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Physicochemical properties of coated tomato during storage

E. O. Oladiti[1,2], I. B. Oluwalana[1], G. I. Pele[1,2]*

[1]Department of Food Science and Technology, Federal University of Technology, P.M.B. 704, Akure, Ondo State, Nigeria.

[2]Department of Food Technology, Federal Polytechnic, Offa. P.M.B. 420, Offa, Kwara State, Nigeria.

ABSTRACT

The impact of post-harvest loss has militated against all-year access to tomatoes. The influence of coating materials on the physicochemical properties of tomatoes during storage was investigated. Tomato was coated with gelatin, carboxyl methylcellulose, alkalinized starch, and honey while uncoated tomato served as control. Results showed that the control tomato sample was kept for 60 days, while titratable acidity, colour intensity, carotene, specific gravity, pH, refractive index, total soluble solids were 0.16, 0.70, 1.22 mg/100g, 1.03, 6.50, 1.440, 5.44%, respectively. The results also showed that tomato coated with gelatine kept till 69 days and the titratable acidity, colour intensity, carotene, specific gravity, pH, refractive index, total soluble solids were 0.15, 0.65, 1.40 mg/100g, 1.05, 6.54, 1.440, 8.14%, respectively. The results further showed that tomato coated with carboxyl methylcellulose kept for 75 days and the titratable acidity, colour intensity, carotene, specific gravity, pH, refractive index, total soluble solids were 0.14, 0.65, 1.83 mg/100g, 1.05, 6.53, 1.438, 8.16%, respectively. Results showed that tomato coated with honey was kept for 90 days and the titratable acidity, colour intensity, carotene, specific gravity, pH, refractive index, total soluble solids were 0.10, 0.65, 2.05 mg/100g, 1.06, 6.50, 1.430, 10.23%, respectively. Results however showed that tomato coated with alkalinized starch kept for 90 days and the titratable acidity, colour intensity, carotene, specific gravity, pH, refractive index, total soluble solids were 0.13, 0.67, 2.01 mg/100g, 1.06, 6.53, 1.405, 10.16%, respectively.

KEYWORDS

alkalinized starch; carboxyl methylcellulose; gelatine; honey; tomato

CORRESPONDING AUTHOR*

Dr. G. I. Pele

INTRODUCTION

About 40 to 50% of post-harvest losses in tropical countries occur between harvesting, transportation and consumption of fresh tomatoes due to short storage time [1]. Storage life is limited by several factors: transpiration, postharvest diseases, increased ripening, and senescence [2]. Among all these factors, the most important is respiration rate, which is associated with tomato postharvest shelf-life, fruit ripening, and deterioration of tomato quality [3]. One way to control tomato ripening is through the manipulation of ambient temperature, gas, and humidity [4]. At low 5 storage temperature, it is possible to maintain freshness and extend shelf-life as the respiration rate and thermal decomposition are reduced [5]. Tomato (*Solanum Lycopersicum*) is one of the vegetable crops which is widely consumed either raw or after processing and can provide a significant proportion of the total antioxidants in a diet [6]. Its antioxidants include vitamin C and E, lycopene, ß-carotene, flavonoids and other phenolic compounds [7]. The fruit also consists of different sugars, acids, phenols and minerals, and a significant amount of water [1]. However, due to its high moisture content, the fruit is subjected to a high rate of metabolic degradation in ambient air. The main causes of tomato deterioration are weight loss, colour changes, softening, surface pitting and loss of acidity, while small variations occur in total soluble solid. Special care is needed with the occurrence of decay, which is mainly due to species of the genera *Alternaria, Rhizopus, Botrytis, Geotrichum* and *Fusarium* [8] which can cause great economic losses although the occurrence of rots and their influence

on tomato, quality have been reported to be dependent on the cultivar and ripening stage at harvest [9]. The objective of the present research, therefore, was to investigate the influence of coating materials on the physicochemical properties of tomatoes during storage.

MATERIALS AND METHODS

Materials

Matured cassava (TME 419) was obtained from the International Institute of Tropical Agriculture (IITA), Ibadan, while gelatin and carboxyl methylcellulose (CMC) were obtained from Pascal Chemicals, Akure. Honey was obtained from Obafemi Awolowo University Teaching Hospital Complex, Ife. Tomato fruit (EVA F1) was obtained from the Federal University of Technology Agricultural Teaching Farm, Akure, Nigeria.

Production of Starch

Cassava starch was produced by using the method described by the International Institute of Tropical Agriculture [10]. The fresh cassava tubers were manually peeled, washed with tap water and wet-milled by a hammer mill. The mash obtained was solubilized with distilled water and filtered by a muslin cloth. The filtrate was allowed to settle (3 h) and the supernatant decanted, while the starch was dewatered by squeezing in the muslin cloth and dried separately in a vacuum oven at 40 ^{0}C to constant weight for 8 h. The dried starch was milled using a double disc attrition mill and sieved. The starch product was packaged in an air-tight polyethylene bag placed in plastic containers and stored at room temperature for further use.

• *Production of Alkalinized Cassava Starch*

Alkalinized cassava starch was produced by the modification of cassava starch using aliquots of 0.1M NaOH (0.5w/v) and dried at 62 ^{0}C for 8h. The modified cassava starch was milled, sieved and packed into polyethylene films prior for further use.

Coating of Tomato

Tomato fruit was rinsed with distilled water and kept at ambient temperature. Alkalinized starch and Gelatin coat were prepared by dissolving 20g of alkalinized starch and gelatin respectively in 100ml distilled water while 10g of CMC was dissolved in 500ml of distilled water. 100% honey was used. These solutions were completely mixed using a spatula until a homogenized solution was formed. Tomato was aseptically dipped into the different prepared coating solutions for 5min. Five (5) different tomato samples were gotten and used for further analysis, they include:

I. Uncoated Tomatoes and stored at room temperature serves as control;
II. Tomato coated with gelatine and stored at room temperature;
III. Tomato coated with Carboxyl methylcellulose and stored at room temperature;
IV. Tomato coated with Alkalinized starch and stored at room temperature; and
V. Tomato coated with honey and stored at room temperature.

Analyses of the Tomato Samples

Colour intensity, carotene content and total soluble solid of the tomato were determined by the method described by FAO (2001) [11]. The titratable acidity of the tomato was determined by the method described by James (1999) [12]. The pH of the tomato was determined by using pH 200 HM Digital (CE 0112309) while the degree Brix of the tomato was determined using an Antago hand refractometer. The specific gravity of the tomato was determined by using a specific gravity bottle while the refractive index of the tomato paste was determined using an Abbe's refractometer.

Statistical Analysis

The data obtained from the experiment were in triplicates and subjected to completely randomized experimental design and statistical analysis using Microsoft Excel version 2010, SPSS version 20 and Mini Tab version 17.

RESULTS AND DISCUSSION

Effect of Coating Materials on the Physicochemical Properties of Tomato during Storage.

The results of the effect of different coating materials on the titratable acidity of the tomato samples for 90 days are shown in Figure 3.1. Results showed that the Control sample significantly decreased in titratable acidity from 0.83 to 0.16 from day 0 to day 60; the Control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly decreased in titratable acidity from 0.83 to 0.10 from day 3 to day 90. Results of the tomato coated with carboxyl methylcellulose showed a significant decrease in titratable acidity from 0.83 to 0.14 from day 0 to day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant decrease in titratable acidity from 0.83 to 0.15 from day 0 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant decrease in titratable acidity from 0.83 to 0.13 from day 0 to day 90.

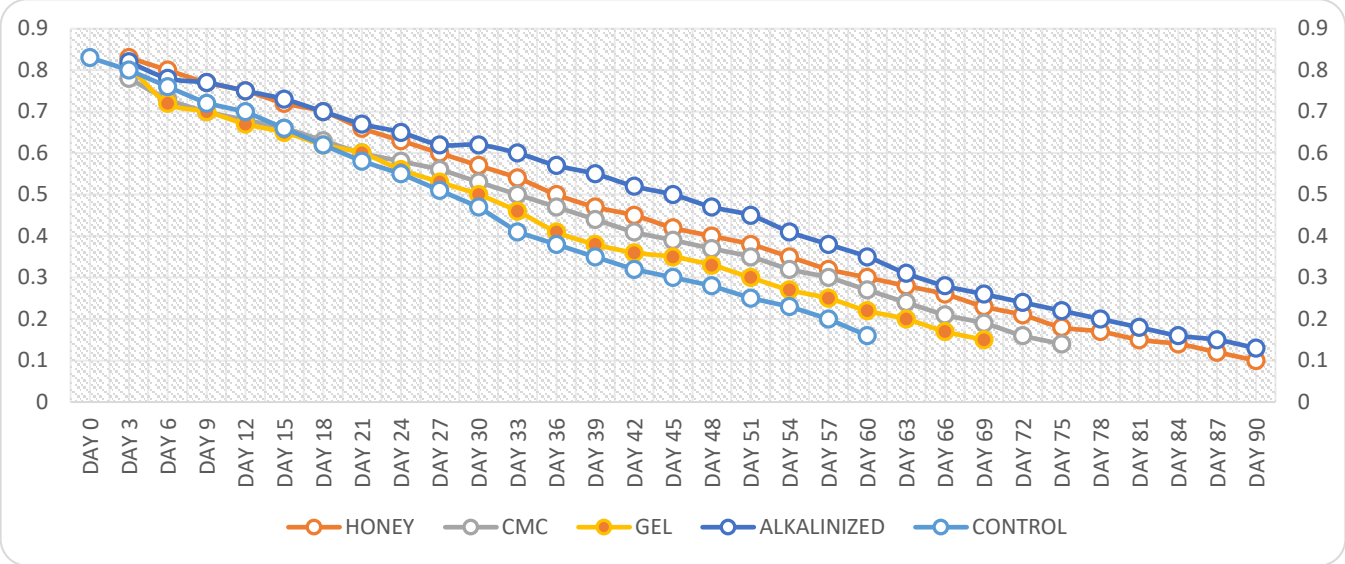

FIGURE 1: Effect of coating materials on the titratable acidity during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

The results of the effect of different coating materials on the pH of tomato sample for 90 days are shown in Figure 3.2. Results showed that the Control sample significantly increased in pH from 5.20 to 6.44 from day 0 to day 60; the control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in pH from 5.20 to 6.50 from day 0 to day 90. Results of the tomato coated with carboxyl methylcellulose showed a significant increase in titratable acidity from 5.20 to 6.53 from day 0 to day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78.

Tomato coated with gelatin showed a significant increase in pH from 5.20 to 6.54 from day 0 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant increase in pH from 5.20 to 6.53 from day 0 to day 90. The results showed that as the titratable acidity decreased, the pH of the tomato sample increased, the implication of this however is that food material is prone to microbiological and biochemical deterioration at neutral pH where most of the spoilage occurs.

The results also showed the ability of both the honey and alkalinized starch to effectively suppress a rapid decrease in titratable acidity and increase in pH for a longer period and as such offer a stable shelf life for tomato within 90 days.

The results of the effect of different coating materials on the colour intensity of the tomato samples for 90 days are shown in Figure 3.3. Results showed that control tomato sample significantly increased in colour intensity from 0.60 to 0.98 from day 0 to day 27, however, a significant decrease was observed from 0.96 to 0.70 from day 30 to day 60; the control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in colour intensity from 0.60 to 0.98 from day 0 to day 60,

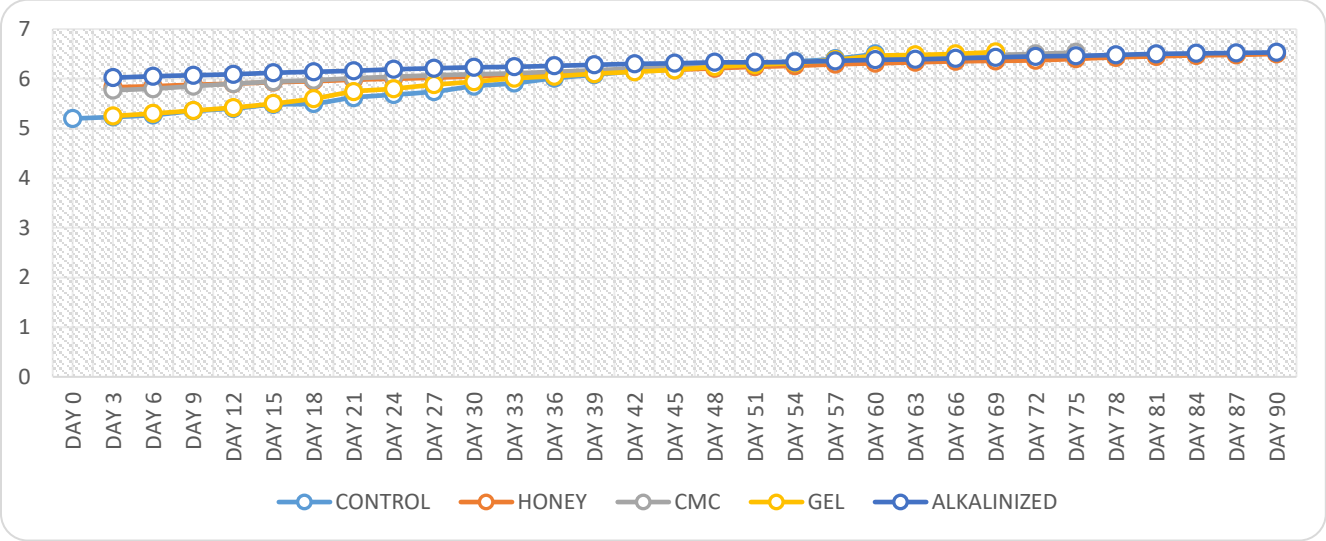

FIGURE 2: Effect of coating materials on the pH during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

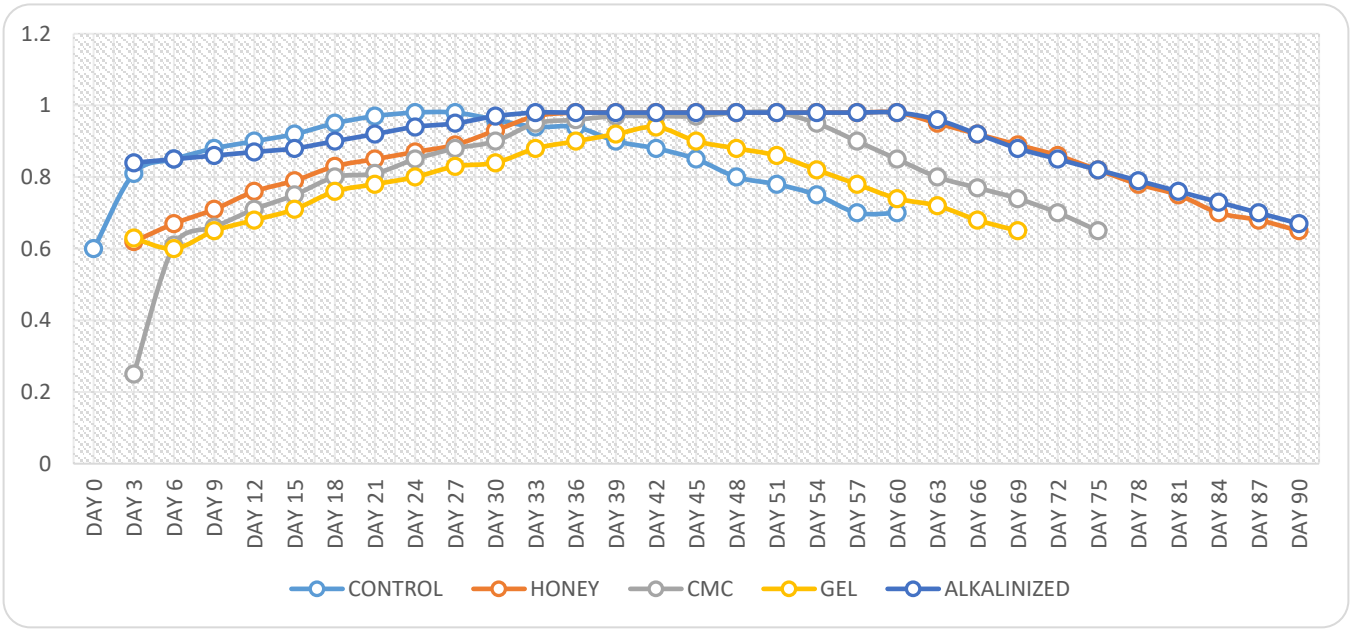

FIGURE 3: Effect of coating materials on the colour intensity during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

a significant decrease was however observed from 0.95 to 0.65 from day 63 to day 90. Results of the tomato coated with carboxyl methylcellulose showed a significant increase in colour intensity from 0.60 to 0.98 from day 0 to day 51, a significant decrease was observed from 0.95 to 0.65 from day 54 to day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant increase in colour intensity from 0.60 to 0.90 from day 0 to day 45, a significant decrease was observed from 0.88 to 0.65; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant increase in colour intensity from 0.60 to 0.98 from day 0 to day 60, a significant decrease was observed from 0.96 to 0.67 from day 63 to day 90.

The results of the effect of different coating materials on the carotene content of the tomato samples for 90 days are shown in Figure 3.4. Results showed that the Control sample significantly increased in carotene from 0.44 to 1.75 mg/100g from day 0 to day 30, however, a significant decrease was observed from 1.65 to 1.22 mg/100g from day 33 to day 60; the control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in carotene from 0.44 to 2.48 mg/100g from day 0 to day 63, a significant decrease was however observed from 2.44 to 2.05 mg/100g from day 66 to day 90. Results of the tomato coated with carboxyl methylcellulose showed a significant increase in carotene from 0.44 to 2.30 mg/100g from day 0 to day 54, a significant decrease was observed from 2.17 to 1.83 mg/100g from day 57 to day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant increase in carotene from 0.44 to 1.95 mg/100g from day 0 to day 48, a significant decrease was observed from 1.90 to 1.40 mg/100g from day 51 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72.

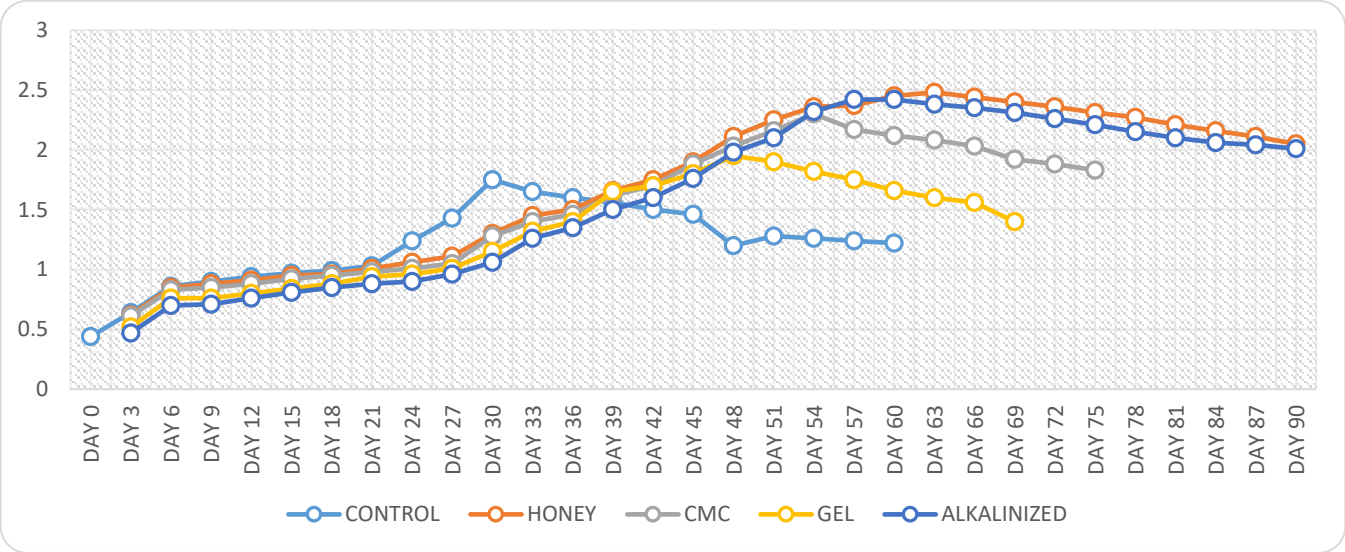

FIGURE 4: Effect of coating materials on the carotene content (mg/ 100 g) during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

Results of the tomato coated with alkalinized starch showed a significant increase in carotene from 0.44 to 2.42 mg/100g from day 0 to day 60, a significant decrease was observed from 2.38 to 2.01 mg/100g from day 63 to day 90. The increase in colour intensity and carotene showed a correlation in the early stage of ripening of tomato samples, while the decreased in colour intensity and carotene showed a varying level of senescence, however honey and alkalinized starch was observed to prolong the period of ripening and delay the period of senescence.

The results of the effect of different coating materials on the specific gravity of the tomato samples for 90 days are shown in Figure 3.5. Results showed that the Control sample decreased in specific gravity from 1.08 to 1.03 from day 0 to day 60, control sample was observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly decreased in specific gravity from 1.08 to 1.06 from day 0 to day 90, while results of the tomato coated with carboxyl methylcellulose also showed a significant decrease in specific gravity from 1.08 to 1.05 from day 0 to day 75, though the tomato was observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant decrease in specific gravity from 1.08 to 1.05 from day 0 to day 69, however, the tomato was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant decrease in specific gravity from 1.08 to 1.06 from day 0 to day 90.

The results of the effect of different coating materials on the refractive index of the tomato samples for 90 days are shown in Figure 3.6. Results showed that control sample increased in refractive index from 1.342 to 1.448 from day 0 to day 54, a significant decrease was observed from 1.445 to 1.440 from day 57 to day 60; control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in refractive index from 1.342 to 1.430 from day 0 to day 90,

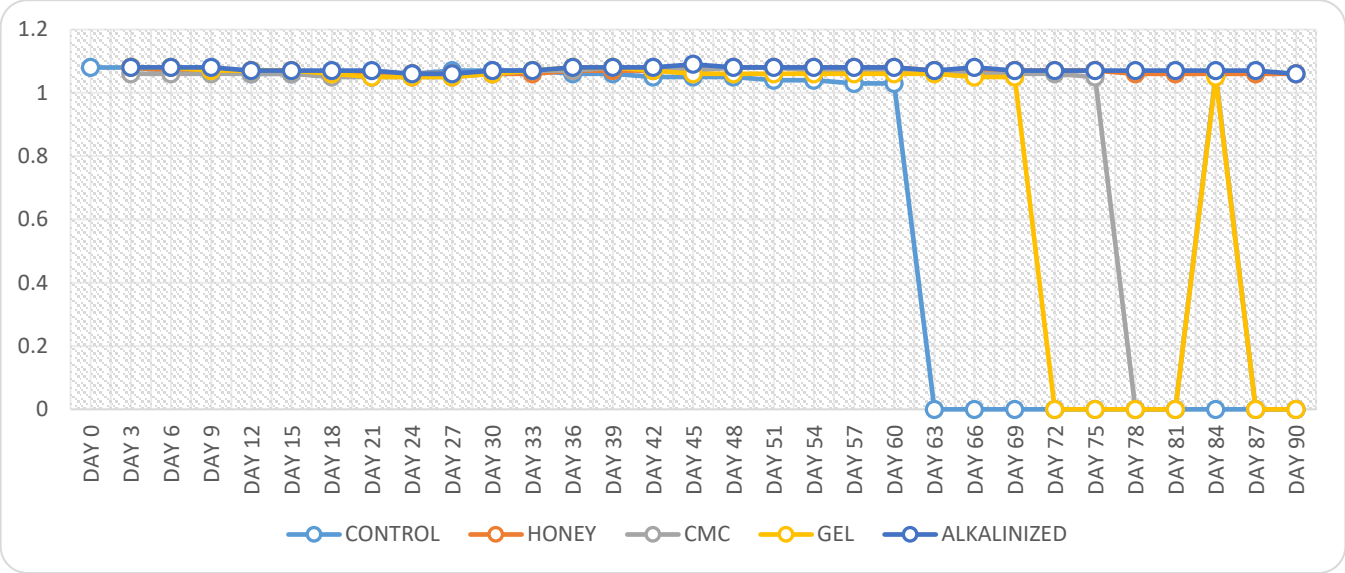

FIGURE 5: Effect of coating materials on the specific gravity during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

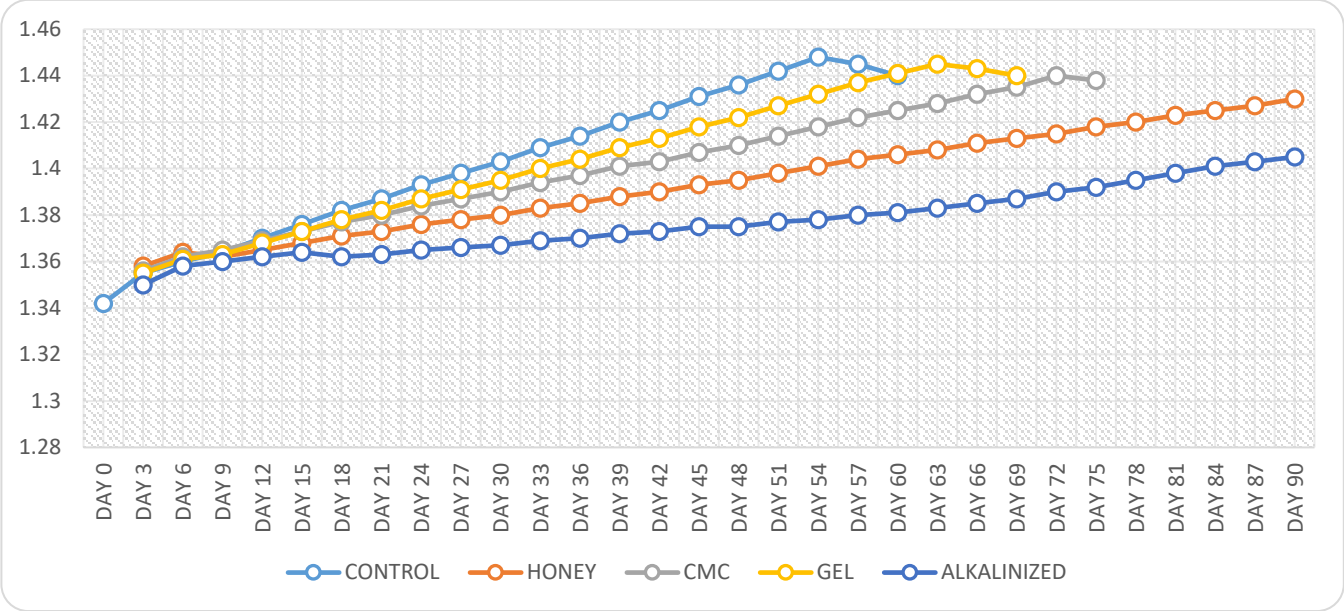

FIGURE 6: Effect of coating materials on the refractive index during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

results of the tomato coated with carboxyl methylcellulose (CMC) also showed a significant increase in refractive index from 1.342 to 1.440 from day 0 to day 72, a significant decrease was however observed at day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant increase in refractive index from 1.342 to 1.445 from day 0 to day 63, a significant decrease was observed from 1.443 to 1.440 from day 66 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant increase in refractive index from 1.342 to 1.405 from day 0 to day 90.

The results of the effect of different coating materials on the Brix of the tomato samples for 90 days are shown in Figure 3.7. Results showed that the Control sample significantly increased in Brix from 4.10 to 5.05% from day 0 to day 54, however, a significant decrease was observed from 5.02 to 4.97% from day 57 to day 60; the control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in Brix from 4.10 to 4.85% from day 0 to day 90, while results of the tomato coated with carboxyl methylcellulose showed a significant increase in Brix from 4.10 to 4.90% from day 0 to day 72, a significant decrease was observed from at day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant increase in Brix from 4.10 to 5.01% from day 0 to day 60, a significant decrease was observed from 4.98 to 4.92% from day 63 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant increase in Brix from 4.10 to 4.70% from day 0 to day 90.

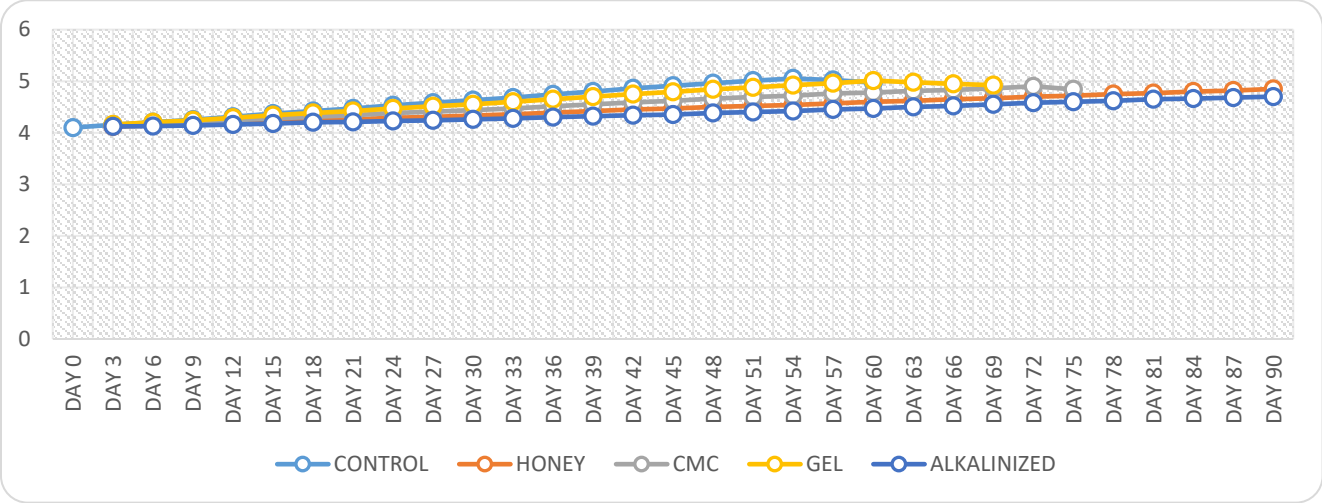

FIGURE 7: Effect of coating materials on the degree Brix (%) during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

The results of the effect of different coating materials on the total soluble solid of the tomato samples for 90 days are shown in Figure 3.8. Results showed that the control tomato sample significantly increased in total soluble solid from 5.88 to 8.20% from day 0 to day 21, a significant decrease was observed from 7.85 to 5.44% from day 24 to day 60; control sample was however observed to have been spoilt at day 63. Results also showed that tomato coated with honey significantly increased in total soluble solid from 5.88 to 10.62% from day 0 to day 75, a significant decrease was observed from 10.59 to 10.50 from day 78 to day 90. The results of the tomato coated with carboxyl methylcellulose (CMC) showed a significant increase in total soluble solid from 5.88 to 8.75% from day 0 to day 51, a significant decrease was observed from 8.66 to 8.17 from day 54 to day 75; tomato coated with carboxyl methylcellulose was however observed to have been spoilt at day 78. Tomato coated with gelatin showed a significant increase in total soluble solid from 5.88 to 8.98% from day 0 to day 42, a significant decrease was observed from 8.82 to 8.11% from day 45 to day 69; tomato coated with gelatin was observed to have been spoilt at day 72. Results of the tomato coated with alkalinized starch showed a significant increase in Brix from 5.88 to 10.70% from day 0 to day 87, a significant decrease was however observed at day 90.

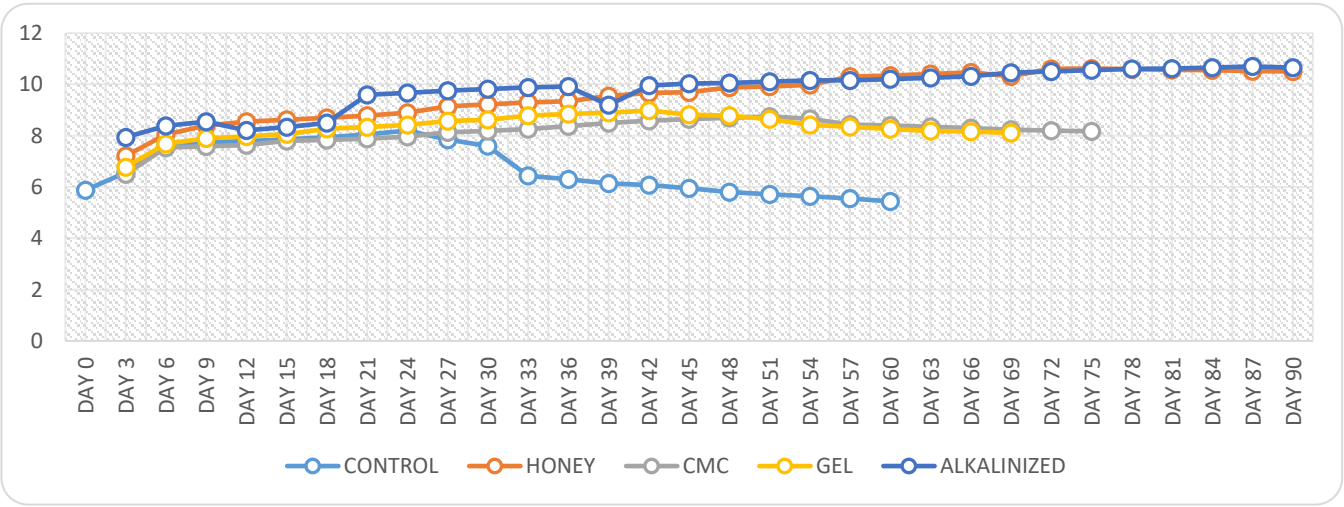

FIGURE 8: Effect of coating materials on the total soluble solids (%) during tomato storage

CONTROL: Uncoated Tomatoes and stored at room temperature serves as the control
HONEY: Tomato coated with honey and stored at room temperature
CMC: Tomato coated with Carboxyl methylcellulose and stored at room temperature
GEL: Tomato coated with gelatine and stored at room temperature
ALKALINIZED: Tomato coated with Alkalinized starch and stored at room temperature

CONCLUSION

Modified starches and honey was successfully applied as the coating materials for the preservation of tomato. The results showed the ability of both the honey and alkalinized starch to effectively ensure decreased pH which increased the titratable acidity of both samples for a longer period, and as such offered a stable shelf life for tomato within 90 days. Other physicochemical properties evaluated also justified the capability of both honey and alkalinized starch to extend the shelf life of tomatoes.

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