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INFLUENCE OF DIFFERENT DRYING METHODS (OVEN, SUN AND GREEN HOUSE) ON SOME MICRONUTRIENT COMPOSITION OF TOMATOES (*Lycopersicum esculentum*)

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Abstract
Tomatoes are climacteric fruits which are known to have short life span once harvested. To extend their shelf life, drying technology is often employed. This work was designed to find the effect of some conventional drying methods on micronutrient composition of tomatoes. Mineral and vitamin compositions were analysed using standard procedures. Data generated were analysed using Statistical Package for Social Science version 20. The result showed that β-carotene contents of the tomatoes ranged between 2680 – 4020µg/100g with fresh tomatoes having the highest value (4020µg/100g) and sun dried tomatoes the lowest β-carotene value (2680µg/100g). The vitamin C content of the tomatoes (7.83 – 12.10µg/100g) was significantly lower ($p<0.05$) than the value (19.59mg/100g) obtained for the fresh sample. The zinc content of oven dried tomatoes was 8.77-fold higher than the zinc content of the fresh tomatoes, while zinc contents of sun dried and greenhouse dried tomatoes were 8.15 and 6.07 folds higher than that of the fresh tomatoes. The copper (0.14 – 0.23mg/100g) and iodine (2.76 – 3.35mg/100g) contents of the dried tomatoes were significantly higher ($p>0.05$) than values obtained in fresh tomatoes. The study showed that minerals and vitamins analysed were better conserved using oven dry method than using sun and greenhouse drying methods.

Keywords: Tomatoes, Drying methods, Vitamins, Minerals

Introduction

Tomato (*Lycopersicum esculentum*) belongs to the family "*Solanaceae*" (USDA, 2005). Report on tomato production between 2001 and 2007, showed that China, USA, Turkey and India were the major producer countries in the world (FAO, 2010) with Nigeria ranking the 16th largest tomato producing nation in the world (FAOSTAT, 2010). The production of tomatoes in Nigeria in 2010 was about 1.8 million metric tonnes, which accounts for about 68.4% of West Africa, 10.8% of Africa's total output and 1.28% of world output (FAOSTAT, 2010). In Nigeria Tomatoes are utilized as fresh (salad), stew and as dehydrated products (component for pizza, vegetable and spicy dishes) (Akanbi *et al*., 2006). Nutritionally, tomatoes are good sources of potassium, phosphate, selenium, copper, manganese and zinc (Kerkhofs *et al*., 2005; Xianquan *et al*., 2005; Fernandez-ruiz *et al*., 2011). Other important nutrients found in significant amount in tomatoes include; lycopene, beta-carotene, vitamins E and C (kalageropoulus *et al*., 2012). Tomatoes and tomato-based foods are considered as healthy foods because their consumption is linked to reduction of the risk of developing certain types of cancer and cardiovascular diseases (George *et al*., 2004). Despite its high nutritional values and health-benefits, tomato being a climacteric fruit, has a short shelf-life once harvested. Over 45% (750,000 metric tonnes) of tomatoes produced in Nigeria is estimated as annual loss due to poor food supply chain management, poor processing technology, lack of good storage system and the transporting system used for the distribution of fresh tomatoes (Jayathunge *et al*., 2012). To extend the shelf-life of tomatoes and ensures its availability all year round in Nigeria both small and large scale famers adopts drying technology of their products (Habou *et al*., 2003). Drying method is the dehydration of tomatoes, either via the sun or with an electric oven or dehydrator (Abdullah *et al*., 2010). Drying of food materials is said to help extend shelf-life, decrease of product volume significantly, increase of product diversity, increase of food process applications and improve the product quality (Maskan, 2001). Though it was observed that among the drying techniques, open sun drying is a seasoned, simple (requires less technology), cost effective and food preservation method used to reduce the moisture contents of all agricultural commodities (Durance and Wang, 2002), Sun drying method was also associated with the acceleration of some reactions that adversely affect nutrients and product quality (Demiray and Tulek, 2008). Knowing the influence of different locally available drying methods on the nutrient compositions of tomatoes has therefore become very imperative. This work was designed to evaluate the effect of oven, sun and greenhouse drying methods on the micronutrient compositions of tomatoes.

Materials and methods

Fresh, firm and ripe tomatoes (12 kg) identified as cherry variety were purchased from Ubani, Umuahia Main Market in Abia State.

Sample preparation

A modified method as described by (Owusu *et al*., 2012) was used to prepare the samples. The tomatoes were washed under tap running water and were divided into four portions using a digital weighing scale (Model-AND-GX 4100). Each portion of the tomatoes (with the exception of the control) was sliced manually using a sharp kitchen knife in the thickness of 10mm each.

Sun drying procedure

The Sample was sun dried in an environment devoid of pests and the drying process was done between the hours of 10:00 am – 5:30 pm for seven (7) days until a constant weight was obtained.

Oven drying procedure

The sliced tomatoes were arranged on a single layer on a foil paper and dried at 65°C for 4 days using a hot air oven (Model: SE 08434) with. Sample was dried and routinely weighed until a constant weight was achieved.

Greenhouse drying procedure

Sliced tomato sample were arranged in flat plastic trays and placed in the drying chambers of greenhouse drying system. Drying of the sample was done for 7 days until a constant weight was attained.

Grounding of Samples

The dried samples were milled separately into fine flour with the aid of Thomas Willey milling machine (Model no: ED-5). Each of the samples was collected in an air tight plastic container for further analysis.

Chemical analysis tomato flours dried different drying conditions

Minerals were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC (2006). The digest was used for the determinations of the minerals. Zinc, iron and copper were determined using Atomic Absorption Spectrophotometer (Model 3030 Perkin Elmer, Norwalk USA).

The β – carotene was determined spectrophotometrically as described by AOAC (2006), while ascorbic acid was determined as described by AOAC (2006) using titration method.

Statistical analysis

The data generated from duplicate analysis were keyed into the computer and analyzed using Statistical product for service solution (SPSS version 20). Means and standard deviations were calculated. Analysis of Variance (ANOVA) was used to compare the means and mean separation was done using Duncan multiple range test. All calculations were done at 5% level of significance ($p < 0.05$).

Results and Discussion

Vitamin and mineral compositions of fresh and dried tomatoes under different drying conditions

Vitamin compositions of fresh and dried tomatoes under different conditions presented on Table 1 showed that the β-carotene content of the fresh tomatoes (4020mg/100g) was significantly higher ($p>0.05$) than the β-carotene content (2680 – 3850μg/100g) of dried tomatoes. Lower β-carotene value obtained in the dried samples compared to the fresh sample was expected as vitamins have been shown to be prone to oxidative destruction in the presence of heat and light (Russell and MacDowell, 2009). The β-carotene value of oven dried tomatoes (3850μg/100g) was however, observed to be higher than the β-carotene values (2680 – 3120μg/100g) of sun dried and greenhouse dried tomatoes respectively. This implies that oven drying method conserves β-carotene better than both sun greenhouse drying methods. β-carotene is the major provitamin A of most carotenoid containing food (Parker,). This vitamin is fat-soluble, essential for vision in dim light, cellular bone and tooth growth, formation and maintenance of healthy skin, hair and mucous membranes, reproduction and immunity boosting (FNB, 2000). When compared to other studies, values of β-carotene obtained in sun dried and greenhouse dried tomatoes fell within values (1770 - 3240μg/100g) reported for sundried tomatoes (Kowsalya *et al*., 2011). Hussein *et al*. (2016) in their study reported higher β-carotene value in dried tomatoes than in fresh tomatoes. Values in that study were not used to compare values in this study due to difference in the expression of unit. The vitamin C value obtained in the samples ranges between 7.83 – 19.59mg/100g with sun dried tomatoes having the lowest vitamin C value (7.83mg/100g) and fresh tomatoes the highest vitamin C content (19.59 mg/100g). Reduction of vitamin C in the dried samples was due to the fact that vitamin C is thermolabile in nature (Hussein *et al*., 2018). Erenturk *et al.* (2005) reported that rising of temperatures decreases retention ability of fruits and vegetables; this implies that, drying at low and control temperature conserves vitamin C better than drying under unregulated temperature. The role of vitamin C in the function of the body cannot be over emphasized and of interest is its ability to transform ferric iron (plant iron) into absorbable iron (ferrous iron). This ability of converting ferric iron to ferrous iron is of significant importance in African diet where the majority of the iron source comes from plant. The results of the minerals analysed is shown on Table 1. Iron value ranged between 0.38 – 2.53mg/100g with oven dried tomatoes having the highest iron value (1.84mg/100g) and fresh tomatoes the lowest iron value (0.28mg/100g). Drying is known to concentrate some nutrients particularly the non organic elements in foods. Füsun *et al*. (2010) finding was in confirmation with the above statement. Iron is an essential component of heamoglobin that transfers oxygen from the lungs to the tissues. It also supports metabolism, growth, normal cellular function and synthesis of some hormones (Murray-Kolbe and Bernard, 2010). Zinc (0.90 -1.27mg/100g) and iodine (2.76 – 3.25mg/100g) contents of the dried samples were also observed to be significantly higher ($p>0.05$) than zinc (0.15mg/100g) and iodine (1.74mg/100g) contents of fresh tomatoes. The zinc content of oven dried tomatoes was 8.77-fold higher than the zinc content of the fresh tomatoes, while zinc contents of sun dried and greenhouse dried tomatoes were 8.15 and 6.07 folds higher than that of the fresh tomatoes. Zinc is an important element needed for proper function of the immune system, it also play significant role in cell division, cell growth, wound healing and carbohydrate metabolism (Us National Library of Medicine, 2018) while iodine is needed for the synthesis of thyrosine (FNB, 2001).

Conclusion

The study showed that drying generally concentrates minerals, but depletes vitamins. Oven drying however conserved both vitamins and minerals better than sun and greenhouse drying.

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Table 1: Vitamin and mineral compositions of fresh and dried tomatoes (*Lycopersicum esculentum*)

Nutrients	**Fresh tomatoes**	**Ovendried tomatoes**	**Sundried tomatoes**	**Greenhouse dried tomatoes**
Beta carotene (µg/100g)	$4020^{a}\pm0.00$	$3850^{b}\pm0.01$	$2680^{d}\pm0.01$	$3120^{c}\pm0.01$
Vitamin C (mg/100g)	$19.59^{a}\pm0.01$	$12.10^{b}\pm0.10$	$7.83^{d}\pm0.03$	$9.10^{c}\pm0.10$
Copper (Cu) (mg/100g)	$0.05^{d}\pm0.00$	$0.23^{a}\pm0.00$	$0.14^{c}\pm0.00$	$0.19^{b}\pm0.00$
Iron (Fe) (mg/100g)	$0.39^{d}\pm0.00$	$2.53^{a}\pm0.00$	$1.08^{c}\pm0.00$	$1.88^{b}\pm0.01$
Zinc (Zn) (mg/100g)	$0.15^{d}\pm0.00$	$1.27^{a}\pm0.00$	$1.18^{b}\pm0.00$	$0.90^{c}\pm0.00$
Iodine (I) (mg/100g)	$1.74^{d}\pm0.00$	$3.25^{a}\pm0.00$	$2.76^{c}\pm0.00$	$2.92^{b}\pm0.00$

Values represent means ± S.D (Standard deviation) of triplicates

a-d Means within the same row with different superscripts are significantly different (p<0.05)