Active Packaging for improving the Shelf life and Quality of Strawberry (*Fragaria* x *ananassa* Duch.)

Abstract-

Strawberry (*Fragaria* x *ananassa* Duch.) is a popular berry of the world but it is highly perishable in nature and possesses an extremely short shelf life. Active packaging in plastic punnets of size 17cm x 11 cm x 3.5 cm of 100 gm capacity with the treatment of Ethylene absorber + moisture absorber + Clo_2 (5ppm) increased the shelf life by 7 days as compared to control 3 days. Physiological Loss in weight 4.4%) and decay incidence was also reduced 36% as compared to control showing PLW 9% and decay incidence of 65%. The mean value after storage of quality parameters such as TSS (10.8 ^{0} Brix) , Titratable acidity (0.8%), Anthocyanin (61.2 mg/100gm) and Ascorbic acid (65.16mg/100g) content was observed which performed better with the organic treatment as compared to the treated fruits .

Keywords- Active, Packaging, Strawberry, Ethylene absorber, shelf life

Introduction

Strawberry (*Fragaria x ananassa*) is a vibrant red colour, juicy, sweet fruit and its very nutritious with its delicious flavour. This berry type of fruit is a member of the Rosaceae family. It is a rich source of vitamin C (58.8 mg/100g), phenolics and a high antioxidant capacity (2 to 11 fold more then other fruits).In recent years strawberry is gaining popularity amongst the farmers of the North East, including Assam. However the major problem in strawberry is its high perishable nature and undergoes quick deterioration due to mechanical injury, physiological deterioration, microbial decay and high water loss,leading to an extremely short shelf life. This reduced post harvest life is mainly due to its high metabolic activity and vulnerability to decay which gets translatedinto rapid dehydration, loss of firmness and tissue degradation, which ultimately makes the fruit susceptible to mechanical injury and leads to colour degradationBaka *et al*.(1). Therefore cost effective technologies to increase the shelf life of strawberry is very important. Active packaging actively changes the condition of the package in order to increase sensory properties of food, maintaining safety and quality and thereby increasing the shelf life of food. Therefore use of active packaging along with ethylene absorbers, moisture absorbers can be a beneficial tool for increasing the shelf life of strawberry Robinson and Morrison,(2). Also use of chlorine di oxide can decrease the microbial decay.

Materials and Methods

Fresh strawberry (*Fragaria* x *ananassa* Duch.) fruits variety sweet Charlie/Chandler were harvested at matured stage from a farm at Jorhat. The experiment was laid out in Randomized Block Design in the laboratory, Department of Horticulture, Assam Agricultural University, Jorhat.. There were three replications and one packaging materials with traditional plastic packaging. Plastic punnets of size 17cmx11cm x 3.5cm of 100g capacity were used for the storage studies. These punnets are easy to handle,looks appealing and the transparency makes the fruits visible from outside.The treatment details are as follows

T1= Ethylene absorber + chorine dioxide (5ppm)

T2= Ethylene absorber + Moisture absorber + chorine dioxide (5ppm)

T3= Control (without treatment)

Chlorine dioxide is a strong disinfectant and antimicrobial in action. It is a reddish brown liquid.5ppm chlorine dioxide was used to wash the fruits before packaging as it can also increase the shelf life of fruits.

Moisture absorbers are desiccants and are enclosed in sachet, and the sachets are enclosed in the package which absorb and reduces the moisture content and thus increases the shelf life. Commonly used desiccants are Silica gel sachets and these were used for increasing the shelf life of strawberry fruits in the active packaging.

Ethylene absorbers absorbs the ethylene released by the fruits, vegetables and flowers.Ethylene a ripening hormone when absorbed can increase the shelf life of the perishables. $KMNO_4$ is a strong ethylene absorbent and used in sachets. In the present experiment $KMNO_4$as ethylene absorbers one per packages sachets were used enclosed in the active packages.

Physiological loss in weight of the strawberry fruits during storage was shown by weighting the fruits at different time intervals and calculated by using the formula

$$PLW(\%)= \frac{\text{Initial weight} - \text{Final weight} \times 100}{\text{Initial weight}}$$

Decay Incidence of fruits was determined visually by counting the diseased and healthy strawberries in each treatment, at every interval and expressed as percentage.

Shelf life of fruits were accessed for shelf life based on visual and textural appearances during the time of storage

The **TSS** of fruits were determined by the Zeiss hand juice refractometer. The refractometer was first calibrated with distilled water before use and few drops of juice were put on the prism and readings noted.. it is expressed in degree Brix Ranganna,(3). TSS was estimated at 2^{nd}, 4^{th} and 6^{th}day of storage.

The **titratable acidity (%)** is calculated using the formula and expressed as percent citric acidHorwitz at al. (4). TA of the stored samples were expressed on 2^{nd}, 4^{th} and 6^{th}day of storage in active packaging.

Titratable acidity (%)=

$$\frac{\text{Titre value x Normality of Alkalix vol. Make upx eq. Wt. Of citric acid x100}}{\text{Aliquot x weight of sample x 100}}$$

Ascorbic acid (mg/100gm of FW) is determined by using 2,6-Dichlorophenolindophenol visual titration method given by Freed. Ascorbic acid of the samples were estimated every 2^{nd}, 4^{th} and 6^{th} day of storage.

Anthocyanin (mg/100g) of the samples were estimated every 2^{nd}, 4^{th} and 6^{th} day of storage by the formula C= Ax288.21m/100g, where C is the concentration of the total anthocyanin.

Table1. Effect of Treatments on the PLW (%), Shelf life (days) and Decay incidence (%) Result

Treatments	PLW (%)	Shelf life (days)	Decay incidence (%)
T1	**4.13**	**4**	**56.33**
T2	**4.32**	**5**	**37.21**
T3(control)	**8.5**	**2**	**95.0**
S.Ed (±)	**0.09**	**0.31**	**1.96**
CD (P=0.05)	**0.20**	**0.64**	**4.02**

Table2. Effect of Treatments on the TSS(^{0} B), Acidity (%),Ascorbic acid (mg/100ml) and Anthocyanin(mg/100g)

Result

Treatments	TSS degree Brix	Acidity (%)	Ascorbic acid (mg/100ml)	Anthocyanin (mg/100g)
T1	**9.0**	**0.89**	**69.44**	**60.05**
T2	**11.0**	**0.90**	**70.31**	**60.00**
T3(control)	**10.0**	**0.91**	**62.36**	**59.90**
S.Ed (±)	**0.09**	**0.008**	**0.79**	**0.50**
CD (P=0.05)	**0.20**	**0.01**	**1.63**	**1.02**

Results and Discussion:

As seen from table 1, significant variations in shelf life were found in response to the treatments under T1, T2 and T3. The highest shelf life was found in T2 (5 days) and the lowest was found in T3 (2 days). This might be due to the influence of ethylene absorber, moisture absorber and chlorine di oxide, remarkable differenceshas been observed in control. Similar results have been obtained by Picon*et al*. (5), AharoniandBarkai-Golan (6) in use of ethylene absorber under polythene packaging in strawberry. Also results have been similar with Aday and Caner (7)in use of moisture absorber, ethylene absorber and chlorine dioxide packed in polythene trays.

Thephysiological loss in weightshowed significant variations , the lowest PLW was observed in T1 (4.13%) and the highest in control (8.5%).This might be due to the effect of Ethylene absorber which reduces the rate of respiration due to reduced metabolic activity.

The chlorine dioxide which acts as an antifungal and delays dehydration. Results were similar to that obtained by Hernandez-Munoz *et al* (8). Less the loss in weight, less is the dessication and shrinkage of fruits.

Significant variations in decay incidence were found in response to the treatments (Table1). The lowest decay incidence was found in T2 (37.21) as against the highest (95%) in T3 *ie* control in the entire storage period. The low decay incidence in T2 may be due to the effect of Chlorine dioxide which is known to have antifungal properties and are very effective in enhancing the shelf life of many fruits. Similar results have been obtained bySong *et al*.(9)in raspberry and peach, Dhakshinamoorthy*et al* (10) in banana.

Significant differences in TSS were obtained amongst the treatments. The highest TSS was observed in T2 (11^0B) and the lowest in T1(9^0B).This may be due to the slowing down the hydrolysis of sugars by minimizing the rate of respiration by the ethylene absorber. Similar results have been obtained by Duran *et.al*.(11) **i**n strawberry.The TSS has a positive effect on the taste of strawberries

The titratable acidity was significantly lower in the control (T3) as compared to both T1(0.89 %) and T2 (0.90%).This may be due to the reduction of respiration due to absorption of ethylene by ethylene absorbers with the combined effect of chlorine di oxide. Similar results have been obtained by Aday and Caner (7)in strawberry.

Significant increase in ascorbic acid were obtained amongst the treatments (Table 2) which is a positive result.The treatments T1(69.44mg/100ml) and T2 (70.44 mg/100ml)of ascorbic acid content was observed as against (62.36mg/100ml) in T3 *ie* control. The higher ascorbic acid content in T1 and T2 as compared to the control may be due to lowering of respiration of the packed strawberries due to the use of ethylene absorbers. Potassium permanganate absorbs ethylene and degrades it to CO_2 and water. This results in an increase of CO_2content at storage atmosphere. This results obtained were similar in use of ethylene absorber toIshaq *et al.* (12) in Apricot and Mir et al. (13) in Peach.

Similarly significant increase in Anthocyanin content were obtained in the treated strawberries as compared to control. T1(60.5mg/100g), T2 (60.0 mg/100g) and T3 (59.9mg/100g).This may be due to the activity of ethylene absorber in T1 and T2 which reduces the activity of polyphenoloxidase and peroxidise enzymes due to changes in the internal atmosphere of the fruits or it may be a natural process of ripening. Similar results were obtained by El Ghaouth***et al***, (14) in strawberry.

Conclusions

It can be concluded that treatment T2 (ethylene absorber+ Moisture absorber+ chorine dioxide) performed best in boosting up the shelf life and quality parameters followed by T1. Moreover, because of its enhanced shelf life, it makes it suitable for long distance transportation of strawberry in plastic punnets. Therefore this treatment can be adopted by farmers or industries.

References

1.Baka, M,;Mercier,J,; Corcuff,R; and Arul, J.(1999). Photochemical treatment to improve storability of fresh strawberries. *Journal of Food Science,***64**(6):1068-1072.

2.Robinson, D.K.R and Morrison,M.J.(2010). Nanotechnologies for food packaging: reporting the science and technology research trends. Report for observatory Nano.

3.Ranganna,S. (1977). Handbook of analysis and quality control for fruits and vegetable products. New Delhi: Tata McGraw Hill Publishing Co. Ltd. Pp. **4-125**

4.Horwitz, W.; Kamps, L.V.R. and Boyer, K.W. (1980). Quality assurance in the analysis of foods for trace constituents. *JAOAC*, **63**(6):1344-1354

5.Picon, A.: Martinez-Javega,J.M.; Cuquerella, J.; Del Rip, M.A. and Navarro, P. (1993). Effects of precooling, packaging film, modified atmosphere and ethylene absorber on the quality of refrigerated chandler and Douglas strawberries. Food chemistry,48(2):189-193.

6.Aharoni, Y. Andand Barkai-Golan, R. (1987). Preharvest fungicide sprays and polyvinyl wraps to control Botrytis rot and prolong the postharvest storage life of strawberries. *J.Hort Sci.*, **62**: 177-81

7.Aday, M.S.andCaner,C. (2011). The applications of 'active packaging and chlorine dioxide' for extended shelf life of fresh strawberries.*Packaging Technology and Science*, **24**(3):123-136

8.Hernandez-Munoz, P.; Almenar, E,; Del Valle, V.; Velez, D and Gavara,R.(2008). Effect of chitosan coating combined with postharvest calcium treatment on strawberry (*Fragaria x ananassa)* quality during refrigerated storage.*Food chemistry*, **110**(2): 428-435

9.Song, J.; Hildebrand,P.D.; Fan, L.; Forney, C.F.; Renderos, W.E.; and Doucette, C. (2007). Effect of hexanal vapour on the growth of postharvest pathogens and fruit decay. *Journal of Food science*, **72**(4): 108-112

10.Dhakshinamoorthy, D., Sundaresan, S., Iyadurai, A., Subramanian, K.S., Janavi &Subramanian , J.(2020). Hexanal vapour induced resistance against major post harvest pathogens of banana (*Musa accuminata* L.). *The plant pathology journal*, **36**(2):133

11.Duran, M.; Aday, M.S.; and Caner, C.(2016). Potential of antimicrobial active packaging containing natamycin, nisin, pomegranate to extend the shelf life of fresh strawberry. *Food and Bioproducts processing*,**98**: 354-363

12.Ishaq, S,: Rathore, H.A.; Masud,T. And Ali, S. (2009)Influence of postharvest calcium chloride application, ethylene absorbent and modified atmosphere on quality characteristics and shelf life of apricot (*Prunus armeniaca* L.) fruit during staorage. *Pak.J. Nutr*, **8**(6):861-865.

13.Mir, A.A.; Bandral, J.D. and Sood, M.(2018). Effect of active packaging on quality and shelf life of peach fruits. *The Pharma Innovation Journal*, **7**(4): 1076-1082.

14.El Ghaouth, A.; Arul, J.; and Boulet, M. (1991). Chitosan coating effect on storability and quality of fresh strawberries. *Journal of Food Science*,**56**(6): 1618-1620.