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RESEARCH ARTICLE

QUALITY EVALUATION OF DRIED TOMATOES TREATED WITH *AFRAMOMUM DANIELLI*

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ABSTRACT

Studies on the quality of dried tomatoes (var. UTC) treated with *Aframomum danielli* were carried out. Samples were sun-dried and oven-dried at 60^0C. Tomato samples were treated with 2.5%, 5%, 7.5% and 10% concentration of *A. danielli*. Dried tomato samples treated with no *A. danielli* served as control for dried tomato samples treated with *A.* Danielli. The treated tomato samples were evaluated for moisture content, ash, pH, crude fibre, titratable acidity, ascorbic acid, total carotenoid, lycopene and total viable and fungal count using standard methods. The results showed that treatment with *A. danielli* significantly ($P<0.05$) increased the pH and crude fibre when compared with the control samples. Ascorbic acid and lycopene value were reduced in sun-dried samples when treated with varying concentrations of *A. danielli*. However, the oven-dried samples treated with *A. danielli*, the ascorbic acid values were better retained with increasing concentrations of *A. danielli* from 2.5 to 10% concentrations. The values of total carotenoid were significantly ($P<0.05$) increased in dried samples treated with 5% and 10% *A.danielli'*. Similarly, significant increase was recorded in lycopene value of oven-dried samples treated with 5% and 10% *A. danielli* when compared to the control sample. However, significant decrease in lycopene values of sun-dried samples treated with 5% and 10% *A. danielli* was recorded. There was also considerable reduction in the values of both viable and fungal count of tomato samples treated with *A. danielli* over the control samples. The findings revealed that oven dried tomato treated with *A. danielli* was the best for preserving quality characteristics of dried tomato.

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INTRODUCTION

Tomato (*Lycopersicon esculentum L.*) is a popular fruit and an important commercial vegetable that is consumed by people across the world with prominent use as cuisines worldwide. In 2017, the worldwide production of tomatoes totalled 170.8 millions tons (FAOSTAT, 2017). China, the leading producer of tomatoes, accounted for 31% of the total production. India and the United States followed with the second and third highest production of tomatoes in the world. They are a natural source of lycopene, a carotenoid that reduces the risk of cancer and coronary heart diseases. Tomatoes are 95% water, 4% carbohydrates, and contain less than 1% of proteins and fats **(**FAOSTAT, 2017). The soluble carbohydrates in tomatoes are almost all reducing sugars and the predominant acids are citric followed by malic. Glutamic acid is the main amino acid, rarely found in other fruits (Abou Dahab, 2006).

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Fresh fruits and vegetables are inherently perishable. During the process of distribution and marketing, substantial losses are incurred which range from a slight loss of quality to total spoilage. Post harvest losses may occur at any point in the marketing process, from the initial harvest through assembly and distribution to the final consumer. The causes of losses are many: physical damage during handling and transport, physiological decay, water loss, or sometimes simply because there is a surplus in the market place and no buyer can be found (FAO, 2018). In order to solve these problems, it is important to preserve fruits and vegetable and make them available when they are out of season. Drying is a common form of food preservation. When drying agricultural products, the aim is to reduce the moisture content to a level that allows the food to be stored safely for an extended period. In addition to increasing the shelf-life, drying reduces the weight and volume of the product, thereby reducing packaging, storage and transportation costs. During the drying process, the moisture content of the dried tomato products is typically reduced to less than or equal to 15%. Drying of tomatoes in Mediterranean countries has traditionally been carried out using sun drying techniques which are simple and have low

capital costs. In order to improve the quality of dried tomato products, industrial drying methods such as hot -air and solar drying are usually used. However, conventional air drying is considered expensive due to the high moisture content in the tomatoes (FAO, 2012). Drying is not a popular way to process tomatoes due to its adverse effect on final product quality. The drying of tomatoes is an inefficient process due to the high moisture content of fresh tomato (93-95%). However, the search for new improvement on the tomato qualities after drying is necessary therefore, pre-treatment operations which include the addition of natural spices; *Aframomum danielli* is aimed at maintaining quality. *A. danielli* is a natural spice that can be used to pre-treat tomatoes prior to drying for its antioxidant effect. *A. danielli* has been found to have preservative properties in some food systems (Adegoke, and Idowu, 2006). This research intends to study the antioxidant effect *of A. danielli* on dried tomatoes. Also, the chemical, physical and microbial effect of *A. danielli* on dried tomatoes and the effects of drying on tomatoes were evaluated.

MATERIALS AND METHODS

MATERIALS

The raw material used in this research work was tomato (UTC variety) and *A. danielli*. Freshly harvested tomatoes were purchased at Wazobia market, Ogbomoso, while *A. danielli* was purchased at Oja Oba market, Ibadan, Nigeria.

METHODS

Preparation of raw materials: The tomatoes used were red in colour with a medium diameter of (45-55mm). The tomatoes were sorted to remove rotten, unripe, infected tomatoes and tomatoes that did not conform to require diameter. The tomato fruits were washed to remove contaminants and then sliced into 10mm using knife and vernier caliper for the measurement. It was then stored at 25^0C. *A. danielli* purchased in its dried form were cleaned of dirts and contaminants. *A. danielli* seeds were separated from the pod. The cleaned spice was made into its powdery form using hammer mill. The powder was sieved with a mesh to obtain fine powder. 2.5, 5, 7.5 and 10g of fine powder was dissolved into 100ml of distilled water to obtain 2.5, 5, 7.5 and 10% concentrations of the spice aqueous extract. The suspension was kept in the refrigerator for 4 days followed by centrifugation as described by Ashaye *et al.,* (2006) and the supernatant was obtained as spice aqueous extract.

Procedures of pre-treatment operation for dried tomato: 600g each of tomatoes slices was immersed into 800ml of the designed varying concentrations of each spice and allowed to stand for 5 minutes to achieve effective pre-treatment operations. The pre-treated tomatoes were removed and dried accordingly. For the oven drying method, the tomatoes were dried at 60^oC for 10hours (Gisele *et al.,* 2004)

Qualitative analysis: The following analyses were carried out on fresh and spice-treated dried tomato samples: Moisture content, pH, Ascorbic acid, Lycopene, Titratable acidity, Crude fibre, Ash, Total carotenoid and Colour. Analysis was done in triplicate.

Moisture content determination: 5g of tomato sample was weighed into a previously weighed metal dish that had been heated for 15 minutes at 105^0C and cooled in a desiccator. The metal dish and sample was transferred into the oven at 105^0C for $1^1/_2$ hours. It was cooled in the desiccator and weighed as soon as possible at room temperature. It was then re-heated at the same temperature for 30 minutes, reweighed after cooling. The process was repeated until a constant weight was maintained and the % moisture was calculated as;

$$\% \text{ moisture} = \frac{\text{weight of moisture evaporated}}{\text{Weight of sample}} \times 100$$

$$= \frac{\text{weight before drying-weight after drying}}{\text{Weight of sample}} \times 100 \quad \text{(AOAC, 2013)}$$

pH determination: 20ml of distilled water was added to 10g of tomato sample and mixed very well. pH meter dielectrode was dipped in and pH value recorded when reading stabilizes (AOAC, 2013).

Ash determination: 2.0g of sample was weighed into a crucible. This was transferred into a muffle furnace set at 550^0C for 4 hours. The crucible was then removed from muffle furnace and allowed to cooled together with its content to about 100^0C in air, and then at room temperature in dessicator and weighed again. For the % ash determination, it was calculated as;

$$\% \text{ ash} = \frac{\text{weight of ash remained}}{\text{Original weight of sample}} \times 100 \quad \text{(AOAC, 2013)}$$

Crude fibre determination: 3.0g of each of the sample was measured and transferred into a 1 litre quickfit conical flask. 200ml of boiled 1.25M of H_2SO_4 was poured into the flask and boiled for exactly 30 minutes under reflux condenser to digest. The digest was filtered by pouring the mixture onto a 100mm diameter No 2 porosity glass sinter funnel that has recently been warmed by running it through hot water. The funnel is connected to a buncher flask and suction is applied so that the mixture is filter in less than 10 minutes. The original flask was washed; the funnel and the insoluble matter with boiling water until the washing are free of acid. The insoluble matter was then washed back into the original flask by means of a quick wash bottle containing 200ml of 0.313M NaOH at approximate 100^0C.

The whole of this 200ml of 0.033M NaOH was added to the flask containing the insoluble matter. The mixture was boiled for 30 minutes. The mixture was cooled for 1minute, and then it was filtered through the 100mm diameter No 2 porosity glass sinter funnel previously used. The whole of the insoluble material was transferred onto the funnel by means of boiling water (using a quickfit wash bottle). The insoluble matter was washed with boiling water, then with 1% hydrochloric acid and finally with boillng water until the washings is free from acid. With the aid of hot water, the insoluble residue was washed into a weighed silica crucible (No 4, porosity). The sintered silica crucible and content was washed twice with absolute alcohol and three times with diethyl ether. The crucible and contents was dried at 100^0C to constant weight. The crucible and content was heated at 600^0c to constant weight and % crude fibre was calculated as;

$$\% \text{ crude fibre} = \frac{\text{weight before incineration-weight after incineration}}{\text{Weight of sample}} \times 100$$ (AOAC, 2013)

Titratable acidity determination: 10g of sample was weighed and 200ml distilled water was added in a 250 conical flask. 4-5 drops of phenolphthalein was added and titrated against 0.1M NaOH. Titre value was recorded and the calculation was made thus;

TA= titre value x 0.09 (AOAC, 2013)

Ascorbic acid determination: 20g sample was weighed and ground with a little glacial acetic acid in a mortar. The extract was transferred quantitatively with distilled water into a 50ml volumetric flask and made up to mark with more water and filtered rapidly. 10ml of the filtrate was taken into a conical flask with one drop dilute acetic acid. It was titrated against the redox dye 2, 6-dichlorophenol solution in the burette. The volume of the dye required to decolorize the 10ml of the sample was noted. Titration was repeated using a standard ascorbic acid solution (1 mg. pure vit/100ml) in a place of the tomato extract. The calculation of ascorbic acid per 100g of tomato was made thus;

$$\text{Mg Vit. C/100g} = \frac{w_1 + w_2}{w_1 \times w_3} \times \frac{v_1}{v_2} \times 100 \ (v \times f)$$

Where w_1 = weight of sample (g)
w_2 = weight of extracting acid (g)
w_3 = weight of slurry taken for analysis (g)
v_1 = volume to which slurry sample is diluted (ml)
v_2 = volume of filtrate taken for filtration (ml)
v = volume of dye solution used for titration
f = ascorbic acid equivalent of dye (mg/ml) (AOAC, 2013)

Total carotenoid determination: 10g of homogenous sample was weighed. 50ml of cold acetone was added and homogenize for 1 minute. It was filtered through Whatman No 4.0 filter paper. Residue from homogenizer was washed with cold acetone until washing is colourless. The extract was poured into a separating funnel and 20ml petroleum ether was added slowly, flowing along the wall of the separating funnel to avoid formation of an emulsion.

It was allowed to stand for a few minutes until the 2 phases separated. The lower aqueous acetone phase was discarded. The petroleum ether phase was washed with water for 4-5 times to remove all traces of acetone. The petroleum ether phase was passed through cotton wool and anhydrous sodium sulphate in a glass funnel. It was collected in 25ml volumetric flask and petroleum ether was added to make up to volume. Absorbance was then measured at 450nm and total carotenoid was calculated as;

$$\text{ug/g} = \frac{A \times \text{vol.} \times 10^4}{A^{1\%/cm} \times \text{weight of sample}}$$

Where A = Absorbance

$A^{1\%/cm} = 2592$

Vol. = 25ml

(Sharoba, 2009)

Lycopene determination: Lycopene standard was prepared by weighing 1g of lycopene powder into 100ml of hexane-acetone mixture. This was allowed to stand for 1 hr before filtration. Then 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9ml of the stock were measured into test tubes and these were made up to 10ml each with hexane-acetone mixture. About 10ml of acetonic hexane mixture was used as blank. This mixture was allowed to stand for another 30 minutes before measuring there absorbance with UV-Spectrophotometer at 475 wavelengths and a standard curve were obtained. About 3g of tomato sample was grinded with pestle and mortal and 1g of each sample was added to 100 ml of hexane and acetone for 1hr with vigorous shaking. From the stock, 1ml of each sample were up to 10ml with hexane and acetone mixture and absorbance read on the spectrophotometer at 475 (Sharoba,2009).

Colour determination: The colour was estimated using the wooden field comparator and the colour observed was quantified using the digital definitions of hues of tomato colours for the visual analog colour scale (Adeyemo and Popoola 2015).

Microbial count: The total viable and fungal counts were estimated. Serial dilution method was employed in the analysis. Nutrient agar was used for the estimation of total viable count while acidified potatoes dextrose agar (PDA) was used for fungal count (Oyebanji *et al.,* 2011).

Statistical analysis: Data was analyzed using analysis of variance (ANOVA) with the aid of SAS (statistical analysis system) software package and means that was significantly different was separated at 5% probability level.

RESULTS AND DISCUSSION

Chemical properties of Fresh and Dried Tomato samples treated with varying concentrations of *A. danielli*.

Moisture, Ash, and Crude fibre: The result of the moisture, ash and crude fibre of dried tomato samples (sun and oven-dried) treated with varying concentration of *A. danielli* are presented in Table 2 and 3 below. Percentage moisture content for fresh tomato as shown in Table 1 was 89.6% which was higher in value than the dried tomato samples (sun and oven-dried samples) treated with varying concentrations of *A. danielli* (Table 2 and 3).

The result confirmed the fact that the major component of fresh tomato is water as reported by FAOSTAT, 2017. % moisture content of sun-dried tomato samples treated with varying concentrations of *A. danielli* ranged between 8.93 and 9.60% and that of oven-dried tomato samples treated with varying concentrations of *A. danielli* ranged between 9.17 and 9.37%. Statistical analysis revealed that differences existed ($P<0.05$) in the % moisture content between the dried samples in Table 2 and Table 3. The variation in % moisture of dried tomato samples could be attributed to uneven distribution of heat reaching the tomato samples during drying (Kolawole *et al.,* 2009). The % ash of fresh sample was 0.47% as shown in Table 1. Sun-dried tomato samples treated with varying concentrations of *A. danielli* (Table 2) ranged from 2.13 to 2.40%. This revealed a higher value in sun-dried tomato when compared to fresh sample and the result was in line with the findings of Babarinde *et al.,* (2009); Neela *et al*, 2017 who

Table 1. Evaluation of selected attributes of fresh tomato

Attributes	Fresh tomato
Moisture content (%)	89.6
pH	2.70
Ash (%)	0.47
Crude fibre (%)	1.93
Titratable acidity (%)	6.07
Ascorbic acid (mg/100g)	61.3
Total carotenoid (mg/100g)	2.90
Lycopene (mg/100g)	1.50
Colour	9.00
Bacterial counts (cfu/ml)	2.05×10^5
Fungal counts (cfu/ml)	2.45×10^5

Table 2. Evaluation of chemical, antioxidant and physical property of sun-dried tomato samples treated with varying concentrations of *A. danielli*

	Chemicals					Antioxidants			Physical
Samples	% MC	pH	% ash	% CF	% TA	AA (Mg/100g)	TC (Mg/100g)	Lyc (Mg/100g)	Colour
0% sun-dried	9.30^c	2.90^c	2.40^a	9.87^c	5.70^a	45.67^a	3.37^{ab}	2.83^a	8.00^a
2.5% sun-dried	9.43^b	3.10^a	2.13^b	10.20^a	5.73^a	35.0^c	3.33^b	2.70^b	5.00^d
5% sun-dried	9.33^c	3.00^b	2.13^b	10.13^{ab}	5.67^{ab}	34.67^c	3.23^c	2.73^b	7.00^b
7.5% sun-dried	8.93^d	3.10^a	2.13^b	10.07^b	5.67^{ab}	35.33^c	3.40^a	2.70^b	7.00^b
10% sun-dried	9.60^a	3.00^b	2.20^b	9.90^c	5.60^b	37.67	3.43^a	2.53^c	6.00^c

Values are mean of three replicates determination. Samples with the same superscript along the column are not significantly different at 5% probability. Key: MC-Moisture content, CF-Crude fibre, TA-Titratable acidity, AA-Ascorbic acid, TC-Total carotenoid, Lyc-Lycopene.

Table 3: Evaluation of chemical, antioxidant and physical property of oven-dried tomato samples treated with varying concentrations of *A. danielli*

	Chemicals					Antioxidants			Physical
Samples	% Mc	pH	% ash	% CF	% TA	AA (Mg/100g)	TC (Mg/100g)	Lyc (Mg/100g)	Colour
0% oven-dried	9.17^b	2.90^b	2.33^a	9.87^c	5.53^{ab}	31.67^c	3.27^c	2.47^d	6.67^c
2.5% oven-dried	9.37^a	2.80^c	2.27^{ab}	10.07^a	5.43^c	38.00^b	3.43^b	2.73^a	7.00^b
5% oven-dried	9.20^a	2.90^b	2.30^{ab}	10.13^a	5.60^a	38.33^b	3.53^a	2.70^{ab}	7.00^b
7.5% oven-dried	9.37^a	3.00^a	2.23^b	9.97^b	5.60^a	41.67^a	3.37^b	2.63^{bc}	8.00^a
10% oven-dried	9.23^b	3.00^a	2.20^b	10.13^a	5.50^{bc}	39.33^b	3.40^b	2.57^c	6.00^d

Values are mean of three replicates determination. Samples with the same superscript along the column are not significantly different at 5% probability. Key: MC-Moisture content, CF-Crude fibre, TA-Titratable acidity, AA-Ascorbic acid, TC-Total carotenoid, Lyc- Lycopene.

Table 4: Microbial evaluations of dried tomatoes treated with varying concentrations of *A. danielli*

	Sun-dried tomatoes treated with varying concentrations of *A. danielli*		Oven-dried tomatoes treated with varying concentrations of *A. danielli*	
Samples	Bacteria (cfu/ml)	Fungi (cfu/ml)	Bacteria (cfu/ml)	Fungi (cfu/ml)
0%conc.	$3.0x10^{3a}$	$3.0x10^{4a}$	$3.2x10^{3a}$	$3.0x10^{4a}$
2.5%conc.	$1.20x10^{2b}$	$2.3x10^{3b}$	$1.0x10^{2b}$	$1.1x10^{3b}$
5%conc.	$1.7x10^{2b}$	$2.2x10^{3b}$	$1.1x10^{2b}$	$1.7x10^{3b}$
7.5%conc.	$1.50x10^{2b}$	$2.0x10^{3b}$	$0.8x10^{2b}$	$1.5x10^{3b}$
10%conc.	$1.20x10^{2b}$	$2.1x10^{3b}$	$1.2x10^{2b}$	$1.2x10^{3b}$

Samples of the same drying method with the same superscript along the column are not significantly different at 5% probability. Note: cfu/ml means colony forming unit per millilitre

reported an increase in ash content of dried tomato samples due to increase in concentrations of mineral element in the dried samples. Sun-dried tomato samples treated with varying concentrations of *A. danielli* (2.5% sun-dried - 10% sun-dried) showed no significant difference ($P<0.05$) but means value was significantly lower ($P<0.05$) when compared to the control counterpart (0% sun-dried). Contrary to Ashaye *et al.,* (2006) who reported that increase in % ash of foodstuff treated with *A. danielli* could be due to the report of Adegoke and Idowu (2006), that *A. danielli* contains a number of essential minerals elements. Likewise, % ash of oven-dried tomato samples (Table 3) treated with varying concentration of *A. danielli* which ranged from 2.20 to 2.33% was higher in value than the fresh sample (Table 1). The result was also in line with the findings of Babarinde *et al.,* (2009), who reported increase in ash content of dried tomato samples due to increase in concentration of mineral elements in the dried samples. Similarly, oven-dried tomato samples treated with varying concentration of *A. danielli* (2.5% - 10% oven-dried) showed no significant difference at 5% probability. 7.5% and 10% oven-dried had the least value of ash content and statistically different compared to control (0% oven-dried) tomato sample. The result is also in contrast to Ashaye *et al.,* (2006), who reported increase in % ash of foodstuff treated with *A. danielli.* On the other hand, the reduction in % ash of sun-dried tomato samples treated with varying concentration (2.5 - 10% concentrations) of *A. danielli*, and oven-dried tomato samples treated with 7.5 and 10% concentration of *A. danielli* could be due to increase in % crude fibre because fibre may bind minerals, making them unavailable for absorption (Joseph and Norman, 2006).

As shown in Table 1, the % crude fibre of fresh tomato sample was significantly lower ($P<0.05$) than sun-dried tomato samples (Table 2) treated with varying concentrations of *A. danielli* (0% -10% sun-dried). This could be associated with high moisture content leading to lower percentage dried matter. The control sample (0% sun-dried) of Table 2 had the least % crude fibre when compared to sun-dried tomato samples treated with varying concentration of *A. danielli* (2.5% -10% sun-dried). The result in Table 2 indicated that the spice contributed to % crude fibre of the dried tomato samples and this could be due to the antimicrobial properties of the spice as reported by Ashaye *et al.,* (2006) which inhibited the action of enzymes and microorganisms responsible for the conversion of complex substances to simpler ones. Similar result was also reported when comparing the fresh (Table 1) and oven-dried tomato samples (Table 3) treated with varying concentrations of *A. danielli.* Oven-dried tomato samples had higher crude fibre content when compared to fresh sample. The control sample (0% oven-dried) of Table 3 also had the least % crude fibre when compared to oven-dried tomato samples treated with varying concentrations of *A. danielli* (2.5% - 10% oven-dried).

Titratable acidity and Ph: The result of the titratable acidity (TA) and pH of dried (sun and oven-dried) tomato samples treated with varying concentrations of *A. danielli* were presented in Table 2 and 3 accordingly. TA of fresh tomato sample in Table 1 was 6.07%. Sun-dried tomato samples (Table 2) treated with varying concentrations of *A. danielli* ranged from 5.6% - 5.7%. This showed a difference in value of TA between fresh and sun-dried tomato samples. At 5% probability level there was no significant difference in TA of the control and sun-dried tomato samples (Table 2) treated

with 2.5, 5 and 7.5% concentrations of *A. danielli* (2.5, 5 and 7.5% sun-dried). Titratable acidity (TA) of oven-dried tomato samples treated with varying concentration of *A. danielli* ranged between 5.6 and 5.5% (Table 2). The result showed that oven-dried tomato samples had a lower TA when compared with fresh tomato sample (Table 1). This confirmed the findings of Babarinde *et al.,* (2009), who reported a significantly lower TA in oven-dried tomato at 60^0C when compared with fresh tomato sample. Toor and Savage (2006) reported a significantly higher TA due to a significantly higher dry matter contents in a semi-dried flavouring variety. As shown in Table 3, there was no significant difference between 5%, 7.5% oven-dried and control sample (0% oven-dried) at 5% probability level. The pH of fresh tomato sample was 2.7 as evident in Table 1. The value was lower than the pH of sun-dried tomato samples (Table 2) and oven-dried tomato samples (Table 3) treated with varying concentration of *A. danielli.* This confirmed the findings of Babarinde *et al.,* (2009) who reported a significantly lower pH in fresh tomato when compared to dried tomato samples.

The control sample (Table 2) had a significantly lower pH ($P<0.05$) when compared with sun-dried tomato samples treated with varying concentrations of *A. danielli*. This could be attributed to the ability of the spice to inhibit microbial activities that could lead to the formation of basic substances which would increase the acidity of dried tomato samples. Joseph and Norman (2006) reported that certain spices and chemicals when combine with heat destroys microorganisms. Sun-dried tomatoes treated with 2.5% and 7.5% concentration of *A. danielli* (2.5% and 7.5% sun-dried) showed no significant difference at 5% probability but significantly different from samples treated with 5% and 10% sun-dried. Similarly, oven-dried tomato samples (Table 3) treated with 7.5 and 10 % concentrations of *A. danielli* had a significantly higher pH ($P<0.05$) value when compared to the control sample and other oven-dried samples treated with *A. danielli.* This could also be due to the ability of the spice to inhibit microbial activities at an increase concentration so that the formation of basic substances that could possibly increase acidity of the dried samples will be barred (Mnkeni *et al*, 2008)

Antioxidants property of Fresh and Dried Tomato samples treated with varying Concentrations of *A. danielli.*
Ascorbic acid: As shown in Table 1, the ascorbic acid of fresh tomato sample was 61.30mg/100g. When comparing this value with the dried samples (sun and oven-dried) treated with varying concentrations of *A. danielli* (Table 2 and 3), it is numerically higher. Fontes (2009) reported that the presence of Vitamin C in a fresh tomato solution decline after it was heated. It was also confirmed by Marfil *et al.,* (2006); Santos *et al,* (2008) that drying reduces the Vitamin C content. The ascorbic acid content of control sample (0% sun-dried) in Table 2 was 45.67mg/100g and sun-dried tomato samples treated with varying concentration of *A. danielli* (2.5% - 10% sun-dried) ranged between 34.67mg/100g and 37.67mg/100g. This result showed a significantly higher ($p<0.05$) Vitamin C content in control sample (Table 2) when compared to sun-dried tomato samples treated with varying concentrations of *A. danielli* (2.5% – 10% sun-dried). The reason(s) for reduction in ascorbic acid content of treated samples (2.5% - 10% sun-dried) when sun-dried was not known since it is thought that spices have antioxidant properties as reported by Babarinde (2009). However, when comparing the control sample (0% oven-dried) with treated oven-dried samples (2.5% - 10% oven-dried), the control sample was significantly lower in ascorbic acid content ($P<0.05$). Adegoke and Idowu (2006) reported that *A. danielli* has been found to have preservative properties on some food systems. The ascorbic acid content of treated oven-dried samples was best retained at 7.5% concentration of *A. danielli* while there was no significant difference ($P<0.05$) in samples treated with 2.5%, 5% and 10% concentrations (Table 3). On the other hand, ascorbic acid content of treated sun-dried tomato samples was best retained at 10% concentration of *A. Danielli* (Table 2).

Total carotenoid: The total carotenoids of fresh and dried tomato samples treated with varying concentrations of *A. danielli* were presented in Table 1, 2 and 3 below. The total carotenoid of the fresh tomato sample was 2.90mg/100g as shown in Table 1. This value was numerically lower ($P<0.05$) compared to the dried tomato samples of Table 2 and 3. Mozumder (2012) reported that thermal processing increases carotenoid concentrations which could be attributed to enzymatic degradations weakening protein carotenoid aggregate. McInerney *et al.,* (2007) also reported that micronutrients and phytochemicals in certain vegetables may be more bioavailable due to treatment. Mozumder (2012) also reported that the increase in total carotenoid could be due to concentration of pigments in dried samples after a considerable amount of moisture was removed Nonetheless, Chantaro *et al.,* (2008) reported that thermal degradation during both blanching and drying caused a decrease in the carotenoid and phenolic compounds, hence leading to loss of antioxidant activity of the final product in carrot peels. The total carotenoid of sun-dried tomato samples (Table 2) ranged between 3.23 and 3.43mg/100g and was best retained at 0%, 7.5% and 10% sun-dried. However, the control sample (0% oven-dried) in Table 3 had the least value of total carotenoid which was significantly different ($P<0.05$) when compared to oven-dried tomato samples treated with varying concentration of *A. danielli*. There was no significant difference ($P<0.05$) in oven-dried samples (Table 3) treated with 2.5, 7.5 and 10% concentrations of *A. danielli* while at 5% concentration, the total carotenoid of oven-dried tomato samples was best retained.

Lycopene: Table 1 showed the lycopene content of fresh tomato sample to be 1.50mg/100g. The lycopene content of sun-dried tomato samples in Table 2 ranged from 2.53 to 2.83mg/100g and oven-dried tomato samples in Table 3 ranged between 2.47 and 2.73mg/100g. The lycopene value of the dried tomato sample from Table 2 and 3 respectively was numerically higher than its fresh counterpart (Table 1). Roldan-Gutierrez and Luque de castro *et al.,* (2007), reported that thermal treatment could increase the release of phytochemicals from the matrix tomatoes. Babarinde *et al.,* (2009) also reported increase in lycopene of hot-air dried tomato. In Table 2, lycopene content of sun-dried tomato samples treated with 2.5, 5 and 7.5% concentrations of *A. danielli* (2.5% - 7.5% sun-dried) showed no significant difference ($p<0.05$), but values were significantly lower ($P<0.05$) than the control sample (0% sun-dried).This could be due to initial low temperature of drying which enhances the growth of microorganism and enzymic activities responsible for the degradation of lycopene. However, in Table 3, the lycopene content of the control sample (0% oven-dried) was statistically lower ($P<0.05$) when compared with treated oven-dried tomato samples (2.5% - 10% oven-dried). The result established the preservative property of *A. danielli* on the antioxidants of tomato.

This was further confirmed in the findings of Adegoke and Idowu (2006) who reported that *A. danielli* had preservative effect in some food system. Adegoke and Idowu (2006) also reported preservative property of spice on antioxidant of foodstuff. Lycopene was best retained in oven-dried tomato samples treated with 2.5 and 5% concentrations of *A. danielli*

Physical Evaluation on Fresh and Dried Tomatoes Treated With varying concentrations of *A. danielli* Colour

The colour of fresh and both sun-dried/oven-dried tomatoes treated with varying concentrations of (*A. danielli*) are presented in Table 1, 2 and 3 accordingly. The colour of fresh tomatoes in Table 1 is rated 9 as detected by the Wooden Analog Field Comparator (Adeyemo and Popoola, 2015). This value was numerically higher than the values of the dried samples in Table 2, 3 and 4 respectively. The rating of the fresh to be 9 indicates higher degree of redness since colour of tomato decreases with decreasing numerical values. Decrease in the colour of dried tomato samples as shown in all the tables when compared to fresh tomato could be due to changes in pigments as caused by heat. Fellows (2009) reported that in fruits and vegetables, chemical changes to carotenoid and chlorophyll pigments are caused by heat and oxidation during drying and residual polyphenoloxidase enzyme activity cause browning during storage. Similarly, Joseph and Norman (2006) reported that heat alters virtually all natural food pigments. Chopping and grinding also generally change food colours because many of the plants pigments are organized tissue cells and pigment bodies, hence, colour changes due to slicing of the tomato prior to drying cannot be overruled and this can be carried to the final product.

Changes in colour of the dried tomatoes could also be due to the action of heat on the sugar constituents of the tomato samples. Colour changes could also be due to reactions between sugar and protein constituent of the tomato In Table 2, when comparing the colour of the dried tomatoes, 0% sun-dried tomato is significantly higher than other sun-dried samples (2.5% - 10% sun-dried). This could be due to colour of the spice since the tomatoes are treated with aqueous extract of the spice. Sun-dried tomatoes treated with 5% and 10% concentrations of *A. danielli* tend to minimize changes in colour when compared to other sun-dried tomatoes treated with *A. danielli.* On the other hand, Table 3 shows a significantly lower value ($P<0.05$) for 0% oven-dried tomato when compared with 2.5, 5 and 7.5% oven-dried tomatoes treated with *A. danielli*. This could be due to the intensity of heat reaching the tomato in the oven during drying and consequently resulted to more pigment loss and more burning of the sugar. The colour of the oven-dried tomato is best retained in oven-dried tomato treated with 7.5% concentrations of *A. danielli* (Table 3).

Microbial Analysis of Fresh and Dried Tomatoes Treated with *A. danielli:* The result of the fungal and bacterial count of fresh and dried tomato samples treated with varying concentrations of *A. danielli* were presented in Table 1 and 4 respectively. The fungal and bacterial counts of the fresh tomatoes were higher than the dried tomato samples. Babarinde *et al.,* (2009) reported that microorganisms reduced with varying drying temperature and conditions. The decrease in both fungal and bacterial count of dried tomatoes over fresh cannot be overruled since heat destroys some microorganism during drying. Similarly, Kolawole *et al.,* (2009) reported that the availability of moisture and nutrients favoured greatly the growth of microorganisms. This can be verified from the decrease in value observed in both bacterial and fungal count for the dried tomatoes which could possibly be due to the reduction in moisture contents, as tomatoes dries and the unavailability of water necessary for the growth of microorganisms. When comparing the dried tomatoes treated with varying concentrations of *A. danielli* (2.5%-10% concentrations) with control counterpart (0% concentrations), a considerable reduction of microorganisms was observed in both sun-dried and oven-dried tomatoes treated with *A. danielli* over the control (0% sun-dried and 0% oven-dried). This observation revealed the antimicrobial activity of the spice as also confirmed by Ashaye *et al.,* (2006). Adegoke and Idowu (2016) also reported that of *A. danielli*. The combined effect of oven temperature and varying concentration of *A. danielli* reduced the fungal and bacterial counts significantly in oven dried samples when compared with treated sun-dried samples. Concentration of 5 and 7.5% of both spices reduced the microbial count better.

Conclusion

Findings showed that tomato samples treated with *Aframomum. danielli* had a higher average value of % ash, ascorbic acid, total carotenoid, lycopene and colour compared with control samples in oven-drying than sun-drying. Oven-drying method reduced the microbial contamination in dried tomato compared to sun-dried, upholding discouragement of open-air-sun-drying of food produce. Although, drying generally resulted into loss of nutritional properties, the oven-drying option is better than losing everything to deterioration. However, order of retaining of antioxidants, physiochemical, and reduction in microbial load in dried tomato is higher for oven-drying than sun-drying.

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