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COMPARATIVE STUDY OF THE QUALITIES OF TOMATO (*SOLANUM LYCOPERSICUM* L.) DRIED WITH NSPRI'S DRYER (PSSD) AND CONVENTIONAL DRYING METHOD

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ABSTRACT

The effect of Parabolic Shaped Solar Tent Dryer (PSSD) in drying tomato was compared with Conventional method of drying in this study. The tomato sample used for this experiment was taken through some standard pre-processing procedures of sorting, washing, slicing, and divided into two groups (drying methods) and each drying method was further divided into two sub-groups where one was untreated (A) and the other blanched (B). The first group was dried with PSSD while the other group was dried by using conventional method. At the end of drying exercise, moisture and ash content of the dried sample ranged from 11.81-17.97% and 7.65-9.13% respectively. The vitamin C content of the dried sample ranged from 38.07-151.33mg/100g compared with the fresh which was 1943.95mg/100g, also lycopene and beta-Carotene content ranged from 0.03-0.18mg/g and 0.18-0.7mg/g respectively. The results indicated that losses in vitamin C, lycopene, and beta-carotene from fresh to dried were significant ($p \leq 0.05$). However, there was no significant difference in the vitamin C between the samples dried in NSPRI' dryer and conventional method. Microbial load reduced significantly ($p \leq 0.05$) in compared NSPRI' dryer with conventional method. The study showed that NSPRI's dryer is safe in term of hygiene and effectiveness in the drying of tomato.

Keywords: Drying, Hygiene, Pre-processing, Tomato, Treatment.

INTRODUCTION

Fruits and vegetables are basic part of balanced diet. They remain an integral part of the world agricultural food production, though they are produced in small quantities in contrast to grains. Fruit and vegetables are good sources of digestible carbohydrates, minerals, and vitamins, particularly vitamins A and C (Idah *et al*., 2010). Tomato has remarkable combination of antioxidants, which include lycopene, beta-carotene, polyphenols, and vitamin C (Tyssandier *et al*., 2004). Tomato is a perishable crop because of its high water content, making it to be prone to a short shelf life of about 48 hours under tropical conditions. Thus, a specialized postharvest handling methods, treatment and practices are needed to extend the shelf life of the crop after harvest (Arah *et al.*, 2016). Major challenges along tomato value chain in Nigeria had been identified to include deficiency in critical inputs such as lack of improved technology, low yield and productivity, high post-harvest losses, lack of processing and marketing infrastructure (Ugonna *et al*., 2015).

Drying is a simple process of dehydration by removing excess solute content from an agricultural or industrial product (Habou *et al*., 2003). The problem of ensuring food security in most developing societies is making food available all year round. Most agricultural products get spoilt easily and they tend to be available at a particular season but absent at

other seasons (Habou *et al*., 2003). Scarcity of agricultural products in certain seasons makes food preservation an important activity in households and communities. Thus, drying ensures the availability of perishable products all year round (Habou *et al*., 2003). Food preservation with drying has been in existence for a very long time (Kumar *et al*, 2015). It provides a better way to preserve food nutritional content and makes it easy to transport and store. Usually during drying two processes are involved simultaneously, i.e. heat transfer from the heating source to the produce and mass transfer of moisture from the interior of the product to its surface and from the surface to the surrounding air. The basic need of drying is to reduce the water content of the product to a barest minimum that prevents spoilage within a specific period, normally regarded as the safe storage period (Kumar et al, 2015).

Traditionally in Nigeria, farmers dry tomatoes in batches spread in open sun, on mats, rock surfaces, mud roofs or bare grounds. Smallholder tomato farmers embark on sun drying to salvage part of their farm income when there is a harvest glut. Thus, the process of sun drying is slow; exposed to delayed or discontinued drying during intermittent rains with consequent mould problems at high moisture. It is difficult to determine the drying time and also result in contamination of the products by flies, birds, rats, insects thereby, bringing about infestation by microorganism (Vuillaume and Tobe, 2017).

Parabolic shaped solar dryer (PSSD) is a solar drying technology for dehydration of agricultural produce. It has a cross sectional view of a parabola with major components made of metal (frame and drying racks and trays) and acrylic (covering materials). The floor is constructed of black materials with proper insulation to prevent heat sink to the ground. In its installation is a set of solar powered blowers for even heat distribution in the drying chamber as well as an aspirator for moisture removal from the system.

Awareness is lacking on the benefit of NSPRI's Improve handling technologies for quality, safety and storage of crops and products, including data for selling NSPRI's Parabolic Shaped Solar Dryer (PSSD) for improved drying of agricultural crops. Although the dryer has been used for crop drying, its effect has not been compared with the conventional method of drying. Thus, the aim of this study was to compare tomato slices dried in NSPRI's dryer with conventional drying method and to determine effectiveness of use and performance.

MATERIALS AND METHODS

Sample Source and Treatment

Tomato variety referred to as UTC (Rio-Grande) was procured in baskets from Mandate market, Ilorin, Kwara State, Nigeria in the month of February 2019 and was taken through standard processing operation of weighing, sorting, washing and manual slicing (average thickness of 5.00 mm transverse section) for treatment groups lots as follows:

Procurement

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Weighing

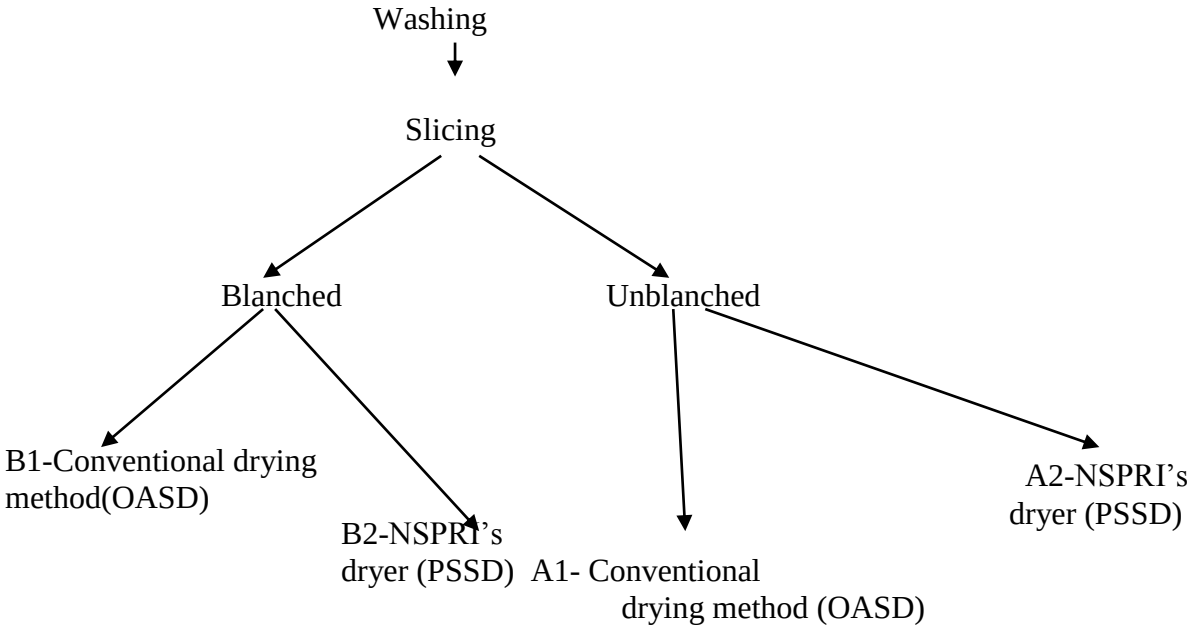
↓

Sorting

↓

Re-weighing

↓



Pre-drying treatment lots of sliced tomato were spread on drying trays of NSPRI's Dryer and conventional drying method to represent common method of drying by farmers with thermo-hydrograph equipment installed (Data logger: TemLog 20H) for temperature and relative humidity record and they were respectively weighed using (CAMRY ACS-30-JE11) and monitored for evaluation of quality parameters (sensory evaluation, physicochemical properties, nutritional and microbiological quality).

Sensory evaluations

Evaluation of the sensory attributes was carried out on the tomato lots daily during drying. Samples were presented to 5-member panelists who were made conversant with consideration for scoring samples for dryness, color, odour, moldiness, and overall acceptability using a five-point hedonic scale (where 5 stands for excellent).

Microbiological analysis

Determination of microbiological qualities of fresh and PSSD dried tomato samples was by serial dilution pour plate technique (Oyebanji *et al*., 2011).

Determination of moisture contents

The moisture contents of fresh and dried tomato samples for pre-drying treatment lots were respectively determined by Oven Method of AOAC (2000).

Determination of ash content:

The ash content of samples was determined using methods of AOAC (2000)

Determination of weight changes during drying

Weights of pre-drying treatment lots of tomato during drying were determined using a top-loading digital balance (CAMRY ACS-30-JE11)

Measurement of pH, titratable acidity (%) and soluble solid

The pH, titratable acidity and total soluble solid were determined using methods described by Sharoban (2009) with little modifications

Determination of total phenol content

The concentration of phenol in the tomatoes was determined using spectrophotometric method described by Vijay and Rajendra (2014).

Determination of vitamin C content (mg/100g)

The method described by Ndawula *et al*. (2004)

Carotenoids determination

The tomato samples were analyzed for carotenoids using Sharoba (2009).

Statistical analysis

Data obtained were subjected to ANOVA and tested for significance difference among treatments by Duncan's Multiple Range F-Test (DMRT) at ($p<0.05$) using SPSS software package version 20.0.0 (IBM Statistics).

RESULTS AND DISCUSSION

Sensory attributes

Table 1 shows result of effect of drying methods (NSPRI's dryer and conventional) on the sensory attributes of tomato after drying for 4 days. There was no significance difference ($p<0.05$) in dryness, colour and odour of the tomato after four days however, the groups dried with NSPRI's dryer had the highest score in dryness, colour and odour. The overall acceptability of the tomato dried with NSPRI's dryer was the highest score at 4.64; this could be linked with other attributes like colour, odour and dryness having corresponding higher score.

Table 1: Effect of drying methods (dryer type) on the sensory attributes of tomato during processing (Overall basis; N=25)

Sample	Dryness	Colour	Odour	Overall Acceptability
A1	2.80^{a}	3.84^{a}	4.16^{a}	4.12^{a}
B1	2.80^{a}	3.72^{a}	4.36^{a}	4.08^{a}
A2	3.40^{a}	4.08^{a}	4.24^{a}	4.64^{b}
B2	3.56^{a}	3.96^{a}	4.16^{a}	4.64^{b}

Readings showed mean of scores by 5 panelist members Means with the same superscripts are not significantly different ($p\geq0.05$).

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2-Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

Microbial quality

Table 2 shows the effect of NSPRI's dryer on the microbiological quality of fresh and dried tomato. The procured fresh tomatoes processed are considered within safe total heterotrophic bacterial and fungal loads as recorded counts were $<10^5$Cfu/g as recommended for foods requiring minimal processing before consumption by the International Commission on the Microbiological Standards of Foods, 2011 (ICMSF), however the presence of Coliforms as established pathogens raises potential health risk that could be associated with the direct consumption of such produce as a ready-to-eat vegetable. The enumerated total and faecal Coliforms (2.40) indicate different probable sources of contamination through production and general postharvest handling. Drying was observed as efficient preservation method which limits microbial survival on the produce, retarding initial enumeration of the respective microflora. Generally, over 80% microbial species reduction was achieved with the NSPRI's dryer and thus yielded dried produce with highest microbiological qualities beyond produce quality from conventional method. Conventionally dried tomatoes were terminally contaminated with Coliforms, with a high documented counts for both total and faecal enumerations, the direct exposure to infestations by insects such as houseflies and other arthropods like birds, lizards, rats is a substantial source of contamination leading to the produce' low microbiological quality; hence this study upholds the discouragement of open air sun-drying for food produce.

Table 2: Effect of NSPRI's dryer and conventional on the microbiological quality of fresh and dried tomato.

Samples	Bacterial (cfu/g) x10^3	Total coliform (cfu/g) x 10^2	Feacal coliform (cfu/g) x 10^2	Fungi (cfu/g) x 10^3
Fresh	8.63^{d} ± 0.35	16.33^{d} ±0.88	2.40^{bc} ±00	15.00^{c} ±0.58
A1	3.77^{bc} ±0.35	2.67^{bc} ±0.63	2.80^{c} ±0.36	10.67^{b} ±0.67
B1	4.03^{c} ±2.14	3.93^{c} ±0.18	1.90^{b} ±0.26	14.0^{c} ±2.08
A2	2.17^{abc} ±0.23	2.33^{bc} ±1.20	0.0^{a} ±0.0	1.93^{a} ±0.02
B2	1.53^{a} ±0.15	0.03^{a} ±0.03	0.0^{a} ±0.0	2.77^{a} ±0.32

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

Physicochemical parameters

Moisture and ash content

Figure 1 shows the effect of NSPRI's dryer and conventional method on the moisture and ash content of fresh and dried tomato. The moisture content of dried tomato ranged from 15.74-17.97% while that of fresh sample was 94.31%, this is not unexpected as moisture content of fresh tomato is usually from 94-95% (Sohal *et al,* 2011), there was significant difference ($p \leq 0.05$) in the moisture content of those group dried with NSPRI's dryer and conventional method. This observation coincided with the report of Mutari and Debbie (2011) which states that the moisture content of fresh tomato was 94.50% per 100 g of fresh weight. Also, the ash content ranged from 7.65-9.13 % while that of fresh was 6.70%. The low ash content of fresh sample could be associated with the high moisture content of fresh tomato, equally the significance increase in ash content of the dried sample could be linked to the accumulation of minerals as a result of water removal, drying generally improves food digestibility,

increases nutrient concentration and can also lead to the availability of some other nutrient (Morris *et al*., 2004). This submission is in accordance with the findings of Hassan *et al.* (2007).

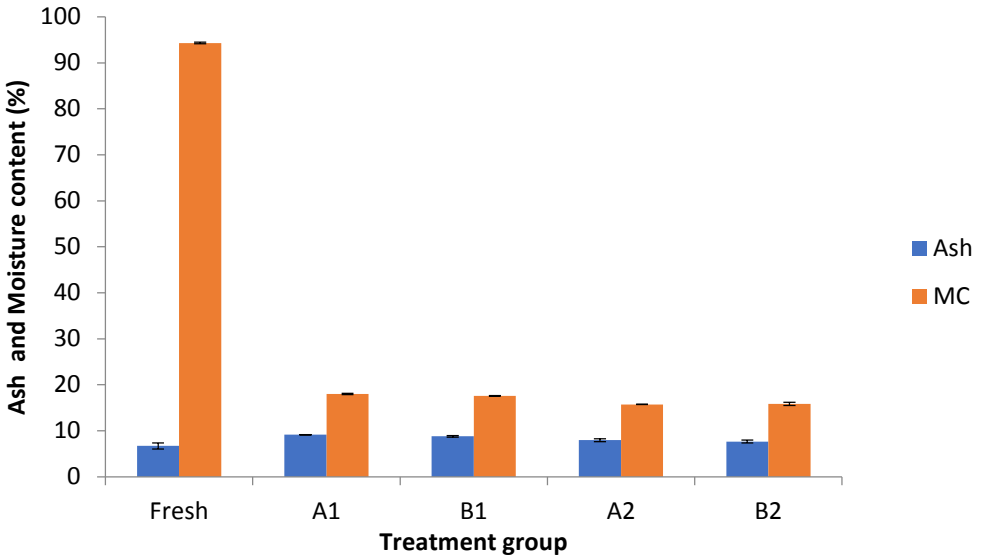


Figure 1: Effect of NSPRI's PSSD and conventional drying method on the moisture and ash content of fresh and dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

Total titratable acidity (TTA), total soluble sugar (TSS) and sugar/acid ratio

The effect of NSPRI's dryer and conventional method of drying on the titratable acidity (TTA), total soluble sugar (TSS) and sugar/acid ratio of fresh and dried tomato was as shown in figure 2. Titratable acidity reduced significantly when compared with the fresh however, the blanched group dried with NSPRI's dryer had significantly high TTA. Also, TSS significantly reduced to 2.77- 4.77°Brix in the dried samples when compared to the fresh samples (5.1°Brix) however, the group dried with NSPRI's dryer had significantly low TSS. Both TTA and TSS determine the taste of the dried sample, their interactions determine the sweetness, sourness, and flavor intensity (Tigist *et al*.,2013).

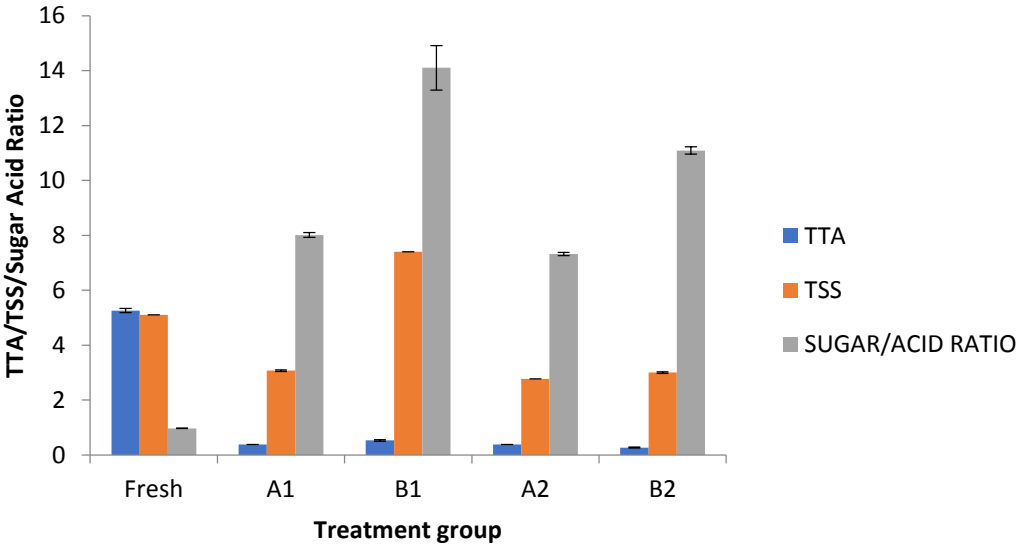


Figure 2: Effect of NSPRI's PSSD and conventional drying method on the titratable acidity (TTA), total soluble sugar (TSS) and sugar/acid ratio of fresh and dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

Weight Changes

The changes in weight of tomato were as shown in figure 3. There was significant difference ($p<0.05$) in weight loss of the tomato as drying proceed. As expected, this could be attributed to the reduction in the moisture content.

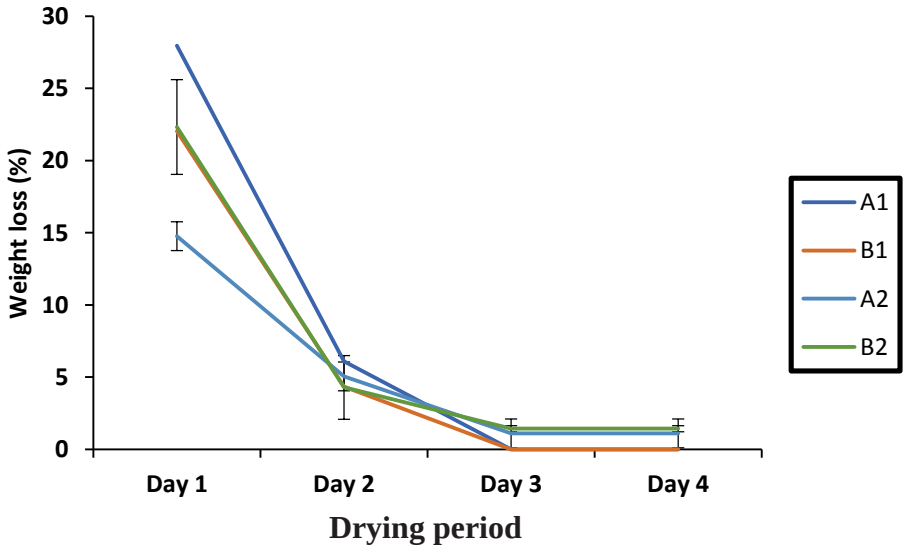


Figure 3: Effect of NSPRI's PSSD and conventional drying method on the percentage weight loss of dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

Vitamin C

Figure 4 shows the vitamin C level of the samples dried with the NSPRI's dryer (PSSD) and conventional method of drying. There was significant loss of 92.22 - 98.04% in vitamin C in the treated groups when compared to the fresh. There was no significant difference ($p \geq 0.05$) in the vitamin C content of both blanched and unblanched sample dried with PSSD and conventional method. This observation conforms to the report by Giovanelli *et al*. (2002) that the temperature, time of exposure to direct sun light, thickness and the presence of air were the major factors that contributed to the reduction in ascorbic acid content. This reduction could also be as a result of leaching of the vitamin being water soluble and oxidation due to longer period of drying. This is in agreement with the works of Shi *et al.* (1999)

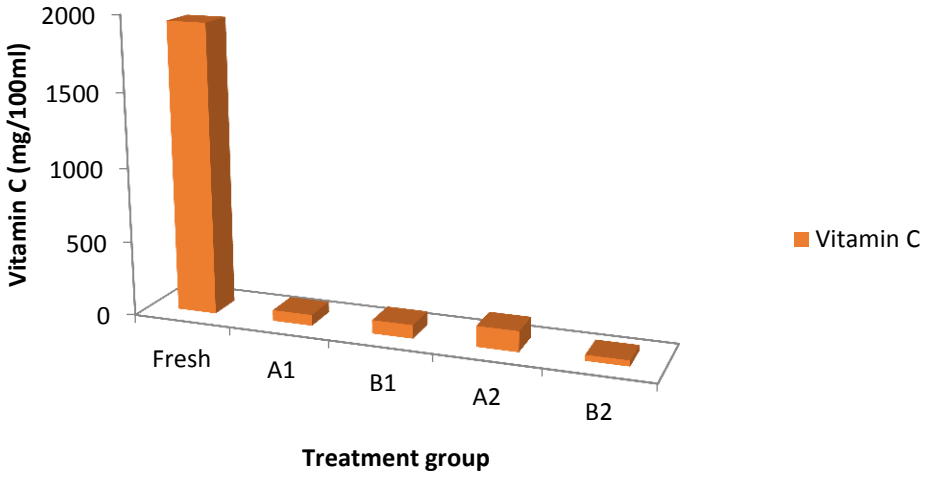


Figure 4: Effect of NSPRI's PSSD and conventional drying method on the vitamin C content of fresh and dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer**.**

Beta-carotene and lycopene

Figure 5 shows the effect of NSPRI's dryer and Conventional method on the beta-carotene and lycopene content of fresh and dried tomato**.** There was significant reduction in beta carotene (0.03 - 0.43 mg/100ml) of dried samples when compared to fresh samples (2.18 mg/100ml).The biological and curative value of dried tomatoes is linked with the red pigment of tomatoes called Lycopene. It contains carotenoid belonging to the same group of β-carotene which determines the red coloration of tomatoes. Also, the carotenoids (lycopene) are the most abundant determinant in the ripened of fruit, accounting for approximately 80-90% of the total pigments being the most prominent phytochemicals in tomatoes (Helyes*et al.*, 2009; Shi *et al.*, 2009). Drying was noted to have contributed to the significant decrease in macronutrient, which could be linked with the stability of the bonds involved in them. This result is similar with the report of Ladan *et al.* (1997) that heat lessens the nutritional composition of tomatoes.

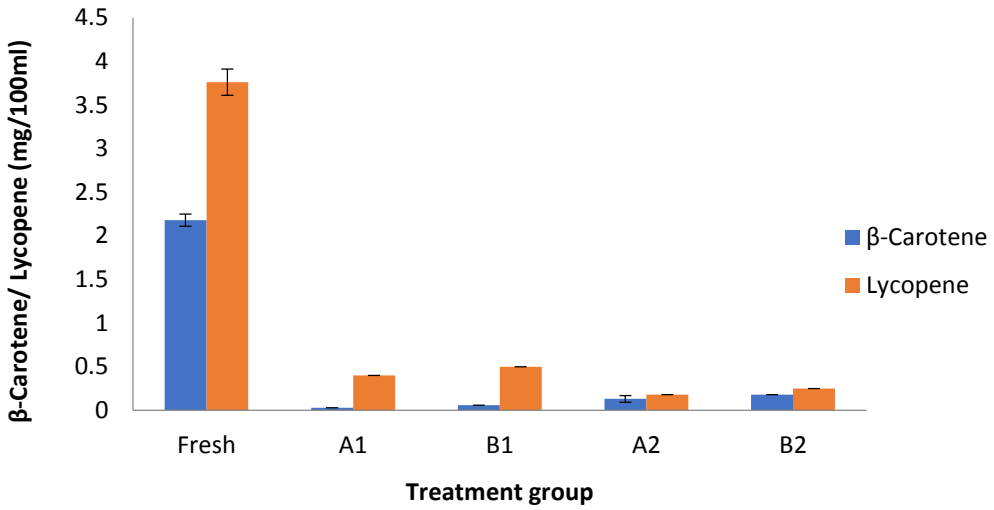


Figure 5: Effect of NSPRI's PSSD and conventional drying method on the beta-carotene and Lycopene content of fresh and dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2-Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

pH of the fresh and dried tomatoes

Figure 6 shows the pH of the fresh and dried tomatoes. The pH ranged from 3.67-5.07. There was significant difference ($p<0.05$) among all the groups. A normal pH range in tomatoes is 4.0-4.5 and the lower the pH the more tart or sour the fruit (Korob, 2019). The increase in the pH of the dried sample could be linked to accumulation of minerals.

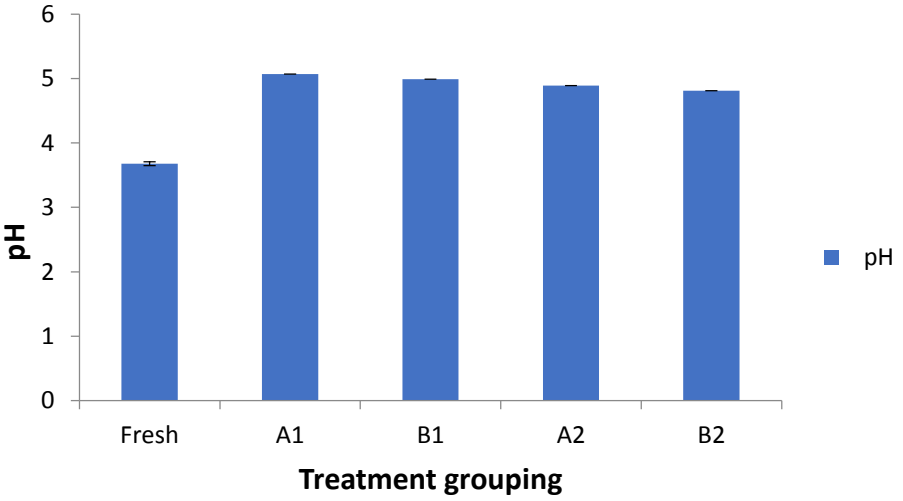


Figure 6: Effect of NSPRI's PSSD and conventional drying method on the pH of fresh and dried tomato.

Keys: A1-Unblanched conventional drying method, B1-Blanched conventional drying method, A2- Unblanched NSPRI' dryer, B2- Blanched NSPRI' dryer.

CONCLUSION

NSPRI's dryer reduce the microbial contamination of the dried tomato compared to conventional method, hence this study upholds the discouragement of open-air sun-drying for food produce. Although, drying generally resulted into loss of nutritional properties, but the drying option is better than losing everything to deterioration. However, order of acceptability of dried tomato from sensory evaluation was highest for PSSD than for conventional method of drying.

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