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CHANGES IN ANTIOXIDANT ACTIVITY, PHYSIOCHEMICAL AND MICROBIOLOGICAL PROPERTIES OF DRIED TOMATOES TREATED WITH CLOVE (SYZYGIUM AROMATICUM)

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Abstract

Tomatoes were pre-treated with *Syzygium aromaticum*, dried and evaluated for its antioxidants, physicochemicals and antimicrobial properties. *S. aromaticum* treatment were made at varying concentrations of 2.5, 5, 7.5 and 10%. Sun drying and oven drying (60ºC) were used to effect the drying process. Dried tomatoes samples treated with no *S. aromaticum* served as control samples. Selected properties evaluated includes; moisture content, ash, pH, crude fibre, titratable acidity, ascorbic acid, total carotenoid, lycopene and total viable and fungal count using standard methods. The results obtained showed that treatment with *S. Aromaticum* significantly ($P<0.05$) increased the pH and crude fibre when compared with the control samples. Ascorbic acid value of the oven-dried control sample was significantly reduced compared to the ascorbic acid value of the sun-dried control sample. However, in treatment with varying concentrations of *S. aromaticum*, the ascorbic acid values of oven-dried samples were better retained. The lycopene and total carotenoid value were also reduced in oven-dried samples compared to sun-dried samples when treated with varying concentration of *S. aromaticum*. There was considerable reduction in total viable and fungal count of tomatoes treated with *S. aromaticum* compared with the control samples. The findings revealed that *S. aromaticum* was a good pre-treatment for preserving quality of dried tomato.

Key words: *Syzygium aromaticum*, lycopene, ascorbic acids, total carotenoid

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is regarded as the poor man's orange and outranked other vegetables in contribution to human nutrition due to its prominent use in cuisines worldwide. Tomato fruits are rich source of dietary fiber and contain many vitamins, including vitamins C, E and A as well as minerals, such as selenium, copper, manganese and zinc, which act as co-factors for antioxidant enzymes (Alfaro-Olivera *et al*, 2016). Tomatoes promote health by preventing diseases, such as cancer, diabetes and coronary heart disease**s**. They are rich in active components, such as polyphenols and carotenoids as well as several rutins and naringenins thus, tomatoes can be considered a functional vegetable (Alshatwi *et al*, 2010). The soluble carbohydrates in tomatoes are almost all reducing sugars and the predominant acids are citric followed by malic. Glutamic acid was reported as the main amino acid, which is rarely found in other fruits (Abou Dahab, 2006).

Fresh fruits and vegetables are noted for substantial postharvest losses. These losses ranged from quality lost to total spoilage. If these losses are not properly addressed, there could be food and nutrition insecurity subsequently, increasing poverty among smallholder farmers (Babarinde *et al.*, 2018). 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 includes 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). There is therefore need to preserve fruits and vegetables to reduce losses while making 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. However, 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%). 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).

The search for new improvement on tomato qualities after drying is increasing due to possibility of using them in Pizza toppings, snacks and other savoury dishes (Lewicki *et al.*, 2002). This search spanned to the use of spices and reason could be attributed to the increasing scrutiny and re-appraisal of synthetic chemicals (such as sodium metabisulphite). The potent sources of natural antioxidants are spices and herbs. Spices and herbs have been reported by Jalosinska and Wilczak (2009) to impact preservatives effect on foods due to their bacteriostatic and anti-oxidative activities. Spices belong to group of component of food that are generally regarded as safe (Fasoyiro *et al.*, 2001). They are readily acceptable by consumers for their safety, reduced or no mammalian toxicity and less environmental hazard (Hassani *et al.*, 2012).

Natural spices can be used to pre-treat tomatoes prior to drying for its antioxidant effect. *S. aromaticum* has been found to have preservative properties in some food systems (Adegoke *et al*, 2007). According to Mahmoud *et al*, (2017), the active ingredient in clove is eugenol, and clove oil contains 80% or more eugenol. Eugenol smells strongly of cloves and thus its practical applications are limited. Cloves have been shown to protect bacon fat from oxidation, and increase the storage life of shortening and baking products prepared from it. Cloves grow in Nigeria and are locally referred to as *albase* in Hausa, *Kloovu* in Igbo and *kanafuru* in Yoruba. This research, therefore, intends to study the antioxidant effect *of S. aromaticum* on dried tomatoes. Also, the chemical, physical and microbial effect of *S. aromaticum* 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 cloves (*Syzygium aromaticum*). Freshly harvested tomatoes were purchased at Wazobia market, Ogbomoso, Nigeria while S*yzygium aromaticum* 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. *Syzygium aromaticum* purchased in its dried form were cleaned of dirts and contaminants. *Syzygium aromaticum* 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 spices 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 60^0C for 10 hour (Gisele *et al.*, 2004)

Qualitative analysis

The following analyses were carried out on fresh and dried tomato samples treated with *S. aromaticum*: 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;

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

$$= \frac{\text{weight before drying-weight after drying}}{\text{Weight of sample}} \times 100$$

(AOAC, 2013)

pH determination

20ml of distilled water was added to 10g of tomato sample and mixed very well. pH meter di-electrode 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;

$$\% \text{ ash} = \frac{\text{weight of ash remained}}{\text{Original weight of sample}} \times 100$$

(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 boiling 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 their 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 made 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 (Oyebaniji *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 *S. aromaticum*

Moisture, Ash and Crude Fibre

The result of the moisture, ash and crude fibre of fresh and dried tomato samples treated with varying concentrations of *S. aromaticum* are shown in Table 1, 2 and 3 respectively. The moisture content of fresh tomato sample was 89.6% (Table 1). This value shows drastic reduction when compared to dried samples as shown in table 2 and 3. The results further affirmed the report that the major component of tomato is water and drying aimed to reduce the moisture content to a level that allows the food to be stored safely for an extended period (Babarinde *et al.,* 2009). In Table 2, % moisture content of sun-dried and oven-dried tomato samples treated with varying concentrations of *S. aromaticum* showed significant difference($P<0.05$). This variations could be attributed to drying air velocity (Fellows, 2009).

The % ash of fresh tomato sample in Table 1 was 0.47%. The % ash of sun-dried tomato sample treated with varying concentrations of *S. aromaticum* in Table 2 ranged between 2.03 and 2.40%. Likewise, % ash of oven-dried tomato samples (Table 3) treated with varying concentrations of *S. aromaticum* ranged from 2.20 to 2.33%. The results of the dried tomato samples as shown in Table 2 and 3 were higher when compared to fresh tomato sample (Table 1). Babarinde *et al.,* (2009) reported an increase in dried tomato samples as a result of increase in concentrations of mineral element in the dried samples. The control samples (0% sun-dried and oven-dried) of table 2 and 3 had higher ash content ($P<0.05$) when compared to dried samples treated with varying concentrations of *S. aromaticum* (2.5%-10%). The decrease in % ash of spice-treated-dried tomato samples could be due to increase in % crude fibre as evident in Table 2 and 3 because fibre may bind minerals, making them unavailable for absorption (Joseph and Norman, 2006). However, in Table 3, oven-dried tomato samples treated with 5 and 7.5% concentrations of *S. aromaticum* exhibited relatively the same % ash content with the oven-dried control sample ($P<0.05$).

In Table 1, the % crude fibre of fresh tomato sample was 1.93%. This value was lower when compared with the dried tomato samples of Table 2 and 3. This could be due to % dry matter in fresh tomato. In Table 2 and 3, the control samples (0% sun-dried and 0% oven-dried) were significantly lowered ($P<0.05$) compared to the dried tomato samples treated with varying concentrations of *S. aromaticum* (2.5 - 10% conc.) of each table and this could be due to ability of the spice to act as antimicrobial agent as reported by Ashaye *et al.,* (2006) thereby inhibiting the action of enzymes and microorganisms responsible for the conversion of complex substances to simpler ones.

Titratable Acidity (TA) and pH

Table 1, 2 and 3 presented the TA and pH of fresh and dried tomato samples (sun-dried and oven-dried) treated with varying concentration of *S. aromaticum* accordingly. The TA of fresh tomato sample was 6.07%. This value is higher than that of the sun-dried (Table 2) and oven-dried tomato samples (Table 3). Babarinde *et al.,* (2009) reported a significantly lower TA ($P<0.05$) in both sun-dried and oven-dried (60^0C) tomato samples compared to fresh tomato sample. From Table 2, the control sample and dried samples treated with 5% concentration of *S. aromaticum* had relatively the same TA. There was no significant difference in the TA of samples treated with 7.5

and 10% concentrations of *S. aromaticum* (Table 2). Titratable acidity for 0, 2.5 and 7.5% concentrations of *S. aromaticum* showed no significant difference (P<0.05) (Table 3). Oven-dried tomato samples with 5 and 10% concentrations of *S. aromaticum* had the highest value of TA (Table 3).

pH value of fresh tomato sample as shown in Table 1 was 2.70. pH of sun-dried tomato samples (Table 2) treated with varying concentration of *S. aromaticum* ranged from 2.90 to 3.40 and in Table 3, pH of oven-dried tomato samples treated with varying concentration of *S. aromaticum* ranged between 2.90 and 3.20. The result of pH for the dried tomato samples showed a higher numerical difference from the fresh sample. Babarinde *et al.,* (2009) reported a significantly lower pH in fresh tomato sample when compared to the dried tomato samples. This could be due to ability of the spice to inhibit microbial activities that could produce basic substance which could subsequently increase the acidity of the dried tomato samples. Joseph and Norman (2006) reported that certain spice and food chemicals when combine with heat destroy microorganisms. Sun-dried tomatoes treated with 5% to 10% concentrations of *S. aromaticum* were not statistically different (Table 2). 2.5% sun-dried had the highest pH value in all treated tomato samples of Table 2. Similarly, oven-dried tomato samples (Table 3) treated with varying concentrations of *S. aromaticum* showed no significant difference (P<0.05) except that of 5% concentration of *S. aromaticum.*

Antioxidants property of fresh and dried tomato samples treated with varying concentrations of *S. aromaticum*

Ascorbic Acid

The ascorbic acid content of fresh tomato was 61.30mg/100g as shown in Table 1. This value was higher than the dried tomato samples treated with varying concentrations of *S. aromaticum* as shown in the Table 2 and 3 respectively. Chang *et al.,* (2006) reported that hot-air-dried tomatoes had higher loss of Vitamin C. Similarly, Fontes (2009) reported that the presence of Vitamin C in a fresh tomato solution declined after it was heated.

In Table 2, the ascorbic acid of the control sample was 45.67mg/100g and the sun-dried tomato samples treated with varying concentrations of *S. aromaticum* ranged between 30mg/100g and 31.67mg/100g. The result of samples treated with *S. aromaticum* was significantly lower (P<0.05) when compared with control (Table 2). However, the oven-dried tomato samples treated with varying concentrations *of S. aromaticum* in Table 3 retained the ascorbic acid better than the control sample (0% oven-dried) and this was significantly different (P<0.05) in sample with 10% *S. aromaticum*. There was significant difference in ascorbic acid values of sun-dried tomato samples treated with 2.5, 5 and 7.5% concentrations of *S. aromaticum* (Table 2).

Total Carotenoid

The value for the total carotenoid of fresh tomato (Table 1) was lowered than the dried tomato samples as shown in Table 2 and 3. McInerney *et al.,* (2007) reported that due to processing, phytochemicals in certain vegetables may be more bioavailable. Increase in total carotenoid of dried tomatoes could be due to concentrations of pigments after considerable moisture was removed (Mozumder, 2012). Sahlin *et al.,* (2004) reported that bound antioxidants are released by processing. Similarly, Sahlin *et al.,* (2004) reported bioavailability of carotenoid due to thermal treatment.

In Table 2, total carotenoid was best retained in sun-dried tomato samples treated with 5 - 10% concentrations of *S. aromaticum* while 0 - 2.5% concentrations have the least retentive ability for total carotenoid. This further affirmed the preservative ability of clove in food system. When comparing the total carotenoid of the dried tomato samples in Table 3, control sample (0% oven-dried) had the highest value but was not significantly different from samples treated with 5% concentration of *S. aromaticum.* Mozumder, (2012) reported that spice act as antioxidant agent however; decrease in total carotenoid could be due to variations in the distribution of heat in the oven. Chantaro *et al.,* (2008) reported that thermal degradation during blanching and drying caused a decrease in the contents of carotene and phenolic compounds, hence leading to the loss of antioxidant activity. There was no significant difference (P<0.05) between oven-dried tomato samples treated with 2.5%, 7.5% and 10% concentrations of *S. aromaticum* (Table 3)

Lycopene

The lycopene content for fresh tomato was 1.5mg/100g (Table 1) which was numerically lower than dried tomato samples (Table 2 and 3). Roldan-Gutierrez and Luque de castro *et al.,* (2007) reported that thermal treatment could increase the release of phytochemicals from the matrix tomatoes. Similarly, Chang *et al*., (2006) reported increase in lycopene content of hot-air-dried tomatoes and it was further confirmed in the work of Babarinde *et al., (*2009). Lycopene content of sun-dried tomato samples with 2.5, 7.5 and 10% concentrations of *S. aromaticum* (Table 2) showed no significant difference ($P<0.05$) but their means were significantly lower ($P<0.05$) when compared to 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 as reported by Kolawole *et al.,* (2009) that if temperature is low at the beginning, microorganism may grow before the food is adequately dried. 5% sundried tomato sample had the least value ($P<0.05$) when compared to other dried samples.

Oven-dried tomato sample treated with 5% concentration of *Syzygium aromaticum* showed no significant difference compared to the control sample (0% oven-dried). However, oven-dried tomato samples treated with 2.5 and 7.5% concentrations of *S. aromaticum* were significantly difference ($P<0.05$) when compared to control sample (0% oven-dried) and this could be due to variations in the distributions of heat reaching the tomato sample in the oven during drying. Chantaro *et al.,* (2008) reported that thermal degradation during blanching and drying caused a decrease in the contents of phenolic compounds.

Physical evaluation on fresh and dried tomatoes treated with varying concentrations of *S. Aromaticum.*

Colour:

Table 2 showed the colour of the sun-dried tomatoes treated with varying concentrations of *S. aromaticum* changed from normal tomato colour when treated with the spice and more colour changes occurred with increasing concentration of the spice. This could be due to high intensity effect of the aqueous extract colour on colour of tomato samples. Oven-dried samples treated with 2.5 and 5% concentrations of *S. aromaticum* retained the colour better when compared with control sample, 7.5% and 10% concentration of *S. Aromaticum.*

Microbial Analysis of Fresh and Dried Tomatoes treated with *S. aromaticum.*

The fungal and bacterial counts of fresh and dried tomato samples treated with varying concentration of *S. aromaticum* are presented in Table 1 and 4. The bacterial and fungal counts of fresh tomatoes were $2.05x10^5$cfu/ml and $2.45x10^5$cfu/ml respectively. These values were higher than values recorded for both sun-dried and oven-dried tomato samples (Table 4). Babarinde *et al.,* (2009) reported that microorganisms reduced with varying temperature and conditions. Reduction in microbial count could be due to destruction of microorganism by heat and substantial reduction in moisture content of tomatoes due to heat. Sun-dried and oven-dried tomatoes treated with *S. aromaticum* have a lower microbial count when compared to both sun-dried and oven-dried control samples. Jalosinska and Wilczak (2009) reported that *S. aromaticum* prolong the shelf life of foods by their bacteriostatic activity and also as an effective antibacterial agent. In Table 4, it was noted that when the concentrations of *S. aromaticum* increased in sun-dried tomatoes, the bacterial count decreased. This could be due to more inhibitory property of microbial activity of the spice at increased concentrations. However, there was no significant difference ($P<0.05$) in fungi count of sun-dried tomatoes treated with *S. aromaticum* with increment in the concentration of *S. aromaticum*. In the same vein, 5% and 7.5% concentrations of *S. aromaticum* in oven-dried tomatoes are more effective in reducing bacteria count.

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 tomatoes treated with varying concentrations *S. aromaticum*

Samples	% MC	pH	% ash	% CF	%TA	AA(mg /100g)	TC(mg/ 100g	Lyc(mg/ 100g)	Colour
0% sun-dried	9.3^{ab}	2.90^{c}	2.40^{a}	9.87^{c}	5.70^{a}	45.67^{a}	3.37^{bc}	2.83^{a}	8.00^{a}
2.5%sun-dried	9.37^{a}	3.40^{a}	2.13^{bc}	10.13^{a}	5.50^{c}	31.30^{bc}	31.30^{bc}	2.63^{b}	6.00^{b}
5% sun-dried	9.23^{b}	3.30^{b}	2.20^{b}	10.03^{b}	5.67^{a}	30.00^{c}	3.50^{a}	2.50^{c}	6.00^{b}
7.5%sun-dried	9.37^{a}	3.30^{b}	2.17^{b}	10.07^{ab}	5.57^{b}	31.30^{bc}	3.43^{ab}	2.57^{b}	5.00^{c}
10% sun-dried	9.30^{ab}	3.30^{b}	2.03^{c}	10.13^{a}	5.60^{b}	31.67^{b}	3.46^{a}	2.63^{b}	4.00^{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 3: Evaluation of chemical, antioxidant and physical property of oven-dried tomatoes treated with varying concentrations of *S. aromaticum*

Samples	% MC	pH	% ash	% CF	%TA	AA(mg /100g)	TC(mg/ 100g	Lyc(mg / 100g)	Colour
0% oven-dried	9.17^{bc}	2.90^{c}	2.33^{a}	9.87^{c}	5.53^{b}	31.67^{b}	3.27^{a}	2.47^{ab}	6.67^{c}
2.5%oven-dried	9.27^{a}	3.20^{a}	2.20^{b}	9.93^{c}	5.57^{ab}	33.00^{ab}	3.10^{b}	2.37^{c}	7.00^{b}
5% oven-dried	9.20^{ab}	3.10^{b}	2.23^{ab}	10.03^{b}	5.60^{a}	32.33^{ab}	3.23^{a}	2.43^{bc}	8.00^{a}
7.5%oven-dried	9.10^{c}	3.20^{a}	2.30^{ab}	10.10^{a}	5.53^{b}	32.00^{ab}	3.13^{b}	2.40^{c}	4.00^{d}
10% oven-dried	9.17^{bc}	3.20^{a}	2.20^{b}	10.07^{ab}	5.60^{a}	33.30^{a}	3.13^{b}	2.53^{a}	4.00^{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-Lycopen

Table 4: Microbial evaluations of dried tomatoes treated with varying concentrations of *S. aromaticum*

	Sun-dried tomatoes treated with *S. aromaticum*		Oven-dried tomatoes treated with *S.aromaticum*	
Samples	Bacteria (cfu/ml)	Fungi (cfu/ml)	Bacteria (cfu/ml	Fungi (cfu/ml)
0%conc	$3.0x10^{3a}$	$3.0x10^{4a}$	$3.20x10^{3a}$	$3.0x10^{4a}$
2.5%conc.	$2.3x10^{3b}$	$2.1x10^{3b}$	$1.10x10^{3c}$	$2.6x10^{3b}$
5%conc	$2.0x10^{3c}$	$1.8x10^{3b}$	$0.9x10^{3d}$	$2.4x10^{3bc}$
7.5%conc	$1.7x10^{3d}$	$2.0x10^{3b}$	$0.9x10^{3d}$	$2.3x10^{3bc}$
10%conc.	$1.7x10^{3d}$	$1.7x10^{3b}$	$1.3x10^{3b}$	$2.0x10^{3c}$

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 milliliter

5. CONCLUSION

Drying concentrated the components of tomato by removing moisture. However, loss in ascorbic acid, TA and colour change occurred due to drying. Similarly, dried tomato samples have reduced microbial count. The values of tomato samples were increased in term of % crude fibre and pH due to the pre-treatment. On the other hand, reduced values for % ash were obtained in dried tomato samples treated with *S. aromaticum*. There was a considerable loss in ascorbic acid of sun-dried samples treated with *S. aromaticum* compared to the control samples, however, oven-dried tomato samples treated with *S. aromaticum* was appreciated when compared with value obtained from control sample. The average value obtained from oven-dried tomato samples treated with *S. aromaticum* in terms of moisture, pH, TA and bacterial counts were lowered compared to sun-dried tomato samples treated with *S. aromaticum*. Hence, it can be established that the combined effects of oven drying and *S. aromaticum* were better when compared to sun drying. However, the average value of oven-dried tomato samples treated *S. aromaticum* in terms of total carotenoid and lycopene were lowered, with a higher average value for fungal count when compared with sun-dried- tomato samples treated with *S. aromaticum*. However, order of retaining of antioxidants, physiochemical, and reduction in microbial load in dried tomato was higher for oven-drying than sun-drying method.

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