Original Article

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Shea butter wax application to enhance the storability of mill tomato and bell green pepper fruits

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ABSTRACT

The consumption of perishable fruits and vegetables forms an essential part of nutrition through the provision of nutrients for growth and good health. However, farmers, marketers, and consumers encounter several challenges regarding the keeping of fresh commodities such as mill tomato and bell green pepper fruits to increase the shelf life due to the quick degeneration and decomposition of the produce at storage. The need for the consumption of fresh fruits and vegetables increased across the world which resulted in the need for storage of these perishables. The objective of the study was to determine the effects of shear butter as a wax on the shelf life of mill tomato and bell green pepper fruits in ambient temperature and charcoal evaporative cooler (CEC), cultivated in communities in the Wa Municipality of the Upper West Region of Ghana. The results obtained on percentage weight loss of fresh green pepper coated with Shea butter stored in CEC and ambient temperature monitored for an experimental period of 7-day showed that the least percentage weight loss for green pepper was found with uncoated fruits sample stored at ambient with 1.37%, but the highest was found with coated in an evaporative cooler. However, the least weight loss for tomato fruit was found in coated tomatoes with 1.07% compared with coated sample at ambient with 2.78%. The experiment was terminated on the day 7 with uncoated green pepper with the highest value of 6 compared with the uncoated sample in the evaporative cooler with 3.7. The uncoated tomato samples showed that fruits in the evaporative cooler were decaying more than those at ambient with the highest value of 5. The least glossiness was found in both uncoated fruits samples in the two conditions, but the highest was shown by fruits sample coated and stored in the evaporative cooler. Based on the scores produced, it was clear that the sample coated in the cooler was more preferred.

KEY WORDS: Mill tomato, bell green pepper, Shea butter, wax, weight loss, decay severity, marketability, glossiness

INTRODUCTION

Mill tomato is one of the most important vegetables grown for the fruits worldwide. They are grown for home consumption as well as small-scale operators for income. The majority of the producers in Sub-Sahara Africa cultivate this crop in the backyard of their homes. The crop is an important source of vitamins and an important cash crop for both small-holders and medium-scale commercial farmers. In general, tomato fruits act as taste enhancers in food, and therefore always in high demand both for fresh consumption and processing. It is one of the food commodities that contribute significantly to the economic growth of Ghana as a source of income. It is very nutritious and a major source of Vitamin A, B, and riboflavin as well as carbohydrate, protein, calcium, carotene in our diet (Enrique *et al.*, 2006). On the other hand, bell pepper fruit is a major spice usually produced in both main and lean seasons and consumed in fresh, dry, or processed form in a salad. They are consumed in such quantity per serving that the constituent is a real table vegetable contributing to the nutritional value of the meal. Green pepper also plays a vital role as a highly nutritious vegetable with a green glossy exterior add of color to any dish. In view of the importance of these two crops coupled with the lack of appropriate technologies for farmers to preserve these commodities, farmers are compelled to sell their produce at lower prices in order not to encounter loses.

There are several factors that account for the high losses of fruits and vegetables such as mill tomato and bell green pepper which include but not limited to the perishability, temperature, and time at storage interaction as well as seasonality and variety. The issues of variety and seasonality of producing peppers such as other vegetables affect their storage. Tunde-Akintunde *et al.* (2005) reported that about 28.6% and 38.7% postharvest losses were recorded during the dry and wet seasons, respectively. Olympio and Kukuih (2002) suggested that there was the need to come up with varieties that could withstand the transportation damages or improve the handling ability of varieties grown. Postharvest management of the fruits and vegetables involve the continuing process of normal physiological activities. Olosunde (2006) suggested that deterioration transforms a physiological mature but inedible plant organ into a visually attractive and edible organ which marks the complete development of fruit and the commencement of senescence, and it is normally and irreversible event. Due to the complex nature of the process of deterioration, Bachman and Earlies (2000) disclosed that crops destined for storage should be as free as possible from skin breaks, bruises, spots, rots, decay, to avoid any risk of deterioration. Mishandling of fruits and vegetables usually leads to cracks, bruises, and cuts which affect the market value of the fresh produce. Changes do occur during postharvest operations for tomato and green pepper fruits which results in a decrease in shelf life which in the long term leads to decrease in the quantity provided for consumption and for the export market. Dvizama, (2000) discovered that the notable changes that do occur during postharvest in respect of quality include color change, loss of weight, change in the firmness, and change in total soluble solids. The issue of saleable weight is also important if tomato and green pepper shelf life. When the harvested produce loses 5% or 10% of its fresh weight, it begins to wilt and soon becomes unusable Enrique *et al*. (2006). The loss of weight comprises of both respiratory and evaporative losses. According to Opara and Tadesse (2000) respiration results in loss of fruit dry matter and weight. They also stated that dry matter content changes with ripening and fruit color, which is the main indicator of maturity. The loss of water during handling of fruits and vegetables contribute to the loss in quality when they are produced in excess. Elazar (2004) suggested that transpiration is the evaporation of water from plant tissues which is a very important cause of produce deterioration, with severe consequences. Reducing the amount of water loss could help to lower the rate of deterioration which can be achieved through waxing. The application of wax as suggested by Mejía-Torres *et al.* (2009) that it is among the current practices used to improve the appearance of tomatoes and reduce loss of weight also revealed that waxing sweet pepper was able to maintain good sensory acceptance and differ weight loss (Raffo *et al.*, 2008; Yage *et al.*, 2011). The relevance of the application of waxes in reducing weight loss and reduce fruit oxygen uptake from the environment which further slow the activity of respiration was earlier suggested by Donhowe and Fennema (1994). According to Javanmardi and Kubota (2006), Shea butter is one of the major sources of fat in the diets of many local communities in Sub-Saharan Africa. A further research revealed that Shea butter provides Vitamin A, E, and F to the people and lowers cholesterol levels (Schreckenberg, 2004; Renfrow, 2008). In Ghana, the Standards Authority is the institution responsible for approving the quality and otherwise of all products and have certification for small-scale operators to many acceptable standards. In the global perspective, however, the European Union indicated that Shea butter was acceptable in the chocolate manufacturing industry with a maximum of 5% fat (OJEC, 2000). The specific objectives of this study were to coat mill tomato and bell green pepper and investigate the effects on decay severity, weight loss, glossiness, and marketability when stored in the evaporative cooling device and the ambient environment.

MATERIALS AND METHODS

Materials used for the experiment include fresh mature 40 (20) each of mill tomato and Bell green pepper fruits and Shea butter oil for coating the produce. Matured fresh harvested tomato and green pepper were purchased from Sing a farming community in the Wa municipality and transported immediately to Wa Polytechnic workshop on the 5th December 2014 for the commencement of the research.

Design of the Experiment

The experiment was set after obtaining the needed materials and equipment. 40 fruits comprising 20 fruits each for mill tomato and bell green pepper were used for the experiment. The produce were divided into 8 groups, thus 20 each of tomato and green pepper fruits were divided into four groups, respectively, each coated 10 fruits in a set. Shea butter was used to coat two set of groups for both tomato and green pepper. The coating was done by dipping the fruits into the shear butter oil for 17 s. The produce both coated and uncoated were stored in a charcoal evaporative cooler (CEC) and ambient temperature, respectively. Their respective weights were recorded daily as weight of produce and monitored for

an experimental period of 7-day. A randomized complete block design with 8 treatments is the experimental design used with 2 replications and 10 fruits per replicate.

Weight Loss Determination

Weight of fresh tomato and green pepper were measured daily throughout the experimental period using a digital measuring scale. Weight loss values obtained from the daily reading of produce were calculated using the formula.

$$\text{Weight loss}\% \frac{W_1 - W_2}{W_1} \times 100$$

Where W_1 = Initial weight of produce, W_2 = Final weight of produce

Determination of Decay Severity

The severity of decay was assessed based on a score key developed which was used for the ratings. 0 = No sign of decay, 1-1.9 = Minor visible signs 2-2.9 = Slight to moderate signs 3-3.9 = Moderate signs 4-4.9 = Clear signs of spots 5-5.9 = Clear signs with slight holes 6-6.9 = Slight hole to deep holes.

Determination of Glossiness and Marketability

A score key was developed purposely for this experiment with a five point hedonic scale for the glossiness with 1designated as excellent, 2 = Very good, 3 = Good, 4 = Fair, and 5 = Poor. A similar key was used for marketability where 9 = Excellent, 7 = Very good, 5 = Good: Limit of marketability, 3 = Fair: Limit of usability, and 1 = Poor: Unsalable.

Data Analysis

The analysis of the data was done using Minitab version 16, data on, weight and decay severity were taking daily during the experimental period. Furthermore, data on marketability and glossiness were assessed on the last day of the experimental period by providing a score key designed purposely for this research. The data were analyzed using the general linear regression model, and means were claimed significant at $P \leq 0.05$. Means separation was done using individual Fisher's error rate.

RESULTS

Percentage Weight Loss

The results obtained on percentage weight loss of fresh green pepper coated with Shea butter stored in CEC and ambient temperature monitored for an experimental period of 7-day showed that on the day 2 coated green pepper fruits in CEC and ambient conditions produced weight loss of 1.05%, and 1.22%, but the uncoated fruits produced weight loss of 1.73% and 2.59%, respectively (Figure 1). Green pepper fruits sample coated and stored in evaporative cooler showed increased weight loss of 1.88% compared with 1.59% for fruits at ambient condition on day 5. However, the uncoated green pepper fruits indicated more pronounced weight loss values of 3.12% and 2.04% for ambient and evaporative cooler, respectively. The least weight loss was found with green pepper fruits uncoated at ambient with 1.37% when the experiment was terminated. However, the coated tomato fruits at ambient increased from 0.42% to 2.78% for the experimental period compared with the coated tomato fruits in the evaporative cooler that increased from 0.39% to 1.07% (Figure 2). The uncoated fruits sample showed

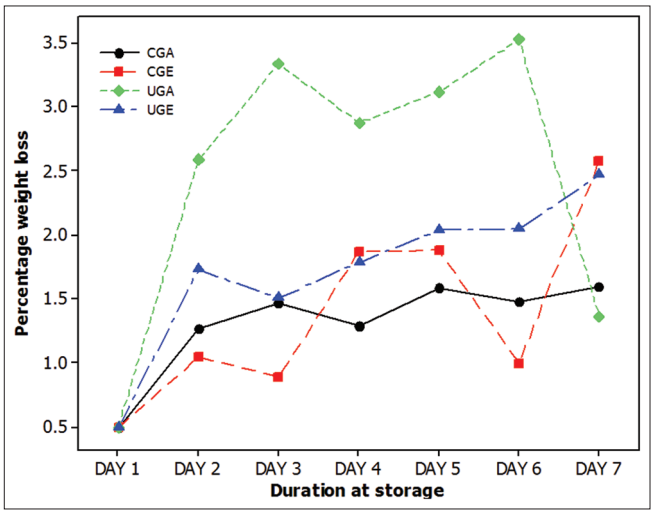

Figure 1: Percentage weight losses coated and uncoated bell green pepper fruits

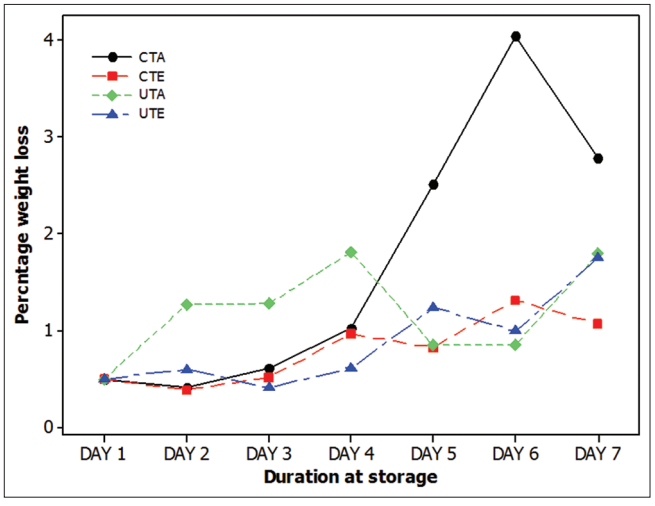

Figure 2: Percentage weight losses coated and uncoated mill tomato fruits

a similar pattern in weight loss values of 1.8% and 1.76 for ambient and evaporative cooler, respectively, when the experiment was terminated.

Decay Severity of Tomato and Green Pepper Fruits

The results produced by the data on decay severity showed that samples began to indicate decay only after the first 2 days. The uncoated green pepper at ambient showed a decay of 4.4 compared with coated fruits in the evaporative cooler with 2.6 on day 4. The coated samples produced decay severity values of 2.4 and 3.8 for ambient and evaporative cooler, respectively, on the day 4. The experiment was terminated on the day 7 with uncoated green pepper with the highest value of 6 compared with the uncoated sample in the evaporative cooler with 3.7 (Figure 3). However, the coated tomato fruits at ambient gradually showed signs of decay from 2.1 in slight to moderate signs to 3.2 as moderate signs for the experimental period compared with the fruits in the evaporative cooler with only slight to moderate signs from 2.4 to 2.8 (Figure 4). The uncoated samples showed that fruits in the evaporative cooler were decaying more than those at ambient with the highest value of 5.

Marketability and Glossiness of Tomato and Green Pepper Fruits

The results produced by the data on marketability assessment test conducted by 14 panelist on overall acceptance and glossiness of fresh green pepper fruits coated with Shea butter stored in CEC and ambient temperature for an experimental period of 7-day showed that average values of 7.4 and 6.1 were scored for overall acceptance but the uncoated fruits in the two conditions produced averages of 6.1 and 3.7 for cooler and ambient, respectively. The highest glossiness was shown by fruits coated and stored in the evaporative cooler while the least was found with uncoated fruits at ambient. Based on the results, it was clear that the panelist would accept to purchase more of the coated fruits in the cooler that the rest of the samples. However, the same panelist scored coated mill tomato fruits in evaporative cooler and ambient by 6.6 compared to 4.4, respectively, for overall acceptance. The uncoated fruits produced values of 4.3 and 4.0 for evaporative cooler and ambient. The least glossiness was found in both uncoated fruits samples in the two conditions, but the highest was shown by fruits sample coated and stored in the evaporative cooler. Based on the scores produced, it was clear that the sample coated in the cooler was more preferred (Figures 5 and 6).

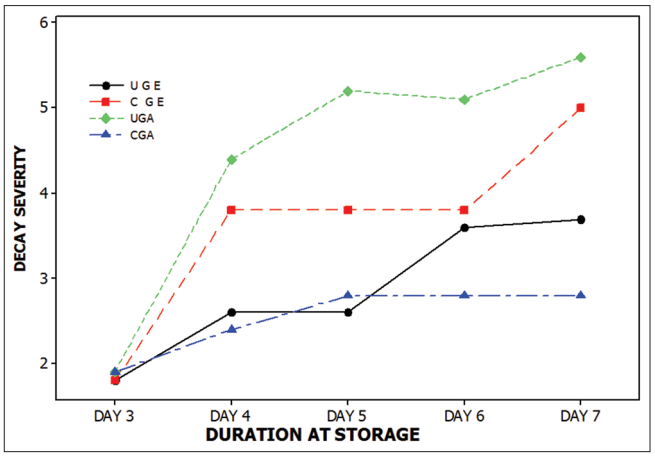

Figure 3: Decay severity of coated and uncoated bell green pepper fruits

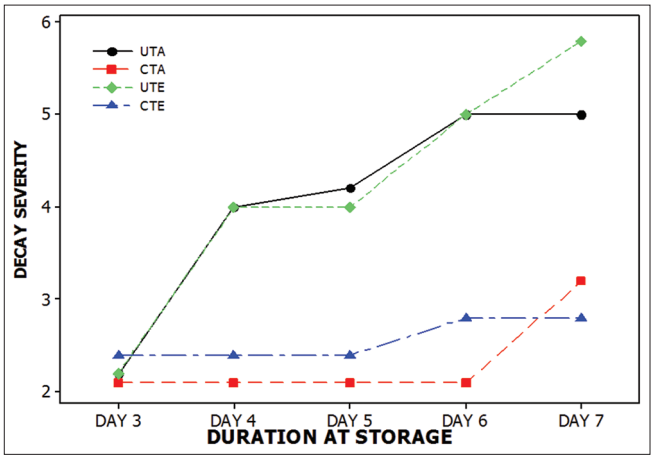

Figure 4: Decay severity of coated and uncoated mill tomato fruits

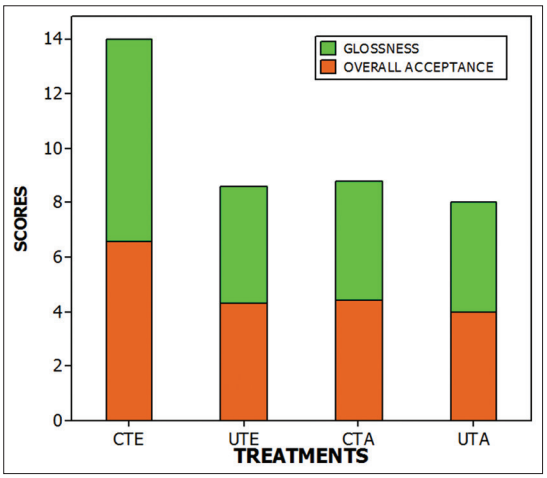

Figure 5: Overall acceptance and glossiness green pepper fruits

DISCUSSION

Percentage Weight Loss

The results obtained from the analysis of the data on percentage weight loss green pepper indicated that no

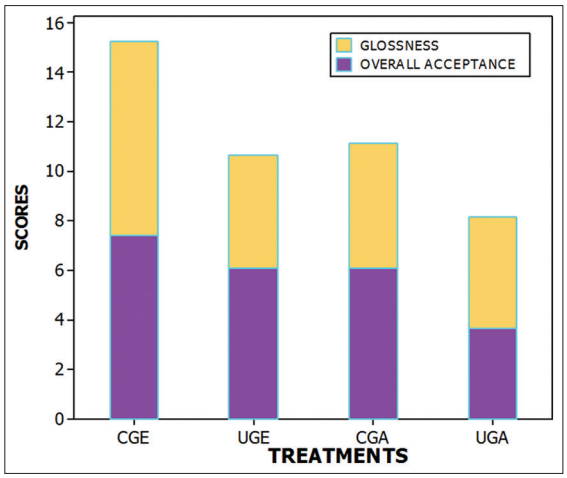

Figure 6: Overall acceptance and glossiness of fresh tomato fruits

significance difference was found with the coating and storage conditions. There was also no interaction effect. The non-significance revealed by the analysis could be due to other factors rather than just effective treatments. The current findings disagree with earlier findings by (Alhassan and Adams, 2014) which demonstrated that coating affected the weight loss of fruits stored on the day 14 of the experimental period. Furthermore, Olosunde (2006) research confirmed that fruits kept inside evaporative chamber recoded lower weight loss than those stored outside the chamber. The fruits were fresh up to 5 days more inside the chamber than outside. Furthermore, based on the analysis of the data from the tomato fruits sample, the coating, and the storage conditions could not produce any statistical difference among the treatments. Part of the storage was done at room temperature that could give the pattern which disagreed with findings by Javanmardi and Kubota (2006) that suggested tomato fruits stored at room temperature produced a significant difference within 7 days.

Decay Severity

The results produced by the analysis on decay severity of tomato fruits demonstrated that coating of the fruits affected the decay significantly for the experimental period. However, the storage condition could not produce any statistical difference for the period on decay. The current research results obtained agree with previous research which indicated that decay severity of tomato fruits stored in the evaporative cooler and ambient temperature of 18°C and 28°C demonstrated that there was a significant difference in decay on the first 6 days by (Abdul-Rahaman *et al.,* 2015). Furthermore, it was further disclosed by (Olympio and Kukuih, 2002; Ruperti *et al.*, 2002) that deterioration of fresh commodities can result from physiological breakdown due to natural ripening process, water loss, temperature injury, physical damage, or invasion by microorganisms. Exposure of fruits to warm temperature may result in moisture accumulation on the surface of commodities (sweating) which may enhance decay development. There were, however, no interaction effects on the coating and the storage condition. Analysis of the results on the decay of green pepper sample clearly showed that the treatments of both coating and storage conditions could not produce any significance difference. The results of the current research were not supported by the findings of Chae *et al.*, 2008; Raffo *et al.*, 2008 that suggested that different storage condition produced significantly different in decay severity.

Glossiness

The results produced from the analysis of data on glossiness green pepper for both coated and uncoated fruits stored in CEC and at ambient temperature which was evaluated by selected panelist showed that no significant differences were found with the coating and storage conditions. The results produced may be attributed to maturity of fruits. Postharvest operations do not stop the fruits from respiring which if not controlled will lead to the over-ripening of the fruits which will lead to early deterioration hence loss of fruits glossiness. Depending on the stage, the fruits are harvested, which in practice varies from mature green to fully ripened fruits (Mejía-Torres *et al.*, 2009).

The results obtained disagree with similar research which suggested that higher loss in green color at ambient temperatures may be caused by increased breakdown of chlorophyll and synthesis of carotene and lycopene pigments, which occur during ripening (Kays, 1991). Lowering the temperature of non-climacteric fruits lowers their rate of ripening and deterioration (Ladaniya, 2001) and hence the high retention of green color observed on fruits. Similarly, the results produced by the data demonstrated that tomato fruits could not show any significant difference among the treatments for the experimental period. The non-significance found in the results could be associated to the duration at storage and wax type. Earlier research by (Vargas *et al.*, 2011; Yage *et al.*, 2011) contradicts the current findings that glossiness is an important characteristic to be measured by in appearance because of the direct relations between the smoothness of surface and appearance as storage proceeds.

Overall Acceptance

The results obtained from the analysis on overall acceptance by the panelist demonstrated that even though the scores were different among the treatments by their judgment,

the difference was not statistically different due to the coating and the storage conditions. The results contradict findings of (El-Ghaouth *et al.*, 1999; Wang *et al.*, 2006) that due to the coating the eating quality tasted the better providing difference with untreated samples. However, (Ladaniya, 2001) intimated that duration of coated fruits affected acceptability after 30 days which was different from the current results. The results produced by the analysis demonstrated that the tomato fruits coated and uncoated stored in the two conditions could not show any significant difference. Based on the results produced, the differences in overall acceptance could be attributed to maturity and cultivar. The findings of the current research disagree with earlier research reported by Donhowe and Fennema (1994) which demonstrated that there was the influence of tomato cultivar and maturity stage on the postharvest quality of tomatoes stored under different conditions. Further research by Abdul-Rahaman *et al.*, (2015) indicated that overall acceptance of fruits stored in evaporative cooling for 10 days experimental period, clearly showed that 15 panelists scored highest overall acceptance of 8.07 for fruits stored in evaporative cooler compared with control sample 6.60 and means were statistically different among the treatments.

CONCLUSIONS

Maintaining quality of fresh fruits and vegetables to extend their shelf life for consumers is a major priority for the postharvest technologist. This study has shown that the use of energy free cold store CEC and Shea butter for coating fruits can reduce the average weight, decay severity, and enhance glossiness of tomato and green pepper fruits hence maintaining their freshness and shelf life for consumers. Although green pepper and tomato fruits stored in CEC could not reduce the weight loss but reduce decay the shelf life was extended better than tomato and green pepper fruits stored at ambient temperature. The tomato and green pepper fruits with similar characteristics from other parts of the globe can be preserved with the technology of Shea butter wax. The combine effects of the wax material and cooling were better in green pepper fruits than the tomato fruits in the maintaining the quality at storage.

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