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Effects of Different Drying Methods on Physico-Chemical and Microbial Properties of Tomato (*Lycopersicon esculentum* Mill) var. Roma

Grace Oluwakemi Babarinde* • **Emmanuel Adedapo Akande** • **Folarin Anifowose**

Department of Food Science and Engineering, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso 210001, Nigeria

Corresponding author: * **gobabarinde@yahoo.com**

ABSTRACT

Different drying methods (sun drying, solar drying and oven drying at 50, 55 and 60°C) were evaluated for their effects on the quality of tomato (*Lycopersicon esculentum* Mill) var. 'Roma'. A fresh sample served as control. The fresh and dried tomatoes were evaluated for changes in total solids, ash content, titratable acidity, pH, lycopene, total carotenoids, ascorbic acid and total microbial and fungi count. The results of the total solids and ash content showed that sun-dried tomatoes had the lowest total solids (89.6%) and mineral retention was highest in the solar-dried samples (2.6%). The contents of ascorbic acid were significantly (P<0.05) reduced after drying from 27.3 mg/100 g in the control sample to 11.4, 7.9 and 5.3 mg/100 g in sun-dried, solar-dried and 60°C oven-dried, respectively. Tomatoes dried in the oven had a significantly lower amount of ascorbic acid when compared to sun- and solar-dried tomatoes. There was a considerable increase in the carotenoids and lycopene contents of the dried samples. Carotenoids were best retained in samples dried at 60°C, and lycopene content was higher in tomatoes dried in the solar dryer. Tomatoes dried in the oven at 60°C had the least aerobe and fungal counts, which were higher in sun-dried samples.

Keywords: lycopene, oven drying, Roma tomato variety, sun drying, solar drying, total carotenoids

INTRODUCTION

Tomato is one of the major fruit-vegetables grown in the tropics (Ihekoronye and Ngoddy 1985). It is one of the mostly used and versatile crops (Sahlin *et al*. 2004). It can be consumed as fresh products as well as processed products such as canned whole tomatoes, tomato juice, tomato puree, tomato ketch up and paste. It is high in vitamins, especially vitamin C, when compared with oranges (Kochhar 1986). Tomatoes and tomato products are rich in health-related food components as they are good sources of carotenoids, lycopene in particular, vitamin C, flavonoids (Leonardi *et al*. 2000). Regular consumption of tomatoes has been associated with reduced risk of cancer and heart disease (Takeoka *et al*. 2001). Tomato is a climacteric fruit with high respiration rate and this results in loss of quality and restricted shelf life which leads to gross post harvest losses. Losses during post harvest operations due to improper storage and handling are enormous and can range from 20-50% in developing countries (Kader 1997).

In developing countries, tomatoes are usually packaged in baskets and during this period, tomato fruit may over ripe quickly. This results in loss of quality and restricted shelf life which leads to post harvest losses. In order to reduce these losses, it is essential to preserve tomatoes using a simple and inexpensive preservative method. Drying is a form of preservation which is used in extending shelf life of produce, reducing risk of microbial spoilage due to reduction of water content to level where microbial growth no longer occurs. Drying tomatoes is a means of eliminating seasonal gluts and shortages, providing a technologically sound base for levelling out food surpluses and shortage within rural and urban areas. Fresh tomatoes can be dried as halves, slices, quarters and powders. Once tomato is dried, it takes up a fraction of the space and can be used in all sorts of ways. It can be used in pizza toppings, snacks and other savoury dishes (Lewicki *et al*. 2002). Drying using different methods will help in determining the most effective method suitable for drying tomatoes with minimum qualitative loss. Therefore, this work aims at investigating the quality of tomato (through assessment of physico-chemical and microbial properties) as affected by different drying methods.

MATERIALS AND METHODS

Procurement of tomatoes

Freshly harvested tomatoes (var. 'Roma') were purchased from Arada Market in Ogbomoso, Nigeria and were processed in the pilot plant of the Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

Sample preparation

Freshly harvested tomato fruits not more than 80% pinkish stage of maturity were sorted, washed with chlorine at 20 ppm, and cut into 10-mm thick slices and then blanched for 1 min at 90°C. Slices were allowed to cool off quickly under running tap water for 90 s, drained and placed on a tray that was covered with aluminium foil. Trays were placed in the sun, locally fabricated solar and electrically heated thermostatic oven (Model DHG-9101) dryers. To ensure even drying for samples dried in the sun, they were turned 2 to 3 times per day. After 72 h drying, they felt brittle and the brittle tomatoes were packaged in low density polyethylene for analyses as described by Thomas and Berry (1997).

Analyses

Moisture and ash contents, titratable acidity, pH and ascorbic acid were carried out on both fresh and dried tomatoes using the AOAC (1990) methods of analysis. Carotenoids in tomato were determined using (AOAC 1990). Water-saturated butanol (40 ml) was

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Research Note

Table 1 Selected physico-chemical properties of fresh and dried tomato samples.

Sample	Total solids (%)	Ash (%)	Titratable acidity (%)	pH (%)	Ascorbic acid (mg/100 g)	Total carotenoids (mg/100 g)	Lycopene (mg/100 g)
Fresh	12.9 c	0.4 c	6.3 a	2.5 e	27.3 a	3.5 d	1.9 c
Sun-dried	89.6 b	2.6 a	5.8 c	2.9 b	11.4 b	5.2 c	3.6 a
Solar-dried	89.8 b	2.6 a	5.8 c	3.0 a	7.9 c	5.3 c	3.7 a
Oven-dried at 50°C	90.5 a	2.2 b	6.2 a	2.7 d	2.6 e	5.4 b	3.1 b
Oven-dried at 55°C	90.4 a	2.3 b	6.3 a	2.7 d	3.5 e	5.5 ab	3.2 b
Oven-dried at 60°C	90.4 a	2.3 b	6.0 b	2.8 c	5.3 d	5.6 a	3.2 b

Means with similar letters of alphabet in the same column are not significantly different at 5% probability

added to 5 g of sample (which included the skin and the pulp) and the content was allowed to stand for 4 h with occasional gentle shaking. After shaking, the contents were filtered using Whatman No 1 filter paper. The carotenoids of the extracts were determined using a spectrophotometer (Beckman Instruments DK2A).

Lycopene content was also determined spectrophotometrically using the method outlined by AOAC (1990).

Total viable and mould counts

One ml of aliquot portion of each sample was aseptically withdrawn after serial dilution into sterilized plates already containing nutrient agar (LAB M International Diagnostics Group, UK) and acidified potatoes dextrose agar (PH EUR-USP a product of Biolab, Hungary) using pour plate method, for determination of total viable counts and mould counts respectively. The plates were inverted after setting and incubated at 30°C for 24-48 hours for total viable count and 28°C for 5 days for plates containing potato dextrose agar. All counts were done in two replicates using Stuart scientific colony counter (Collins *et al.* 1989).

RESULTS AND DISCUSSION

Total solids and ash contents

The result of total solids is shown in **Table 1**. The total solids ranged from 89.6% to 90.5% for the dried samples while that of the fresh was 12.9%. Of all the drying methods, the oven-dried sample had the highest total solids while sun-dried had the least. The oven-dried sample had the least drying time while the drying time for the sun-dried products was relatively longer. The ash content ranged between 2.2 and 2.6% for dried tomatoes and that of fresh was 0.4% which shows that there was a significant difference (P<0.05) between the fresh and dried samples. This could be due to concentration of mineral contents in the dried samples.

The solar- and sun-dried samples had the highest ash content while the oven dried at 50°C had the lowest. There was no significant difference (P<0.05) between the solar- and sun-dried sample but the different was significant (P<0.05) when compared with the oven-dried samples at their varied temperatures.

Titratable acidity and pH

The titratable acidity and pH are recorded in **Table 1.** The titratable acidity of the fresh sample was 6.3% and the dried sample ranged between 5.8 and 6.3%. Solar- and sun-dried samples had significantly lower titratable acidity than other samples. The oven-dried sample retained the initial titratable acidity. Toor and Savage (2006) reported a significantly higher titratable acidity due to a significantly higher dry matter contents in semidried flavouring variety. The pH of the fresh sample was 2.5 and the dried samples ranged between 2.7 and 3.0. pH was lower in oven-dried samples than solar- and sun-dried samples as shown in **Table 1**.

Ascorbic acid

The ascorbic acid content of the fresh sample was 27.3 mg/100 g while that of the dried samples ranged between 2.6 mg/100 g and 11.4 mg/100 g. The different drying methods reduced the vitamin C content as also found by Zanoni *et al.* (1999). Marfil *et al*. (2008) also reported a decrease in vitamin C content at different drying conditions. From the data in **Table 1**, the sun- and solar-dried samples had higher ascorbic acid values when compared with oven-dried samples. This confirmed the finding of Chang *et al*. (2006) who reported that hot-air-dried tomatoes had higher loss of vitamin C than other drying methods used. Retention of ascorbic acid in samples dried in sun and solar dryer could be as a result of radiation used. This could have inhibited irreversibly or destroyed completely enzymes responsible for the destruction of ascorbic acid as reported by Joshi *et al.* (1991, 2009). Reduction in vitamin C at 50°C could be due to action of enzymes which degraded substrate at higher rate until water content was reduced to such an extent that they lost their activity as reported by Joshi *et al.* (1991).

Total carotenoids

The total carotenoids of the fresh and dried samples are reported in **Table 1**. The carotenoid of the fresh sample was 3.5 mg/100 g and those of the dried sample ranged between 5.2 mg/100 g and 5.6 mg/100 g. The total carotenoids were best retained at 60°C in oven-dried tomatoes than sun-dried and solar-dried samples. The increase in total carotenoids could be due to concentration of pigments in dried samples after a considerable amount of moisture was removed (Thompson 2000). Tonucci *et al*. (1995) reported that bound antioxidants are released by processing. Bioavailability of carotenoids can also be enhanced by thermal treatment (Sahlin *et al.* 2004). Rodriquez-Amaya (1997) also reported that thermal processing increased carotenoid concentration which could be attributed to enzymatic degradation weakening protein carotenoid aggregate. The sun-dried sample had the least amount of carotenoids and this could be associated with percentage of total solids present.

Lycopene

The lycopene content ranged between 3.1 mg/100 g and 3.7 mg/100 g for the dried tomatoes and that of fresh was 1.9 mg/100 g. The lycopene content increased during drying which confirmed the findings of Dewanto *et al*. (2002), who reported that thermal treatment could increase the release of phytochemicals from the matrix tomatoes. After the drying process, solar-dried sample had the highest lycopene value and the difference was significant at 5% probability level. The increase in lycopene in all the dried samples could be due to breakdown of cell walls by thermal process which weakens the bonding forces between lycopene and tissues matrix and hence makes lycopene more accessible. Chang *et al*. (2006) also reported increase in lycopene of hot-air-dried tomato. Comparing the dried tomato samples, the lycopene was more in the sun- and solar-dried samples than the oven-dried samples at varying temperatures used (**Table 1**).

Microbiological analysis

The fresh tomatoes had both bacteria and fungi when isolated on both nutrient agar and potato dextrose agar. The micro organisms reduced with varying drying temperature

Table 2 Microbial evaluation of fresh and dried tomato samples.

Sample	Total viable counts (cfu/ml)	Fungal counts (cfu/ml)
Fresh	2.85×10^5	3.00×10^5
Sun-dried	2.00×10^5	2.00×10^5
Solar-dried	1.80×10^5	1.80×10^5
Oven-dried at 50°C	3.00×10^5	0.31×10^5
Oven-dried at 55°C	2.80×10^5	0.27×10^5
Oven-dried at 60°C	0.23×10^5	0.22×10^5

cfu = colony forming unit

and conditions as shown in **Table 2**. The solar-dried tomato and the tomato dried at 60°C had the least total viable counts while oven-dried sample had the least fungal counts. The microbial load was higher in the sun-dried sample for both bacterial and fungal growth. This was probably due to the fact that the sun-dried sample was exposed to air which resulted into higher microbial load. The oven-dried sample at 50 and 55°C had higher count of bacteria but lower count of fungi. This could be due to the ability of bacteria to withstand the temperature at which the samples were dried.

CONCLUDING REMARKS

Solar- and sun-dried samples were better than oven-dried samples in terms of lycopene content, ash content and ascorbic acid retention. Sample dried in oven at 60°C had the least microbial counts and was better in term of carotenoids and total solids when compared with solar- and sun-dried samples. Therefore, choice of tomato drying methods would depend on attributes of interest in the processed product.

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