with major portion of it being used for preparation of convenience food. Thus, there exists a need to develop suitable technology for processing and preservation of this valuable produce in a way that will not only check losses but also generate additional revenue for the country.

Tomato as other fruits and vegetables can be dried using various methods. The quality of dehydrated tomato depends on many parameters such as tomato variety, total soluble solid content (°Brix) of the fresh product, the air humidity, the size of the tomato segments, the air temperature and velocity and the efficiency of the drying system. The rate of drying affects the final quality of dehydrated product.

Tomato has a limited shelf life at ambient conditions and is highly perishable. It creates glut production season and becomes scanty during off-season. Short shelf life coupled with inadequate processing facilities results in heavy revenue loss to the country. The demand for dehydrated tomato is increasing rapidly both in domestic and international market with major portion of being used for preparation of convenience food. Thus, there exist a need to develop suitable technology for processing and preservation of this valuable produce in a way that will not

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only check losses but also generate additional revenue for the country.

The objectives of the present investigation were: (a) to study the effect of different pre-treatments on physicochemical characteristics of tomatoes var. Avinash; (b) to determine the influence of different types of driers and dehydration conditions on physicochemical properties of tomato slices; and (c) to study the lycopene retention and browning reaction as affected by different packaging materials, pre-drying treatments and dehydration methods after storage.

2. Materials and methods

2.1. Source of material and sample preparation

Tomatoes of var. Avinash harvested from a farm near the institute and used for the experiments. Tomatoes were sorted and washed with water to remove dirt and soil; further tomatoes were cut into the slices with thickness of 5 mm by using a slicing and dicing machine (HADDLE RG-400, Sweden).

2.2. Pre-treatments given prior to dehydration process

The tomato slices were treated as follows: (a) Dipping in 1 g/100 g calcium chloride ($CaCl_2$) in water solution (1:1 w/w) at room temperature for 10 min. (b) Dipping in potassium metabisulphite (KMS) 0.2 g/100 g solution (1:1) at room temperature for 10 min. (c) Dipping in 1 g/100 g $CaCl_2$ in combination with 0.2 g/100 g KMS in an equal mass of water for 10 min. (d) Dipping in 7 g/100 g sodium chloride (NaCl) at 80 °C for 5 min in an equal mass of solution. The salt concentration and temperature were standardized in preliminary studies. Best combination was selected based on minimum salt absorption and maximum moisture removal. (e) Tomato slices dipped in an equal mass of plain water for 10 min at room temperature were considered as control sample.

2.3. Chemical analysis

Moisture content was estimated as described by Rangana (2000). The carbohydrate content in tomato was determined by the phenol-sulphuric acid method (Dubois, Gilles, Hamilton, Rebers, & Smith, 1956). To 0.1 ml of suitably diluted sample, 0.4 ml of distilled water, 0.3 ml of 5 g/100 g phenol were added and mixed thoroughly. To this, 1.8 ml of concentrated sulphuric acid was added and mixed. The color obtained was read at 480 nm. Glucose was used as standard. Titrable acidity (TA) was determined according to Rangana (2000).

2.4. Estimation of lycopene content by HPLC method

Lycopene extraction procedure was similar to the published procedure for carotenoids extraction from vegetables and fruits (Hart & Scott, 1995). For every storage condition, 2 replicate samples of tomato either fresh tomato (10–20 g, in different stages of ripening) or powder (0.3 g, reconstituted by addition of 10 ml of distilled water), vortexed for 1 min, and transferred into a glass fiber filter (10–20 μm) Buchner funnel. 40 ml of tetrahydrofuran and methanol (1:1 v/v THF: MeOH) were added and the suspension filtered under vacuum. When needed for additional removal of color, a second extraction was done with 20 ml THF/MeOH as described to produce a gray/white precipitate. The combined filtrate was transferred to a separatory funnel. Twenty milliliter of petroleum ether (40–60 °C fraction) and 20 ml 10 g/100 g NaCl solution were added and mixed by careful shaking. The lower THF/MEOH/aqueous phase was drawn off. The upper soluble materials, transferred into a 50 ml flask, and evaporated to dryness under nitrogen. The residue was dissolved, to a final volume of 4 ml of hexane, filtered (0.45 μm) and analyzed by high performance liquid chromatography (HPLC). All procedures were performed under reduced light.

Reverse phase HPLC was used with C18 (201 TP540) analytical column (5 μm, 25 cm × 4.6 mm; VYDAC, Hesperial, CA, USA). A 20 μl loop was used for solvent injection. Solvent delivery was achieved with spectra physics Sp8800 system at a flow rate of 1 ml/min. An isocratic mobile phase system of acetonitrile: methanol: 2-propanol (44:54:2 by volume) was used. Detection was monitored with a diode array 1040 A Hewlett Packard absorbance detector that also stored spectral data over the range of 190–600 nm for spectrophotometric peak identification. The chromatograms were simultaneously monitored at 350, 470 and 503 nm. Lycopene standard was obtained from Sigma chemical Co. (St. Louis, MO, USA). Peak identification was based on retention time and published absorbance spectral data. Lycopene in extracts of tomato powder was quantified spectrophotometrically using photo diode array detector ($\lambda_{max} = 470$ nm) using UV–visible.

2.5. Dehydration processes

Pre-treated tomato slices were drained thoroughly after dip treatments and used for dehydration using two different dehydration techniques.

A pilot-plant scale solar drier was used for the dehydration experiments of tomato. Solar drier had dimensions of 1.0 × 1.0 × 1.5 m made from galvanized steel and covered with 5 mm thickness transparent glass with a tilt angle of 30 °C facing in South east for optimum solar radiation in Mysore (India) located at 770 m above sea level at 12.18°N 76.42°E. Four flat plate photo-cells were provided for drier to absorb the solar energy which is used to run four small fans, so that the circulation of air can facilitate dehydration process. The equipment was kept in open place exposed to the sun light for drying process. Treated tomatoes were loaded into the trays at rate of