ABSTRACT

Tomato is a climacteric fruit that continues to respire and ripen even after harvest and has short shelf life. The deterioration of tomatoes resulting from mechanical damage, moisture loss, respiration, enzymatic action and microbial spoilage causes huge losses during postharvest handling. In order to extend the shelf life of tomatoes, the parameters such as gas concentration inside the package, moisture loss, ripening, temperature and relative humidity are need to be manipulated. The advanced and novel technologies such as active packaging (AP) and edible coating (EC) were used for extending the shelf life of tomatoes, as these have potential to address all the issues together while maintaining the quality of the tomatoes. The physicochemical parameters of light red tomatoes (USDA color scale 5) were determined. Values of color parameters, L*, a*, b*, C* and h* of the tomatoes were 57.32, 15.62, 42.98, 44.53 and 66.03, respectively. Firmness, pH, total soluble solids (TSS, °Bx) and titratable acidity (% citric acid) were 1378 g, 4.03, 2.9 and 0.838, respectively. Average size of tomatoes was 0.052 m diameter and 80.36 g weight. The respiration rate of tomato and absorption kinetics of scrubbers were studied at temperatures ranging from 10 to 35 °C. The values of the OTR_{req} (oxygen transmission rate required) and CTR_{req} (carbon dioxide transmission rate required) were 83.038 and 531.4437 cm^3/m^2.day.atm. The LDPE 50 matched the gas requirement (OTR = 101.85 and CTR = 542.82 cc/m^2.24h for 0.045 m^2 package area) for the selected pack size. The absorption capacity was found to be 23 ± 0.38 mL of O_2/sachet (1 sachet = 0.84 g) for oxygen scrubber, 40.8 ± 1.64 mg of water/g of weight of moisture scavenger and 3 cc/g of $KMnO_4$ for ethylene scrubber.

The concentration of scavengers was varied from 0 - 10 g of moisture scrubber (MS, silica gel), 0 - 1 g of ethylene scavenger (ES, potassium permanganate) and 0 - 4 sachets of oxygen scavenger (OS, FT 20 cc O-buster) for 250 g of fruit using central composite rotatable design (CCRD). The optimized concentration of scavengers was 7.8 g MS, 0.8 g ES and 3 sachets of OS per 250 g of tomatoes with more than 3 fold increase in shelf life (55 days) at 10 °C and 85%. Weight loss of tomatoes varied from 0.71% for 2.03 g to 5.1% for 7.97 g of MS. The firmness of the tomatoes after 55 days was 1327 ± 42.52 g, which was comparable to the firmness of fresh tomatoes 1365 ± 24.66 g. A mathematical model for active packaging system was developed and validated, the relative deviation between experimental and predicted values of gas concentrations was 4.81% and 4.26% for O_2 and CO_2, respectively.

The concentration of sodium alginate (0 to 1.5%, w/v) and glycerol (0 to 2%, v/v) were optimized using CCRD and RSM methods. This was followed by optimization of concentration of sunflower oil (1 - 3%, v/v) and clove oil (0 - 0.5%, v/v) using a 3-level factorial design, at fixed (optimized) levels of sodium alginate and glycerol; millipore water was used for volume makeup. Coating time was varied from 0 - 5 min. Tomatoes coated for 4 min showed the minimum physiological weight loss (3.43%) and change in gas concentration i.e. 1.1% CO_2 and 19.4% O_2 using 4.9 ± 0.3 g of coating solution for one kg of tomatoes; the coating thickness was 12.5 ± 0.87 µm. The optimum composition of the coating solution was 1.12 % sodium alginate (w/v) and 1 % glycerol (v/v), sunflower oil (3%) and clove oil (0.25%) with more than three times increase in shelf life of tomatoes (49 days) at 10 °C and 85% RH.

Evaluation of quality parameters during storage at 10 °C and 85% RH, ranked the EC tomatoes as the best sample followed by AP, and control tomatoes. The lycopene content for control, AP and EC tomatoes was 7.5, 11.96 and 12.7 mg/ 100 g of fresh fruit weight, respectively, at the end of their storage. The ascorbic acid content decreased significantly ($p < 0.05$) from 16.44 to 7.69 for control tomatoes, 10.24 for EC tomatoes and 9.27 mg/ 100 g for AP tomatoes during storage for 15, 49 and 55 days, respectively. The hydrophilic phenolic content for the control, AP and EC tomatoes was 17.44, 19.92 and 21.63 mgGAE/100g; lipophilic phenolic content was 4.24, 5.43 and 6.49 mgGAE/100g. The hydrophilic and lipophilic antioxidant activities of control, AP and EC tomatoes were 124.78 & 9.86, 173.54 & 13.44 and 178.86 54 & 15.94 mmol TEAC/kg, respectively.

Keywords: Tomato, active packaging, edible coating, shelf life extension, kinetics, mathematical modeling, respiration rate.