EFFECT OF FORMULATION ON POST-HARVEST QUALITY OF TOMATOES

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Abstract - Fruits and vegetables are highly perishable commodities that require to be handled with much care to minimize losses, especially while being transported and stored. Because of their high moisture content horticultural crops are inherently more liable to deteriorate especially under tropical conditions. Due to biological activity and biochemical alterations the quality of fruits is compromised. Tomato is second largest vegetable crop in India. With an annual production of 5 million tons, India contributes about 7% to world production. Tomatoes are highly perishable and have limited shelf life. By the time they reach to the consumers, tomatoes lose their physical appearance as well as other qualities and are not accepted. Short shelf life coupled with inadequate processing facilities results in a heavy revenue loss to the country. This work focuses on increasing the shelf life of tomatoes, by dipping them into the solution of Active ingredient P-104 and triethyl amine. Fruit quality was evaluated by measuring physiological weight loss, color and textural changes as well as microbiological evaluation of uncoated and coated tomatoes, which shall be discussed in the paper.

Keywords - Coating, Horticulture crops, Microbiological Activity, Shelf life, Tomatoes.

I. INTRODUCTION

Agricultural products such as fruits and vegetables are highly perishable commodities, which needs much care to minimize losses. When found under Tropical conditions, they are more likely to deteriorate as a result of their high moisture content. These fruits are biologically active and carry out transpiration, respiration, ripening and other biochemical activities, which result in quality deterioration [1, 2,5].

Tomato is the second largest vegetable crop in India. With an annual production of 5 million tones, India contributes about 7% to the world production. Being highly perishable in nature, tomato has limited shelf life [8]. It creates glut during production season and becomes scanty during off-season. Short shelf-life coupled with inadequate processing facilities results in heavy revenue loss (about Rs. 5 crores per annum) to the country. Thus, a need exists to develop suitable technology for processing and preservation of this valuable produce in a way that will not only check losses but also generate additional revenue for the country. For fresh tomatoes, the two quality attributes that are most important to buyers and consumers are texture and skin color. Texture is influenced by flesh firmness and skin strength. Softening during storage, distribution and ripening of tomatoes can be a major problem because it may increase their susceptibility to damage. The degree of fruit firmness has been used as an indication of fruit quality [3,4] and firmness may be the final index by which the consumers decide to purchase a given batch of tomatoes.

There is increasing consumer concern about the eating quality of tomatoes. After harvest, ripening continues and tomatoes can become overripe very rapidly. This can result in loss of quality and restricted shelf life. The textural quality of tomatoes is influenced by flesh firmness. Changes in firmness were highly correlated with surface appearance characteristics of tomatoes which were related to color, shape and sense of feel for firmness at the time of purchasing. A number of works have been published on tomato fruit firmness measurements, and different instruments for measuring firmness have been illustrated. Satisfactory information was not found on whether the measured firmness values of tomatoes were within the acceptable levels or not for consumers.

Color is often used as an external index for firmness and overall quality because of its easy and inexpensive estimation. Tomato color is another important quality factor for the consumer [9]. It can be commonly determined instrumentally because it gives more accurate information than other methods. The most common instrument used is a color difference meter and a model of the Minolta Chroma Meter. There is some contradictory information about the results of color and firmness measurements in the literature and no satisfactory information on whether firmness or color values of tomatoes are within the acceptable levels required by consumers.

Several other works have been carried out on the preservation and extension of shelf life of the tomatoes using different methodologies [12,13,14,15].

II. MATERIALS & METHODS

2.1. Fruit source and treatment

Tomato (Lycopersicon esculentum Mill.) used for the present study were purchased from authentic Agricultural Produce Marketing Cooperatives (APMCs). Experiments were done in the month of February. Half of the fruits were kept uncoated while

the remaining half were treated with the coating solution B - prepared from P-104. The fruits were stored at ambient temperature for progressive assessments.

2.2. Synthesis of P-104

Active ingredient P-104 was obtained as per the patented process. Formulation developed from P104 was oil-in-water (O/W type) emulsion. Sodium dodecyl sulphate (SDS) was added as the surfactant for solubilization of P-104 in water. Formulation was prepared by mechanical stirring of 10 g of P-104 and 2 ml of triethyl amine in 77 ml of 100 mg/l SDS, final volume was made upto 100 ml with double distilled water [6,7].

2.3. Weight loss

Eight fruits of each treatment (the same fruit during all the storage time) were weighed at the beginning of the experiment and after every five days of storage. The results were expressed as percentage loss of initial weight.

2.4. Firmness

The quality of fruit is mainly determined by appearance (color, visual aspects), firmness, and flavor. Firmness is a criterion often used to assess fruit quality because it is directly related to fruit ripeness and storage state. So the firmness was applied to determine the maturity of tomatoes. For each fruit, texture was determined using a 2mm diameter probe coupled on a TA.XT plus Texture Analyzer (Stable Micro Systems, Surrey, UK) interfaced to a personal computer. Penetration rate was 2 mm sec^{-1} for 5 mm after contacting the flesh and results were expressed in N.

2.5. Color

Color characteristics (L*, a* and b*) were assessed using a ColorQuest Hunter colorimeter (HunterLab, Hunter Associates Laboratories Inc., Virginia, USA to determine L value (lightness or brightness), a* value (redness or greenness) and b* value (yellowness or blueness) of peach samples. Twelve readings were obtained for each treatment from 6 replicates with 2 readings for each replicate by changing the position of the pear to get uniform color measurements. Measurements were taken every 5 days up to 30 days for fruits stored at ambient temperature. A standard white plate (X =78.45,Y =83.16,Z =88.81) and a black plate were used to standardize the instruments. The total color difference (ΔE) was calculated using the following equation, viz:

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

Where, ΔE is total color difference, ΔL is the change in Hunter 'L' values with time, Δa is the change in Hunter 'a' values with time and Δb is the change in Hunter 'b' values with time.

2.6. Microbiological evaluation

Plate Count Agar (PCA) medium was used for all the experiments. The pH of the medium was adjusted at 7.0 ± 0.2 and autoclaved at 15 lb/ $inches^2$ pressure for 20 minutes. The medium was then poured into petriplates. Samples of 10 g of fruit pulp were blended and then added to 100 ml of 1% sterile peptone water at different dilutions (10^{-1}-10^{-8}). Aerobic mesophilic microorganisms were counted by plating 1 ml of the corresponding dilution and the plates were incubated at 35º C for 48hrs. All the experiments were done in triplicate and only counts of 30-300 colony forming units (CFU) were considered. Microbial counts were determined by using standard procedure available in the literature [1,3].

2.7. Statistical analysis

The data were subjected to a one-way analysis of variance *(ANOVA*) and the differences among means were compared by L.S.D. test ($P \leq 0.05$) [1,2,4,5].

III. RESULTS AND DISCUSSION

3.1. Weight loss

Mass loss occurs in fruits due to respiration and by transpiration due to the water vapor pressure difference between the fruit and the atmosphere (low relative humidity). Coating fruits with a film checks moisture loss keeping them fresh during storage. As shown in Fig. 1 there is a considerable increase in mass loss over the storage period in all the treatments. The untreated tomatoes show a significantly higher mass loss ($p<0.05$) on the 7th, 14th and the 21st day compared to the treated tomatoes. Increased mass loss in thickly coated tomatoes is reported to be due to loss of sugars, heat generation and production of end products from anaerobic fermentation. Chitosan films are said to be more permeable to moisture than other polysaccharide films, thus making them suitable for fruits and vegetables. Uncoated fruits when stored at ambient temperature showed 26.55 % weight loss after 30 days of storage while the coated fruits showed only 14.45 % weight loss which is nearly half of the loss shown by uncoated tomatoes (Fig. 1). The lower weight losses in coated fruits compared with controls originated from low rates of water loss in coated fruits due to coating with formulations developed from P-104 which provides a solution to problem of physiological weight loss.

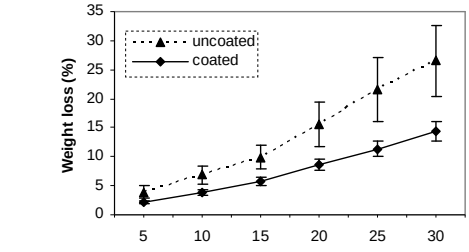


Fig.1. Percentage of weight loss during storage at ambient high temperature in coated and uncoated tomato

3.2. Firmness

Firmness of the tomatoes was better preserved by the application of the films as seen in Tab. 1. It decreased in both coated and uncoated tomatoes from the initial value of 19.22 N. At the end of three weeks storage all the tomatoes were ripe. No significant difference was observed between the treated and the untreated tomatoes, though the uncoated tomatoes were least firm. There was a small variation in firmness between 1% and 2% chitosan treatments. This is an important factor indicating the internal freshness of tomatoes. Reduction of respiration and decrease in water loss may result in retention of firmness during storage. The respiration and O_2 consumption of coated tomatoes were lower than those of uncoated tomatoes. Progressive loss in firmness during ripening is the result of transformation of protopectin to pectin by enzymes.

Storage days	Firmness (N)	
	Uncoated	Coated
0	0.902 ± 0.05	0.871 ± 0.05
5	0.738 ± 0.02	0.797 ± 0.08
10	0.689 ± 0.03	0.752 ± 0.08
15	0.645 ± 0.01	0.668 ± 0.03
20	0.535 ± 0.01	0.618 ± 0.02
25	0.452 ± 0.01	0.568 ± 0.04
30	0.382 ± 0.01	0.514 ± 0.04

Values are mean (n=6) ± standard deviation.
Table. 1: Fruit firmness (N) during storage at ambient temperature in coated and uncoated Tomato.

3.3. Color

The light red stage is the one that is commonly marketed. It was found that at this stage the Minolta a_=b_ values ranged from 0.60 to 0.95. The red stage of USDA tomato color is a little more overripe for normal maturity. The Minolta color values at the red stage had a Minolta a_=b_ range from 0.95 to 1.21. In a ripening tomato, color changes are characterized by degradation of chlorophyll and accumulation of lycopene. Fig. 2 shows that the coated tomatoes ripened much slowly than the untreated ones and the changes seem to be very gradual.

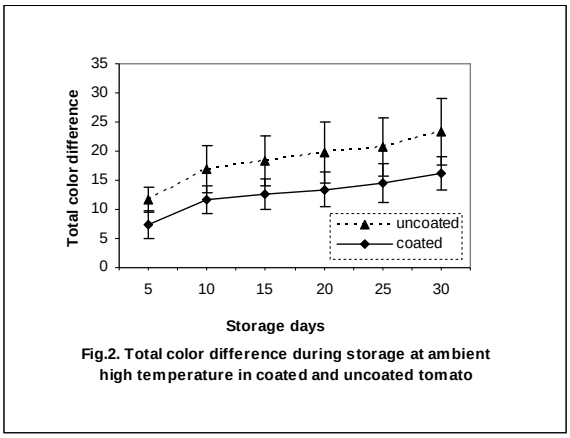


Fig.2. Total color difference during storage at ambient high temperature in coated and uncoated tomato

3.4. Microbiological Evaluation

The Microbiological Evaluation on both uncoated and coated Tomatoes was done. The study showed the significant difference in both the cases as shown in Fig. 4. Microbial counts of coated and uncoated apples increased throughout the shelf-life of fruits. Total microbial counts for uncoated tomato of 2.55, 5.52, and 9.36 and for coated tomato 1.62, 2.95, 4.44 were observed at day 5, 10, 15 of observed up to day 30 of storage (27±2°C). Though there seems to be no separate standards for microbial specifications for apples in India, International Commission on Microbiological Specifications for Food (ICMSF 1974) set a maximum limit of 7 log cfu/g of total aerobic mesophilic bacteria.

It has been observed that the coated apples showed an increase in the shelf-life of apples up to 30 days as compared to 15 days for uncoated apples.

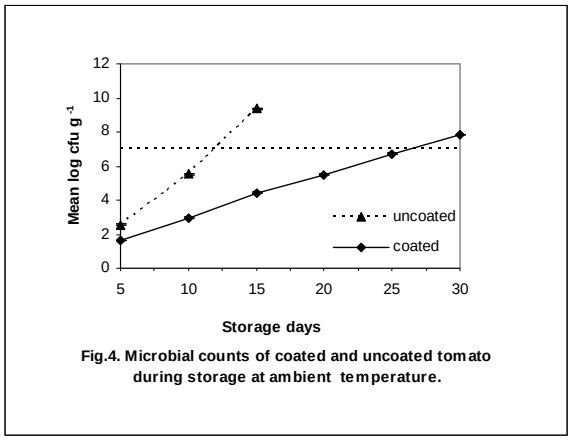


Fig.4. Microbial counts of coated and uncoated tomato during storage at ambient temperature.

CONCLUSION

The coating formulated from P-104 is an effective coating composition for storage of tomatoes for 30 days without refrigeration. The coating has shown significant effects on weight loss, color, and microbial counts of tomatoes. In case of firmness of the fruit, there were no significant alterations seen in the values. The derived formulation and study has significance for the development of technology for reduction of post-harvest losses for tomatoes and has a potential to minimize costs towards energy for cold storage and refrigerated transportation of horticultural produce. In conclusion, a dip in the developed formulation is an effective method to prolong storability and shelf life extension of tomatoes at room temperatures (27±2 °C).

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