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# Evaluating the effects of blanching and dehydration methods on the ambient storage of dried tomato slices

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**ABSTRACT**

Tomato slices were dried using open sun drying and Nigerian Stored Products Research Institute (NSPRI) solar drying technologies (ii) Parabolic Shaped Solar Dryer (PSSD) and (iii) Solar Tent Dryer (STD) packaged and stored at ambient. Some Lots were treated using blanching while others were untreated. Samples of stored-dried tomato slices were investigated for moldiness, bacterial contamination and some physiochemical properties. Total viable counts for bacteria and fungi reduced significantly during the six months storage period. There was no significant difference recorded at $p<0.05$ in the Total viable counts of bacteria and fungi for the different lots of tomato dried slices. Further, blanching had no significant effect on the different dried tomato slices after storage in terms of the microbiological quality. Though moisture contents increased in the 3 lots of dried slices of tomato during storage in the plastic packs, the difference was not significant at $p<0.05$in the content of moisture which increased between the blanched and un-blanched samples. The ash content reduced progressively as storage time increased for stored dried tomato lots from the different dryers. However, ash content of blanched lot dried using the PSSD had no significant change after six months. The pH of stored-dried tomato lots increased significantly during the six months but was within the pH of 4.35-5.87. Reduction in microbial load during storage indicates effectiveness of drying. Moisture reduction using the improved solar drying technologies, increase in pH and decreases of ash contents can also be associated in the slight increase of moisture content. Therefore, drying of tomato slices using the NSPRI improved drying technologies is advocated for, because of the cleanliness of drying compared with the contamination with dirt in open-air sun drying

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## 1.0 Introduction

Tomato (*Solanum Lycopersicum L.*) is a member of the family "Solanaceae". It is an agricultural commodity that is cultivated worldwide. Tomato comes after potato amongst cultivated horticultural crops. As at 2016, about sixty percent of global vegetable production was accrued to the production of tomatoes, and this is estimated to be about 177 million tons worldwide (Rudolf Mulderij, 2018). Tomatoes have short post-harvest lifespan in the fresh form, which creates a problem of need for special storage or handling strategy for marketing the crop and this leads to significant high post-harvest loss of tomatoes resulting in deterioration and huge revenue losses (ICMSF1986). Hence, the development of low-cost preparation methods to produce tomato shelf products that is stable and convenient. This is very paramount for conservation, preservation and marketing of the crop.

Dehydration is one of the methods to reduce post-harvest losses of tomatoes. Dried tomato products are used as important ingredient for spicing dishes, making soups and stew (Zanom *et al*., 1999). Sun drying has long been the conventional method of drying tomatoes in Nigeria for preservation. This method has the advantage of low capital investment and operating cost with little need for expertise or monitoring difficulty (Gupta and Nath, 1984). However, tomato products derived from such process in traditional practice were usually of inferior quality, contaminated with dirt and associated with growth and development of microorganisms, due to poor sanitary handling, environment and/or inadequate drying (Dauda *et al.,* 2019). Furthermore, other issues with sun-dried tomatoes are the colour, flavor suitability and acceptability. The dried tomatoes usually become darkened or discoloured (Gupta, and Nath, 1984). Furthermore, since there is increase need for adequately prepared products, that are safe and retain more of their sensory properties and nutritional values, there continue to be a need to explore for more of those methods that are more adequate for sun drying tomatoes for storage.

## 2.0 Material and methods:

### 2.1 Collection of tomato fruits, pre-drying treatments or preparation, drying methods, packaging and storage of lots

Five baskets (about 50 kg each) of tomatoes (*Solanum Lycopersicum*: UTC var.) Was bought from Mandate market in Ilorin metropolis of Kwara State, Nigeria. The tomato purchase was done in the month of February, 2019. The stocks were bulked and shared into 6 lots for blanched and Unblanched, each in triplicates for 3 solar drying methods trials) as shown in Table 1. Each lot was taken through standard processing operation of weighing, sorting for wholesome ripe fruits, washing, draining and manual slicing to average thickness of 5mm transverse section). The blanched and untreated lots of sliced tomatoes were respectively spread on drying trays of Solar Tent Dryer, Parabolic Shaped Solar Dryer and on tarpaulin for open-air sun-drying as conventional or control. The dried tomato slice lots were removed from the dryers after three days and cooled, and then they were respectively packaged in opaque hermetic containers for initial and monthly analyses of samples through 6 months storage.

**Table 1: Lots pre-drying treatments, drying methods and identity of sample**

| [redacted] | | |
|---|---|---|
| **Untreated** | Solar tent dryer (STD) | STD A |
| | Parabolic shaped solar dryer (PSSD) | PSSD A |
| | Open Air Sun drying (CONV) | CONV A |
| **Treated (Blanching)** | Solar tent dryer (STD) | STD B |
| | Parabolic shaped solar dryer (PSSD) | PSSD B |
| | Open Air Sun drying (CONV) | CONV B |

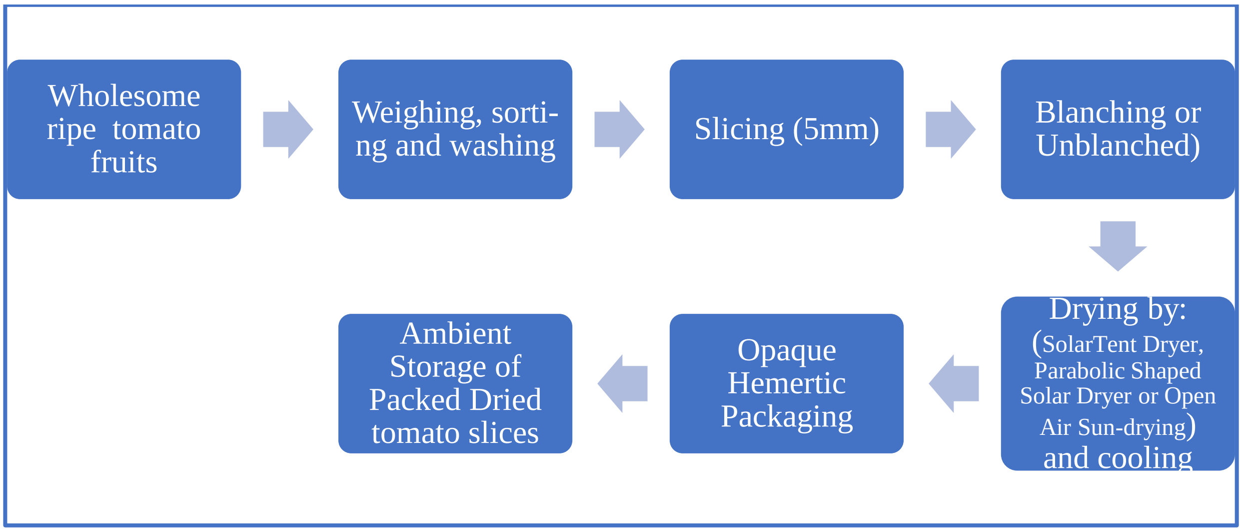


**Figure 1: Flow chart for tomato processing into dried tomato slices**

### 2.2 Microbial culture medium and isolation

Microbiological assessments of samples dried and stored tomato slices were done following standard procedures of Food and Agricultural Organization (FAO, 1997). Samples were serially diluted up to five folds; aliquots were taken from desired dilutions for enumeration of microbial species using pour plate technique in Nutrient Agar (Biomark, India). Resulting bacterial and fungal colonies were respectively presented as Colony forming unit per gram (cfu/g) of the sample.

### 2.2 Measurement of moisture and ash contents

Estimation of moisture and ash contents of dried tomato slices was done following the methods according to Association of Analytical Chemist (AOAC, 2000)

### 2.4 Determination of pH.

The pH was determined using method described by Sharoba (2009). The pH was measured at 20$^{o}$C with a pH meter (PHS-3C; Searchtech Instrument England).

### 2.5 Statistical analysis

Various results obtained were arranged in Complete Randomized Design (CRD). Analysis was done using One-Way Analysis of Variance (ANOVA) on SPSS software package version 20.0.0 (IBM Statistics Inc). Significance between means determined by New Duncan Multiple Range F-Test (DMRT) at 95% confidence limit (p=0.05).

## 3.0 Results and Discussion

### 3.1 Effects of blanching and dehydration methods on microbiological quality of dried tomato during storage

The effects of dehydration and solar drying on the microbiological quality of dried tomato slices were shown in Table 2. The Total Bacterial Counts (TBC) and Total Fungal Counts (TFC) of improved solar dried and Open Air Sun-dried of tomato varied consistent with expectation for cleanliness of drying using NSPRI's improved solar dryers. Microbial loads ranged from 0.2 to $4.033\times10^{3}$cfu/g and 0.167 to $3.133\times10^{3}$cfu/g respectively for bacterial and fungal loads. Generally, TBC and TFC reduced significantly during the six months storage period. Whereas, there was no statistical difference ($p<0.05$) in both TVC and TFC for all the different dried samples in 6-month storage of the Open-Air Sun-dried tomato (CONV A and B) had high bacteria counts (TBC) at drying (month zero) while the mould counts (TFC) was high in Solar Tent Dryer dried tomato (A and B) just after drying. Observations suggest higher tolerance of fungal spores to drying than bacteria. Further, Blanching had no significant impact on the quality of dried slices microbiologically before and after storage. Both bacteria and mould counts were less than the order of $10^5$cfu/g before and after storage. Thus, the dried tomato slices from all the drying methods might be considered within safe total heterotrophic bacterial and fungal loads according to recommendations for foods requiring minimal processing before consumption by standard body (ICMSF, 1986). Even so, it is not allowed in food safety and standard to bypass due process for prevention or reduction of contamination, in spite of later cooking plan. That is, there is outright objection to the practice of Open-Air Sun-drying on bare ground. The control in this study rather used Tarpaulin and also follows due pre-drying preparation (of washing, draining and slicing to dry), unlike in traditional practice (direct slicing of harvested tomato for drying). Further reduction in the status of dehydrated tomato products in storage indicated the absence of proliferation and showed adequacy of drying to low moisture content enough for prolonged storage. That is the NSPRI's solar dryers were effective for moisture reduction planned and the packaging was adequate for retention of the low moisture enough to limit microbial growth, development and activity during the 6 months storage.

**Table 2: Effect of blanching and dehydration methods on the microbiological properties of dried tomato during ambient temperature storage**

| Sample | Storage Time | TVC ($\times 10^3$cfu/g) | TFC ($\times 10^3$cfu/g) |
|---|---|---|---|
| STD A | 0 month | $2.067^{cde} \pm 0.289$ | $3.033^{defg} \pm 0.961$ |
| STD B | | $2.900^{def} \pm 1.203$ | $3.133^{efg} \pm 0.493$ |
| PSSD A | | $1.533^{c} \pm 0.153$ | $1.933^{cd} \pm 0.351$ |
| PSSD B | | $2.167^{cde} \pm 0.404$ | $2.767^{def} \pm 0.551$ |
| CONV A | | $3.767^{fg} \pm 0.603$ | $1.067^{abc} \pm 0.115$ |
| CONV B | | $4.033^{g} \pm 2.136$ | $1.400^{bc} \pm 0.361$ |
| STD A | 6 months | $0.200^{a} \pm 0.000$ | $0.167^{a} \pm 0.058$ |
| STD B | | $0.267^{ab} \pm 0.058$ | $0.267^{ab} \pm 0.058$ |
| PSSD A | | $0.267^{ab} \pm 0.058$ | $0.133^{a} \pm 0.058$ |
| PSSD B | | $0.267^{ab} \pm 0.058$ | $0.167^{a} \pm 0.058$ |
| CONV A | | $0.300^{ab} \pm 0.000$ | $0.267^{ab} \pm 0.058$ |
| CONV B | | $0.300^{ab} \pm 0.000$ | $0.267^{ab} \pm 0.058$ |

Results showed mean ± SD of three determinations (n=3). Mean values with similar alphabets in the same column are not statistically different (p=0.05). TVC=Total Viable Counts, TFC=Total Fungal Counts, cfu=colony forming unit. STD A=solar tent dried (untreated); STD B= solar tent dried (blanched); PSSD A=parabolic shaped solar dryer (untreated); PSSD B=parabolic shaped solar dryer (blanched); CONV A=open sun drying (untreated); CONV B=open sun drying (blanched).

### 3.2 Effect of blanching and dehydration methods on moisture content and pH of dried tomato during storage:

#### 3.2.1 Effect blanching and dehydration methods on the moisture content of dried tomato during storage

Outcome of blanching and dehydration methods on the moisture content of the dried tomato was as shown in Figure 1. The moisture contents of tomato dried from all 3 solar drying methods were low, but increased slightly within the 6 months storage period, but not significantly different between blanched and untreated samples, except for Solar Tent Dryer dried tomato slices (STD A lower than B). The reason for higher moisture content in the blanched Solar Tent Dryer dried sample might not be anything than tissue of higher hygroscopic nature or softening in the blanched sample which could increase moisture absorption potential in the sample.

Moisture content is a key factor in storage of dry food substances as it controls most biochemical and microbiological activities under ambient tropical temperature. Increase in moisture contents suggests some imperfection in expected air tightness of packaging and impact of relatively higher outside atmospheric humidity that seeped in during storage, related to the degree of air tightness of the covering lids of packs. Relative humidity (RH) of environment is an important factor in storage because of water activity. About seventy percent relative humidity is considered as safe limit and commodities that maintain moisture content that balanced with 70 percent relative humidity are comparatively stable. Hygroscopic products shift moisture with the atmosphere of storage until a balance is achieved. That is, dried substances gain moisture if stored in atmosphere of high relative humidity. The facts that moisture contents increased during storage (six months) showed that moisture barrier was imperfect or air tightness was not as much as expected in the packaging used. Packaging material should be hermetic, with air tightness enough to create a moisture barrier between the dried product and the outside environment.

**3.2.2 Effect of blanching and dehydration methods on the ash content of dried tomato during storage**

The effect of blanching and dehydration methods on the ash contents of dried tomato was as shown in Figure 2. Ash content reduced progressively as storage time increased in all the different dryers dried samples. Nevertheless, blanched tomato sample dried with PSSD (PSSD B) had no significant change in ash content after six months of storage. Ash content might indicate directly the amount of minerals present in a food sample, the higher the ash content, the higher the amount of minerals present. Decrease in the ash contents of all the tomato slices dried with different dryers might be as a result of slight gain in moisture throughout the storage time since the ash content was express on wet basis.

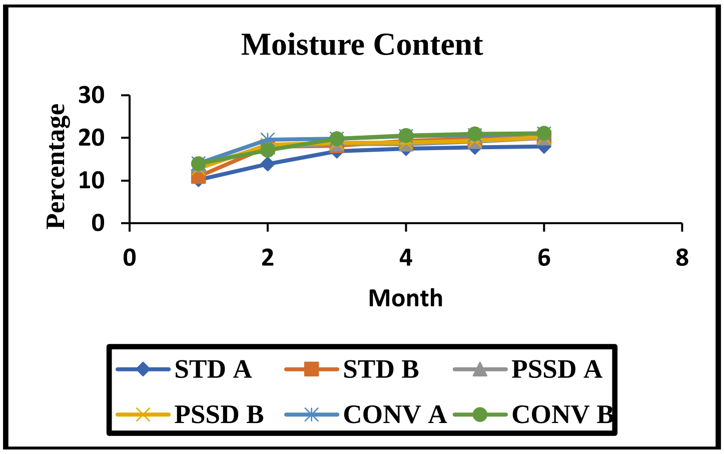


Figure 1: Effect of pre-drying treatment and drying methods on the moisture content of dried tomato slices during storage.STD A= Solar Tent Dryer dried (untreated); STD B= Solar Tent Dryer dried (blanched); PSSD A=Parabolic Shaped Solar Dryer dried (untreated); PSSD B=Parabolic Shaped Solar Dryer dried (blanched); CONV A=Open Sun Drying (untreated); CONV B=Open Sun Drying (blanched).

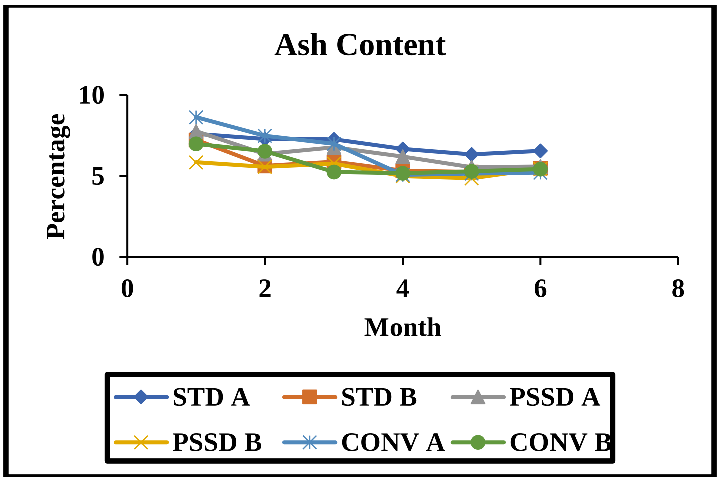


Figure 2: Effect of blanching and different solar dehydration methods on the ash content (wet basis) of dried tomato during storage. .

### 3.2.3 Effect of blanching and dehydration methods on the pH of dried tomato during storage

The effects of blanching and the different dehydration methods carried out on the pH of dried tomato during storage is as shown in Figure 3. The pH of dried tomato varied significantly for different months but was within4.35–5.87 units. Significant increase was recorded in each of the drying methods in 6 months storage. Also, there was statistical difference at $p<0.05$ in the pH values of different pre-drying treatments (blanched and untreated). Increase in pH of dried tomato may also be associated with the effect of the slight gain in the moisture contents of the packed lots during storage.

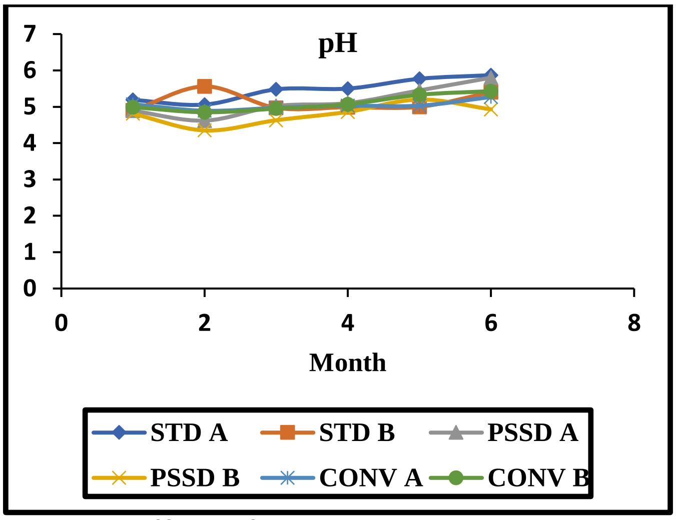


Figure 3: Effects of blanching and solar dehydration treatments on pH of dried tomato during storage.

## Conclusion

The study has shown drying effectiveness of Solar Tent and Parabolic Shaped Solar Dryer. They are more effective in drying of tomato slices than the conventional open-air sun-drying, with respect to rate of moisture reduction and extent (moisture content achieved) and the microbiological quality of the dried tomato lots. Meanwhile, PSSD was more effective with respect to drying time and hygienic drying of tomatoes, because higher mould counts was observed in the Solar Tent Dryer dried tomato slices. The effectiveness of the improved solar dryers advocates for consideration of strategies to ensure availability and access for the use of stake holders for clean and effective drying of tomato slices, since tomato is highly perishable in the fresh form due to the fleshy, high moisture and continued living nature post-harvest. The high moisture content of fresh tomato must be brought down, within the shortest possible time to avoid unacceptable deterioration, including discolouration and mould growth in the dried products. Blanching can also be recommended because it aids drying (softening tissues for easier dehydration) and helps to improve colour and appearance of the dried tomatoes.

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