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Quality Characteristics of Freeze and Cabinet Dried Tomato Pomace

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ABSTRACT

In the present study the tomato pomace was subjected to two different types of dryings: freeze drying and cabinet drying. The freeze dried pomace was found having better retention of color, lycopene and total phenolics in comparison to cabinet dried pomace. Initially, the pomace was found to have ascorbic acid content of 19.32 mg/100g, lycopene content of 12.75mg/100g, and phenolics content of 60.20 mg GAE/100g. After drying the pomace was found to have higher contents of lycopene and total phenolics, due to the release of these constituents from cells and tissues. The freeze dried pomace was found to have higher amounts of lycopene (95.25) and total phenolics (85.30) as compared to cabinet dried (80.30) and (65.30) respectively. The freeze dried pomace also retained better color than cabinet dried due to more browning in cabinet drying. Due to the presence of these bioactive constituents, the dried tomato pomace could found better utilization in bakery products as a functional ingredient.

Key words: *Tomato, Solanaceae, Fruit, Fat*

INTRODUCTION

Tomato (*Lycopersicon esculentum*) belongs to family Solanaceae, is one of the most popular and most consumed vegetable constituting an integral part of human diet worldwide. Significant amounts are consumed in the form of processed products such as juice, paste, puree, ketchup, and sauce. Tomato (*Lycopersicon esculentum* L.) is one of the most consumed vegetables in the world, both as fresh and in processed form. Tomato is grown in almost every corner of the world from the tropics to within a few degrees of the Arctic Circle. During tomato processing a by-product, known as tomato pomace, is generated. This by-product represents about 4% of the fruit weight.

Tomatoes are widely consumed either raw or after processing and can provide a significant proportion of the total antioxidants in the diet[9]. Tomatoes constitute the predominant source of lycopene and phenols in the diet because of their year round availability, high utility in culinary preparations and their cheap price. However, when tomatoes are processed into products like Catsup, tomato paste and sauces, 10–30% of their weight becomes waste or pomace[5]. The pomace consists of the crushed skins and seeds of the fruit.

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The pomace is rich in protein (20–23% on dry basis) and fat (12–18%, mostly located in the seeds), while crude fibers comprise the third main component (12–30%)[8]. Food by-products usually represent an environmental problem for the industry, and many studies have been carried out about the potential utilization of several vegetable origin byproducts for their inclusion in the human diet, which could reduce industrial costs and justify new investments in equipment, providing a correct solution for the pollution problem connected with food processing[7]. Al-Wandawi *et al*.,[2] reported that tomato skin contains high levels of lycopene compared to the pulp and seeds. In addition, tomato seeds and skin were reported to contain essential amino acids and tomato seeds had particularly high amounts of minerals (Fe, Mn, Zn and Cu) and monounsaturated fatty acids (especially oleic acid).

Drying is a process that has been used for centuries to preserve foods. Fruits like tomato, which have a short shelf life and are sold for only a short season during the summer, can benefit from this process to make it more available throughout the year and to make it more versatile for use in different products. Because the drying method and the conditions used will impact how different properties of the product are affected, it is important to evaluate the quality of the product after drying. In the case of tomato, which is rich in lycopene, this is especially important since lycopene is very sensitive to light, heat, and oxygen and therefore, the drying method used will affect how much lycopene will be lost. Color is an important quality attribute of foods, especially when it comes to their acceptability, and it is important to study how processing may affect it. Color usually changes during drying due to a number of chemical and biochemical reactions including enzymatic and non-enzymatic browning, caramelization, and ascorbic acid browning.

The drying reduces the moisture content of the product and enhances its shelf life, reduce packaging costs, enhance appearance, encapsulate original flavor, and maintain nutritional value. The pomace being highly perishable and subjected to microbial degradation leads to environmental pollution and problem of disposal. So, different drying methods were available in order to reduce the problem especially, freeze and cabinet drying. Freeze drying was carried out to retain most of the phytochemicals especially lycopene in tomato pomace. The cabinet drying however resulted in some loss of vitamins and other nutrients. Krokida *et al*.[6] reviewed the effect of hot air, vacuum, microwave, freeze- and osmotic-drying on the color of dehydrated agricultural commodities and stated that the browning of fruits and vegetables during drying is due to both enzymatic and non-enzymatic browning reactions. Browning is usually a negative quality attribute, but other studies show that overall antioxidant properties of some foods may be enhanced due to formation of melanoidins during the advanced steps of the Millard's reaction[3]. The dried pomace was later grounded into fine powder by the use of grinder-mixer. Keeping in view the nutritional importance of tomato pomace research was conducted to evaluate its potential value for different purposes.

The objectives of this study were to:

A) Evaluate the physico-chemical composition of tomato pomace
B) To study the effect of different drying methods on quality of tomato pomace.

MATERIAL AND METHODS

Generation of Pomace

The study was carried out during 2014-15 in the Division of Post Harvest Technology. The tomatoes were procured from the Division of Olericulture at a mature stage and were brought to the Food Processing and Training Centre (FPTC) for processing. Tomatoes were sorted, weighed, washed and poured in to a pulper to extract juice. After extraction of tomato juice, the leftover material is pomace which includes seeds, skin and pulp. The juice and pomace obtained were weighed to determine the percentage yield of each component, which was calculated by dividing component weight by the total weight of the

fruit processed and then multiplied by 100. The pomace obtained was divided into two lots: one lot of pomace was cabinet dried in a cabinet drier. The pomace was spread thinly on the trays and placed inside the drier at a temperature of 60 ^{o}C for 8-9 hours. The dried pomace was ground in a grinder and sifted through a mesh sieve into a fine powder. The other lot of pomace was placed in a freeze drier for 12-13 hrs and then ground into fine powder.

Chemical characteristics

Analytical methods

Determination of Moisture Content

Moisture was estimated by weighing accurately 5g of ground sample and subjected to oven drying at 70 ^{o}C for 4h. It was again weighed after cooling in desiccators until the constant weight was obtained. The resultant loss in weight was calculated as moisture content.[1]

$$MC = \frac{(W2-W) \times 100}{W1-W}$$

Where, W= Weight of empty petridish

W1= Weight of petridish with sample before drying

W2= Weight of petridish with sample after drying to constant weight

Determination of fat

5g ground sample was weighed accurately to thimble and defatted with the petroleum ether in soxhlet apparatus for 6-8 hours at 180 ^{o}C. The resultant ether was evaporated and lipid content was calculated.[1]

$$\text{Fat (\%)} = \frac{(W2-W1)}{W} \times 100$$

Where, W2= Weight of flask with oil (g)

W1= Weight of empty flask (g)

W=Weight of initial sample (g)

Determination of protein

Protein was determined by Micro-kjeldhal method[1] using 0.5g of ground sample by digesting the same with concentrated H2SO4 containing catalyst mixture for 3-4 hours at 450 C. It was then distilled with 40% of NaOH and liberated ammonia was trapped in per cent of boric acid and then it was titrated with 0.1N HCL using mixed indicator (Methyl red: Bromocresol green @ 1:5). The percent percentage was estimated in the sample using multiplying factor 6.25.

$$\text{Nitrogen \%} = \frac{[(\text{sample titer} - \text{blank titer}) \times \text{Normality of HCL} \times 14 \times 100]}{[(\text{Weight of sample} \times 100)]}$$

$$\text{Protein \%} = \text{Nitrogen\%} \times 6.25$$

Determination of carbohydrate

5g of sample was weighed accurately in test tube and kept in ice water bath for few minute followed by the addition of cold H_2SO_4 (72%) with gentle stirring. The viscous pest was diluted with distilled water to obtain final concentration 2N with respect to acid. It was then refluxed at 980C for 3-4 hrs to achieve complete hydrolysis. The sugar content was estimated by phenol H_2SO_4 method, using glucose as standard curve. The optical density was measured at 480nm using spectrophotometer.

$$\text{Amount of carbohydrate in 100mg of sample} = \frac{\text{mg of sample} \times 100}{\text{Volume of test sample}}$$

Determination of ash content

5g of sample was weighed into crucible which was heated at low flame till all the material was completely charred and cooled. Then it was kept in muffle furnace for about 5hrs at 6000C. It was again cooled in desiccators and weighed and repeated until two consecutive weights were constant. The percent ash was calculated by knowing the difference between initial and final weight.[1].

$$\text{Total ash} = \frac{(W2-W)}{W1-W} \times 100$$

Where, W= Weight of empty dish

W1=Weight of dish with sample

W2=Weight of dish with ash

Determination of crude fiber

The fat free sample (2g) was taken in triplicate and digested with 200ml of 1.25% H2SO4 by gentle boiling for 30 min and filtering the content through muslin cloth under succession. Washed the residue free of acid using hot distilled water and then transferred to the beaker for alkali digestion by treating with 1.25% NAOH (200ml) for 30 min. the contents were filtered through muslin cloth. Wash the residue free of alkali by using hot distilled water. The residue was dried in an oven for 4hrs. The loss in weight after ignition represents the crude fibers content in the sample[1].

Determination of Total Phenolic Content*.:*

Determination of total phenolic contents was performed using Folin- Ciocalteu reagent as adapted from Velioglu *et al*.[12] with slight modifications. In brief, 20 μL of extract was mixed with 100 μL of Folin-Ciocalteu reagent previously diluted with 1.58mL of distilled water and allowed to stand at room temperature for 8min; 300 μL of sodium carbonate (20%) solution was added to the mixture. After 120 min at room temperature, absorbance was measured at 725nm within the range of linearity (0.05–0.8mM). Results were expressed as mg gallic acid equivalents in 100 g of the dried extract (mg GAE/100 g). Each measurement was performed in triplicate.

Ascorbic acid

Ascorbic acid content was determined as per AOAC[1] using 2, 6-dichlorophenol indophenol dye. The sample was extracted in 3 per cent metaphosphoric acid (HPO_3) solution and titrated with the standard dye to pink colour persisting for 15 seconds. The results were expressed as mg/100g of sample.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre x Dye factor x Volume made up}}{\text{Aliquot of extract taken x Weight of sample}} \times 100$$

Sugars:

a. Reducing sugars

Sugars were estimated according to Lane and Eynon,s volumetric method given by Ranganna. Measured quantity of sample (20g) was taken in 250 ml volumetric flask to which about 100 ml distilled water was added and neutralized with 40 per cent sodium hydroxide using phenolphthaline as indicator and clarified with 2 ml of 45 per cent neutral lead acetate for about 10 minutes. Excess of lead was removed by adding 5 ml of 22 per cent potassium oxalate. The volume was made to 250 ml and filtered through whatman No. 4 filter paper. 100 ml of the filtrate was taken and hydrolysed by adding 5 ml of concentrated HCl and kept overnight for estimation of total sugars. Boiling mixture containing five ml each of Fehling A and Fehling B was titrated against aliquot using methylene blue as indicator. The end point was marked by the appearance of brick red colour. Volume of aliquot was noted and the reducing sugars were calculated as per the procedures described in A. O. A. C.[1].

b. Total sugars

For estimation of total sugars the excess of HCl in aliquot was neutralized by adding NaOH. Boiling mixture containing 5 ml each of Fehling A and Fehling B was titrated against hydrolysed aliquot, using methylene blue as indicator. The end point was marked by the appearance of brick red colour. Total volume of aliquot used was noted and the total sugars were calculated by the procedure described in A. O. A. C.[1].

$$\text{a) \% Reducing sugars} = \frac{\text{Factor x Dilution}}{\text{Titre x Weight of sample}} \times 100$$

$$\text{b) \% Total sugars} = \frac{\text{Factor x Dilution x Dilution x100}}{\text{Titre x Weight of filtrate x Weight of sample}}$$

Titratable acidity

Titratable acidity was determined by titrating a known quantity of sample (10 ml) against standard solution of 0.1 N sodium hydroxide to a faint pink colour using phenolphthalein as indicator. The results were expressed as percent citric acid.

$$\% \text{ Titratable acidity} = \frac{\text{Titre} \times \text{Normality of alkali} \times \text{Equivalent weight of acid} \times 100}{\text{Volume of aliquot taken} \times \text{Weight of sample taken} \times 1000}$$

Lycopene Analysis

Sample (2 g) was extracted with acetone in a pestle and mortar till residues became colourless. Lycopene was transferred into petroleum ether phase by diluting acetone extract in a separating funnel, passed through sodium sulphate, volume made to 50 ml and absorbance was measured at 503 nm using UV visible spectrophotometer[10]. The extinction coefficient (17.2 x104 mol cm^{-1}) was verified with standard lycopene solution (Sigma Chemical) and used to calculate the lycopene in sample.

Statistical analysis

The results obtained were statistically analysed using Completely Randomised Design (CRD) and CRD factorial for interpretation of results through analysis of variance.

RESULT AND DISCUSSION

During tomato processing the by-product generated is "tomato pomace". It represents, at most, 4 % of the fruit weight. Tomato pomace consists of the dried and crushed skins and seeds of the fruit. The skin, important component of pomace, is rich source of lycopene. Lycopene is an excellent natural food color and also serves as a functional ingredient with important health benefits beyond basic nutrition. Table 1 reveals the bioactive and physico-chemical characteristics of fresh tomato pomace. The physico-chemical characteristics of the fresh tomato pomace revealed that the fresh tomato pomace contained 87.36 per cent moisture content, 4.50 per cent total sugars, 1.10 per cent ash, 0.28 per cent acidity, 2.20 per cent soluble fibre, 3.10 per cent insoluble fiber. The bioactive constituents of tomato pomace include ascorbic acid 19.32 mg/100, lycopene 12.75 mg/100g and total phenolics 60.20 mg GAE/100g.

Table 1: shows the physic- chemical characteristics of fresh tomato pomace

Moisture content (%)	87.63 ± 0.12
Total sugars (%)	4.50± 0.70
Ash content (%)	1.10± 0.65
Ascorbic acid(mg/100g)	19.32± 0.42
Total phenolics(mg GAE/100g)	60.20± 0.35
Lycopene content (mg/100g)	12.75± 0.20
Soluble fibre (%)	3.10± 0.21
Insoluble fibre (%)	2.20± 0.11
Acidity (%)	0.28± 0.12

The tomato pomace so obtained was subjected to different drying methods namely cabinet drying and freeze drying. The cabinet drying was carried under cabinet drier and freeze drying by freeze drier. The dried pomace obtained was analyzed for different parameters. Table-2 reveals the effect of different drying methods on physico-chemical characteristics of tomato pomace. The table revealed that the cabinet dried tomato pomace contained 95.23 per cent dry matter, 32.07 per cent total sugars, 7.82 per cent ash, 10.15 mg/100g ascorbic acid, 80.30 mg/100g lycopene, 65.30 mg GAE/100g total phenolics, 1.99 per cent acidity, 22.09 per cent insoluble fibre, 15.68 per cent soluble fibre. On the

other hand the freeze dried tomato pomace had 92.63 per cent dry matter, 31.20 per cent total sugars, 7.62 per cent ash, 17.10 mg/100g ascorbic acid, 95.25 mg/100g lycopene, 85.30 mg GAE/100g total phenolics, 1.94 per cent acidity, 21.44 per cent insoluble fibre, 15.25 per cent soluble fibre.

Table 2: Chemical composition of dried pomace

Parameter	Cabinet dried pomace	Freeze dried pomace
Dry matter (%)	95.23	92.63
Total sugars (%)	32.07	31.20
Total ash (%)	7.82	7.62
Ascorbic acid (mg/100g)	10.15	17.10
Lycopene content(mg/100g)	80.30	95.25
Total phenolics (mgGAE/100g)	65.30	85.30
Insoluble fibre (%)	22.09	21.44
Soluble fibre (%)	15.68	15.25
Acidity (%)	1.99	1.94

The tomato pomace obtained through cabinet drying had ascorbic acid content of 10.15 (mg/100g) while as the tomato pomace obtained through freeze drying having ascorbic acid content of 17.10 (mg/100g). There is considerable degradation of ascorbic acid during dehydration process and the extent of degradation is correlated to the severity of heat and oxidative stress. In case of freeze drying due to low temperature and presence of vacuum, the ascorbic acid degradation is reduced to a considerable extent as compared to the cabinet drying. The results are in proximity with Toor and Savage[11] and Davinder and Dalbir[4]. The freeze dried tomato pomace was found to contain significantly higher amounts of lycopene (95.25mg/100g) than cabinet dried (80.30mg/100g) due to less heat damage as compared to cabinet drying. Similar results were obtained by Yaymed D. A. in watermelon pomace. Similarly, total phenolics were found higher in freeze dried pomace (85.30) as compared to cabinet dried pomace (65.30), mainly due to little damage of heat compared to cabinet drying. Simiar results were found by Yaymed D. A. in watermelon pomace. The color retention was better in freeze dried pomace as compared to cabinet dried pomace as shown in fig 1.

CONCLUSION

The study revealed that the effect of freeze drying on tomato pomace was significant as compared to cabinet drying in relation to lycopene content and total phenolics content, which are having health related benefits and found subsequent application for different purposes in bakery, confectionery etc. The dried pomace could be ground into fine powder and utilized for incorporation in

various products to enhance nutritional importance especially the antioxidant effects of lycopene and phenolics.

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