Journal of Postharvest Technology
2019, **07**(4): 14-24
http://www.jpht.info

RESEARCH ARTICLE

Application of groundnut oil as plant based preservative to optimise postharvest quality of Padma 108 tomato fruits

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Received: 05.08.2019 Accepted: 25.10.2019

ABSTRACT

Tomato fruits are cultivated across the regions in large and small scale quantities in sub Saharan Africa as food as well as economic crop. In Ghana, it is almost an obligatory ingredient in the daily diets of people across all regions. Tomato is consumed in diverse ways, including raw, as well as an ingredient in many dishes. The challenge however is the short shelf life which makes it difficult to preserve for longer duration resulting in lower return on investment. This research was carried out to examine how oil extracted from waste groundnut nut could be used to preserve Padma 108 variety of tomato fruits. Tomato fruits were held at 10ºC and 25ºC for 12 days after the application of plant based oil to compare with fruits without oil preservative. The experiment was laid out in Completely Randomized Design with three replications. Quality parameters assessed were Firmness, Total soluble solid, pH, percentage weight loss, taste and marketability. It was demonstrated that significant differences were found due to the variation in temperature in firmness and TSS at $P \leq 0.05$ with fruits stored at 10°C showed firm texture and high TSS found at fruits held at 25°C. Preservative application also produced significant difference at $P \leq 0.05$ in pH, weight loss, taste and marketability. Based on the findings from the research conducted, Padma 108 tomato variety quality can be optimized using combine effects of waste groundnut oil as plant based preservative and held at lower temperature.

Keywords: Tomato, Quality, Postharvest Treatment, Groundnut oil, Lower temperature

Citation: Abdul-Rahaman, A., Mahama, A.P., Wahab, S.A., Bashir, B., Nipurmeh, M., and Adama, B.A. 2020. Application of groundnut oil as plant based preservative to optimise postharvest quality of padma 108 tomato fruits. *Journal of Postharvest Technology*, **7**(4): 14-24.

INTRODUCTION

Tomato belongs to the Solanaceae family, which is one of the most important and popular food crops in the world (Agrios, 2005; Peralta and Spooner, 2007). In Ghana, it is almost an obligatory ingredient in the daily diets of people across all regions. Tomato is consumed in diverse ways, including raw, as an ingredient in many dishes. The Tomato fruit contain vitamins, essential mineral, antioxidants, bio-flavonoids, dietary fibres and flavour compounds (John et al., 2010; Osemwegie et al., 2010; Pramod et al., 2016). Tomato fruit contain carotenes, vitamin C and several phenolic compounds such as flavonoids and hydroxycinnamic acid derivatives, which are believed to be beneficial to human health (Kabelka et al., 2004; Gautier et al., 2008). Tomato had an estimated global production of over 120 million metric tons (FAO, 2007). Adu-Dapaah and Oppong Konadu (2002) also noted that tomato cultivation in Ghana forms a key farming activity for people living in the savannah and forest savannah belts of the country. Tomatoes production accounts for about 4.8 million hectares of harvested land area globally with an estimated production of 162 million tons of which Ghana recorded an estimated production of tomatoes as

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ISSN: 2348-4330

321,000 metric tons (FAOSTAT, 2014). Losses of horticultural produce especially tomato are a major problem in the postharvest value chain. Losses are caused by myriad of factors ranging from growing conditions through to handling at retail level. Losses clearly are a waste of food, and represent a waste of human effort, farm inputs, livelihoods, investments and scarce resources such as water (Jenny, 2002; Kamrul et al., 2010).

Postharvest losses have been highlighted as one of the determinants of the food problem in most developing countries like Ghana. Losses were mainly because of high rates of temperature variations, bruising, water loss, and subsequent decay during postharvest handling (Kitinoja, 2002; Ray and Ravi, 2005; Siddiqui et al., 2016). It is against this background that this study seeks to examine the effects of groundnut oil extracted through intermediate technology in reducing postharvest losses on the quality of Padma 108 tomato with emphasis Firmness, Total soluble solids, pH weight loss and marketability.

MATERIALS AND METHODS

Plant Material

Fruits were harvested at horticultural maturity when light red, considered adequate for commercial purposes. One Hundred and twenty (120) fruits were harvested with the calyx attached at private tomato farm located at Busa. Tomatoes were carefully accommodated inside isothermal boxes and transported to the Postharvest Technology Laboratory at Wa Polytechnic.

Oil Extraction Technology

The groundnut used for the extraction were nuts sorted out considered as waste which was treated by cleaning, selection, sun drying to reduce the moisture content to 5%, cold conditioning at temperature of between 60-70°C.Grinding was carried out to obtain the paste and pressing was carried out and oil collected. Through treatments, the materials have a certain structural performance that meets the requirements of the crude oil produced. These oils were kept under ambient temperature for forty eight (48) hours before application.

Application procedure

The method of application was manually carried out by immersion of fruits until surfaces are covered with oil. The duration of immersion was 3minutes and it was constant for all treated fruits. The fruits were immediately stored after application and monitored daily while readings taken every two days for a period of 12days.

Experimental design

The experimental trial was 2 x 2 factorial design arranged in Completely Randomised Design. Fruits were selected for unity and freedom from defects and blemishes. Fruits were further randomly divided into two equal lots. The first lot then surface coated with groundnut oil while the second lot as used control. After the treatments, the fruits were stored at 10°Cand 25C for fourteen days. Stored fruit were monitored and assessed after every two days for weight loss (%), fruit decay severity, Total Soluble Solids, Marketability, firmness and pH.

Fruit firmness (N/Cm): Fruit firmness was measured as the maximum penetration force (N) reached during tissue breakage using a standard plunger. The registered force at the penetration of a plunger up to a certain depth (cm) will be read as

firmness. A handheld fruit pressure tester with a smaller mm plunger will be used to determine the firmness adapted from Kumah et al. (2011).

Total Soluble Solids –TSS (%): The TSS content of the fruits was be measured by placing a sample of juice on the prism of a handheld refractometer and reading taken and reported as percent brix as suggested by Ayman (2016).

pH; The digital pH meter obtained from 691, Metrohm, Swiss Made was used to test for the pH of sample fruits juice squeezed onto a container. The hole in the electrode after removing from a soaking solution was checked, rinsed and immersed in water that provided a neutral pH of 7.0 as known standard. A pH were only taken when the meter stabilized after the immersing of the electrode in the juice**.**

Weight loss (%); Fruits were regularly weighed and loss in fruit weight recorded for each replicate and then was calculated as percentages in relation to the fruits weight at day zero and at storage and subsequently using the formula WL (%) = $\frac{W1-W2}{W1} \times 100$ as suggested by Nirupama et al. (2010). Where W_1 = tomato fruit weight at day zero and W_2 = tomato fruit weight at subsequent days at storage.

Marketability potential

A fifteen-member panel, made up of staff and students of Wa Polytechnic for sensory analysis of tomato slices. Panelists were selected based on their ability to distinguish between stored and fresh tomato slices and their availability during the study .They were shown how to assess the following visual quality and consumer acceptance of the fruits. The following score keys were developed as a guide in the assessment. Panelists were taken through how to use the score keys just before the assessment started. After each of the test they use treated water to rinse their mouths to avoid continued influence of the taste. The Nine (9) and Three (3) point's hedonic scales were used. Visual quality;

3=Good, 2=Average, 1=Poor

Overall acceptance;

9= Excellent,

7=Very Good,

5=Good: Limit of Marketability,

3=Fair: Limit of Usability and

1=Poor: Unsellable.

Data Analysis

Data generated from the experiment was subjected to Analysis of Variance to find out whether the fruit attributes studied differed significantly at $p \leq 0.05$. The means separation was done using the Fishers's least Significant Difference (FLSD).

RESULTS

Firmness (N/Cm)

The results obtained from the analysis of the Padma 108 tomato fruits treated with groundnut oil preservative and held at 25°C (OTC) showed a gradual reduction in fruit firmness with an average firmness of 4.4 N/Cm compared with treated tomato fruits held at 10°C (OT10) which produced an average firmness of 3.9 N/Cm for the first six days after storage. On day 12 when the experiment was terminated, tomato fruits treated with groundnut oil preservative held at 25°C produced an average firmness of 2.1 N/Cm compared with treated tomato fruits stored at 10°C which produced an average firmness of 2.4 N/Cm. The fruits treated and stored at lower temperature were firmer than fruits held at higher temperature. Analysis of the firmness of untreated tomatoes stored 25°C (UTC) produced 5.1 N/Cm compared with 5.6 for untreated sample held at 10°C for the first week. The average firmness for both samples of untreated tomatoes stored at 25°C and 10°C on day 12 was 3.5 N/Cm respectively (figure 1). There was significant difference on firmness due to temperature at $p \leq 0.05$.

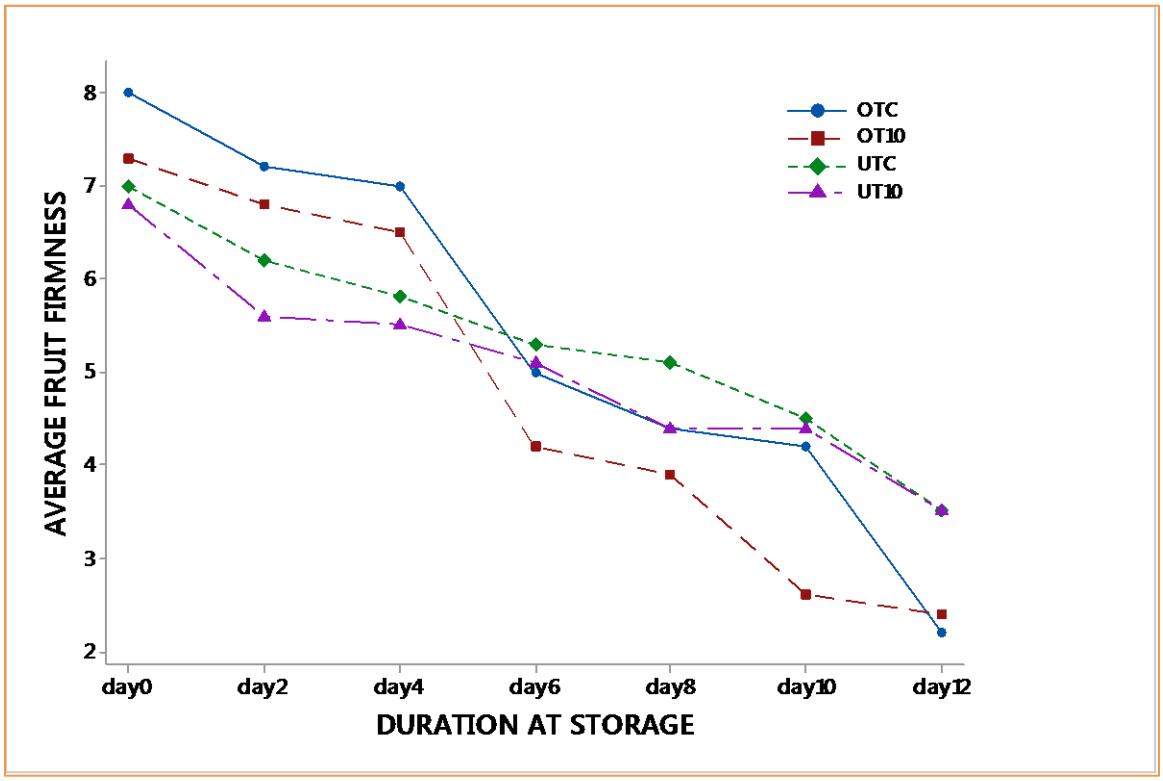

Figure 1. Average firmness of Padma 108 tomato fruits treated with groundnut oil and stored 10°C and 25°C for 12 days

Total Soluble Solids –TSS (%)

The results obtained from the analysis of the Padma 108 tomato fruits treated with groundnut oil preservative and held at 25°C (OTC) showed a continues increased in fruit TSS with an average TSS of 6.2% compared with treated tomato fruits held at 10°C (OT10) which produced an average TSS of 6.1 % for the first six days after storage. On day 12 when the experiment was terminated, tomato fruits treated with groundnut oil preservative held at 25°C produced an average TSS of 7.1 % compared with treated tomato fruits stored at 10°C which produced an average TSS of 7.0 %. The fruits treated and stored at lower temperature (OT10) were slower in TSS changes than fruits held at higher temperature (OTC). The analysis of the TSS of

untreated tomatoes held at 25°C (UTC) produced 6.3% TSS compared with 6.2% for untreated sample held at 10°C for the first week. The average TSS for fruits untreated and held at 25°C was 7.8% compared with 6.9% for fruits held at 10°C on day 12 (figure 2). Results could not produce significant difference due to preservative application but there was significant difference on TSS due to temperature at p≤0.05.

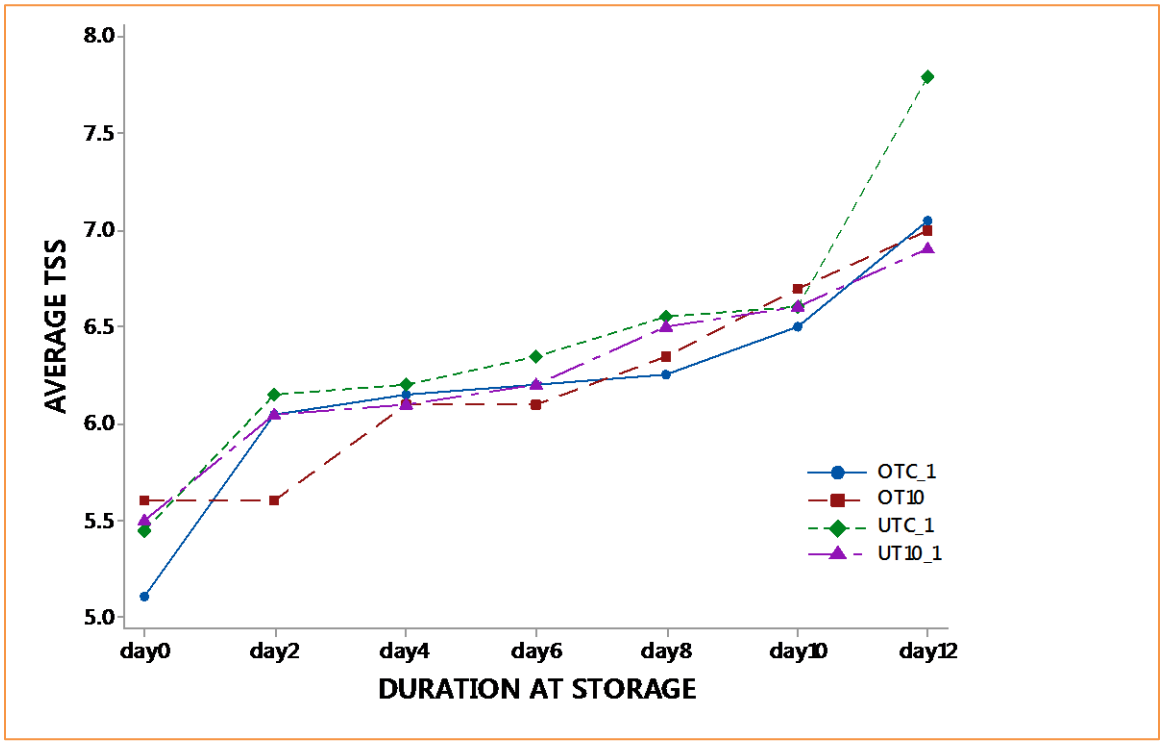

Figure 2 . Average TSS of Padma 108 tomato fruits treated with groundnut oil and stored at 10°C and 25°C for 12 days.

pH

The results obtained from the analysis of the Padma 108 tomato fruits treated with groundnut oil preservative and held at 10°C (OT10) and 25°C (OTC) showed a continues increased in fruit pH with an average pH of 4.3 respectively six days after storage. On day 12 when the experiment was terminated, tomato fruits treated with groundnut oil preservative held at 25°C produced an average pH of 4.5 compared with treated tomato fruits stored at 10°C which produced an average PH of 4.4. It was clear that the fruits applied with oils produce least pH. The analysis of the pH of untreated tomatoes held at 25°C (UTC) produced a pH of 4.1 compared with 4.3 for untreated sample held at 10°C for the first six days. The average pH for fruits untreated held at 25°C was 4.6 compared with 4.5 for fruits held at 10°C on day 12 (figure 3). Results produced significant difference due to preservative application as well as due to temperature at p≤0.05.

Weight Loss (%)

The results obtained from the analysis of the Padma 108 tomato fruits treated with oil preservative and showed a gradual increased initially which later reduced as storage proceeds while the untreated demonstrated a continues increased in weight loss. Fruits treated and held at 10°C produced a weight loss of 2.0% compared with 14.3% in the first six days of storage. On day 12 when the experiment was terminated, tomato fruits treated with groundnut oil preservative held at 25°C produced the

highest percentage weight loss of 24.6% compared with treated tomato fruits stored at 10°C which produced 3.6%. It was clear that the fruits applied with oils and held at 10°C produced least weight loss. The analysis of the weight loss of untreated tomatoes held at 25°C (UTC) produced a weight loss of 7.1% compared with 2.0% for untreated sample held at 10°C for the first six days of storage. The percentage weight loss for fruits untreated held at 25°C was 8.2. Compared with 2.7 for fruits held at 10°C on day 12(Figure 4). Results produced significant difference due to preservative application but not due to temperature at p≤0.05.

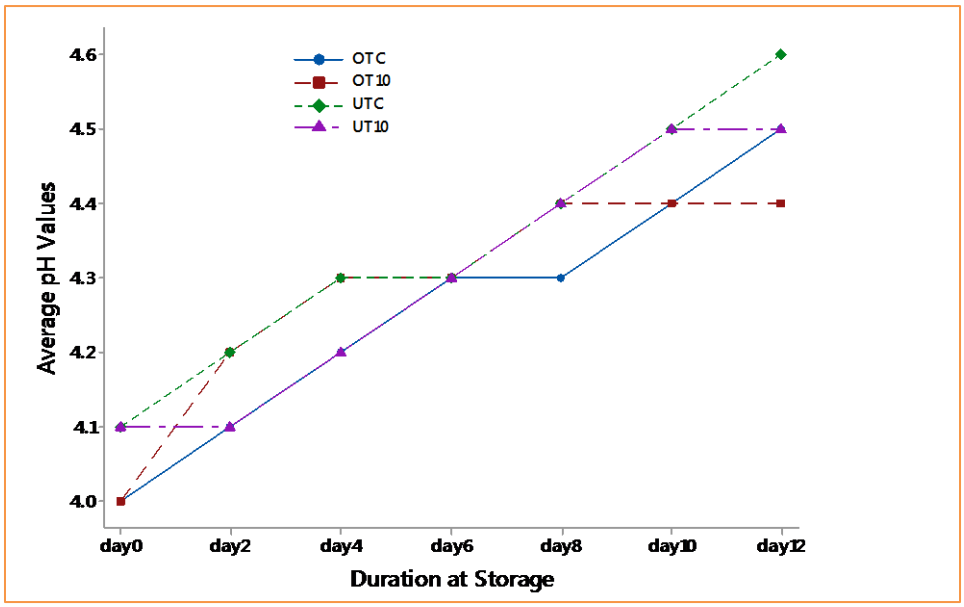

Figure 3 . Average pH values of Padma 108 tomato fruits treated with groundnut oil and stored 10°C and 25°C for 12 days

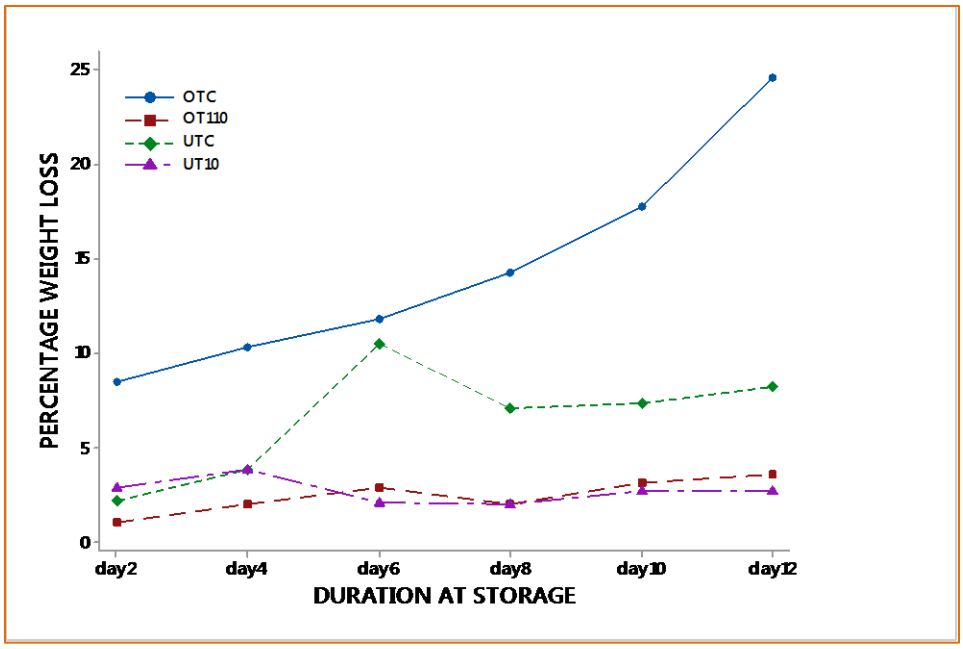

Figure 4 . Percentage weight loss of Padma 108 tomato fruits treated with groundnut oil and stored 10°C and 25°C for 12 days

Marketability

The results produced by fifteen (15) panelists for marketability of Padma 108 tomato fruits treated and untreated which was held 25°C and 10°C for an experimental period of 12 days. However, Padma 108 tomato fruits that were treated with groundnut oil and stored at 10°C (OT10) indicated marketability values of 9 which were described as excellent fruits for acceptability as compared with samples treated with groundnut oil and held at 25°C (OTC) which was scored 1 to mean poor. Taste for untreated samples stored at 10°C (UT10) was scored 3 to mean good taste as compared with untreated samples that were held at 25°C (UTC) which were scored 2 to mean fair for taste. (Figure 5). Analysis showed that there was significance difference on taste of the treated Padma108 tomato fruits due to the use of groundnut oil as a coating material for tomatoes at p≤0.05. Also the results showed that there was significance difference on overall acceptability of the treated tomato fruits at the end of the experiment due to both temperature and groundnut oil preservative at p≤0.05.

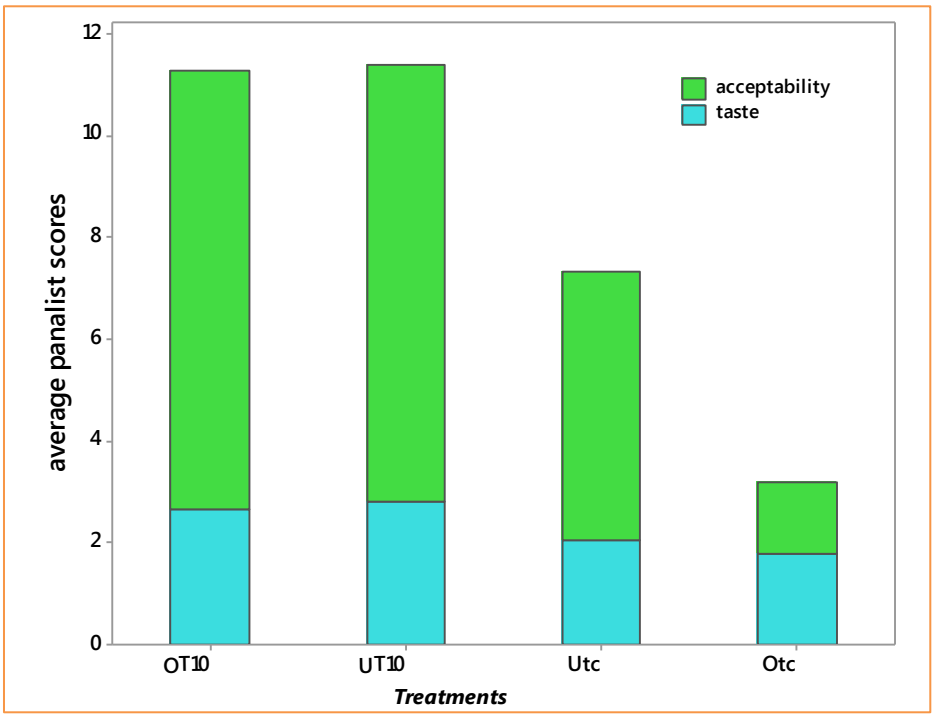

Figure 5 . Taste and marketability of Padma 108 tomato fruits treated with groundnut oil and stored 10°C and 25°C for 12 days

DISCUSSION

Firmness

The firmness of the fruits recorded significant difference at p≤0.05 with storage time due to temperature. The analysis of variance on fruit firmness showed highly significant differences due to temperature. The results obtained indicated that lower temperature combine with the oil preservative significantly (p≤0.05) retained the firmness of the fruits and acted as a control of gas exchange, nutrients and water loss. At the end of storage (12 days), control fruit clearly showed the lowest firmness. This lower firmness could possibly be attributed to metabolic degradation due to loss of internal food reserve. Similarly, Tanada-Palmu and Grosso (2005) reported that lower temperature storage combine with coated wheat gluten-based films retained

firmness better than control fruit. The current study findings contradicts previously reported findings by Kumar and Bhatnagar (2014); Pramod et al. (2016) that edible coating reduces firmness of fruits and vegetables

TSS

The study result revealed that there was a significant difference between tomato fruits held at temperature 25°C and 10°C in soluble solids. It was found that temperature had significant effect on the Total Soluble Solutes of the tomato fruit samples. However groundnut oil coating could not produce significant effect on TSS at $p \leq 0.05$ in the current study. Similarly related studies by Kader (2002), Kader and Saltveit (2003), Kay and Paull (2004), and Wills et al. (2007) demonstrated that among the external factors affecting respiratory rate of fresh fruits and vegetables after harvest, temperature is considered the most important in modulating this physiological parameter. Also gradual increase of TSS content during advancing stages of storage was possibly due to hydrolysis of starch into sugar (Rawal et al., 2016).This increase in TSS was more pronounced in the fruits of the 25°C set and it was significantly delayed in coated fruits at 10°C. Such progressive increases in TSS, explained as the consequences of water evaporation from fruits surface, were widely reported in previous studies using different cultivars (Pretel et al., 2006).

pH.

Based on the analysis in this study the pH content of the tomato fruit varied significantly at different stages of the storage period. Organic acids provide most of the hydrogen ions in tomatoes and normally decrease with ripening, producing an increased in pH. It was found that pH increases with the advancement of the ripening of fruit in all the tomato fruits resulting in differences among treatments. Gol et al., (2013) reported that a decline was less significant in coated fruits thereby supporting the idea that coated material may delay fruit senescence which is linked to the progress of fruit senescence. The combined effect of coating with groundnut oil and temperature was found significant on the pH content which fail to support the findings Nandane and Jain, (2011) that the effect of coating treatments on pH value is statistically insignificant ($p \leq 0.05$). The current research findings conforms to previously reported findings by Kaliana et al. (2014) who found significant difference in pH in tomato stored for 14 days when coated with Aloe Vera gel.

Weight Loss

The analysis of the results in this current research demonstrated significant differences among fruit weight loss due to coating. However, weight loss observed among fruits indicated no significant differences due to temperature. Fruits coated with groundnut oil preservative had less weight loss during storage than the control, and weight loss increased gradually during the storage period. The results obtained demonstrated that oil significantly ($p \leq 0.05$) reduced weight loss and acts as barrier against water loss. Pramod et al., (2016) established that edible coatings have good barrier properties to O_2, CO_2, moisture and water vapour. Low levels of O_2 and high levels of CO_2 limit the activities of enzymatic Several related studies by Kader (2002); Kader and Saltveit, (2003); Kay and Paull (2004); Wills et al. (2007); Dhall (2013) all found that edible coatings or edible films contributed to enhance the shelf life of fruits and vegetables by reduction of moisture loss, limit solute migration and gas exchange as well as by reducing the physiological disorders with the latest findings. Lin and Zhao (2007) further supported the findings that the function and performance of edible coating mainly depends on its mechanical, barrier and colour properties, which control the gas transfer and moisture loss of fruits and vegetables.

Marketability

In order to confirm the role of groundnut oil preservative coating as a keeping quality agent, sensory evaluation was carried out by 15 panellists and the results showed sensory attributes of coated and uncoated fruits at the end of the storage period revealed significant ($p \leq 0.05$) differences on taste and overall acceptability. The acceptability of the sample fruits base on taste was significantly different at ($p \leq 0.05$) due to both groundnut oil preservative coating and temperature. The results obtained further demonstrated that groundnut oil preservative coating and temperature of treated tomato fruits at 10°C (OT10) retained the oxidized reserved energy in soluble solutes. All other sensory attributes such as overall acceptability followed the trend similar to that obtained for taste. Similar results were observed by El-Anany et al. (2009) when they treated fruits with gum as coating. Also, Woo et al. (2016) established that coated fruits had higher average flavour and overall impression scores than control fruits. Oil preservative has very a good flavour during coating however at the time evaluation sensorial properties of the fruits was not affected and overall, sensory analysis showed that the tested coating did not have a negative impact on consumer perception. The description of the previous studies confirms the findings of the current research.

CONCLUSION

Postharvest coating of tomato fruits into different plant extracts like groundnut oil, can prolong the shelf life and improve marketability of tomato fruits without pronounced result on the qualities of the fruits. Groundnut oil as a preservative when coated on the surface of tomatoes showed superior performance in the experiment indicating that, the use of groundnut is good for extending the shelf life of Padma 108 tomato fruits. Based on the current study, there are great potentials in the control of storage using naturally occurring substances that are both humanly and environmentally friendly and at the same time affordable at less cost to the users.

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