jpht
www.jpht.info

Journal of Postharvest Technology
2018, **06**(4): 91-105
http://www.jpht.info

RESEARCH ARTICLE

Effect of chemical treatments to control enzymatic browning in minimal processed and packaged eggplant

Harish Kumar R.K., Dr.Tanweer Alam and Dr. Priti Khemariya

Indian Institute of Packaging, New Delhi-110092, India

Received: 23.09.2018 Accepted: 19.10.2018

ABSTRACT

Minimal processing is a technique that is devised to preserve food as well as retain the nutritional quality and the sensory characteristics of the food product. This is done by reducing the reliance on heat as the main preservative action. To extend the shelf life of fruits and vegetables, this study is focused on developing a minimum processing packaging procedure with reduced undesired physicochemical reactions. In the present investigation shelf life of minimally processing studies on brinjal at different parameters and storage conditions has been carried out to control enzymatic browning.

Keywords: Fresh-cut, brinjal, enzymatic browning, packaging, minimal processing

Citation: Harish K. R. K., Alam, T., and Khemariya, P. 2018. Effect of chemical treatments to control enzymatic browning in minimal processed and packaged eggplant. *Journal of Postharvest Technology*, **06**(4): 91-105.

INTRODUCTION

Vegetables as a group are important supplements to the human diet as they provide useful sources of a number of nutrients including vitamin C, vitamin K, folate, thiamine, carotenes, several minerals, trace elements and dietary fibre. India is the second largest producer of vegetables in the world, accounting for 15% of world's production of vegetables (FAO STAT., 2017). India being an agricultural country however lags the infrastructure required for post-harvest handling of the fresh produce. Production of eggplant is concentrated, with 85% output arriving only from three countries i.e. India, China and Egypt.The eggplant, aubergine or brinjal is a perennial plant often cultivated annually. The peel of eggplant contains a high quality of anthocyanins, especially in the purple coloured species; moreover the flesh contains high content of phenolic compounds. However, the vitamin C content present in the flesh is lower (Passam and Karapanos., 2008). Whitaker and Stommel (2003), studied the principal class of phenolics (hydroxycinnamic acid conjugates) in the flesh of seven eggplant cultivators and found the predominant compound to be chlorogenic acid (5-o-caffeolquinic acid). The total content of hydroxycinnamic acid conjugates ranged from 0.5-1.5% on a dry weight basis, which ranks eggplant as among the highest in phenolic acid content.

Minimal processing is a technique that is devised to preserve food as well as retain the nutritional quality and the sensory characteristics of the food product. This is done by reducing the reliance on heat as the main preservative action. This process generally involves cleaning, washing, trimming, coring, slicing, shredding etc (Fellows et al., 2000; Hong et al., 2004).

For Correspondance: T. Alam (Email: amtanweer@rediffmail.com) **ISSN: 2348-4330**

According to Motey and Lele (2003), about 70-80% portion of cauliflower is discarded as waste at various stages of its processing. Thus, the property of highest waste to edible ratio and high value of vegetables makes cauliflower one of the best candidates for minimally processed ready-to-cook vegetables. A study conducted by Ambareesha (2016), to standardise minimal processing technology for the developing of ready-to-use amaranthus with extended shelf life and nutritional quality. The study revealed that surface sanitation with 2 ppm ozonised water, pre-treatment with sodium benzoate + citric acid (0.1%) and pre-packaging in micro ventilated polyethylene had the highest percentage of microbial reduction (40.53 per cent for leaves and 39.15 per cent for stem), highest retention of ascorbic acid, anthocyanin and mean score for visual parameters. Hence, extending the shelf life of minimally processed amaranthus up to eight days when stored under refrigerated condition and four days under ambient conditions (Ambareesha., 2016).

In lieu of this, minimal processing cause stresses on fresh produce due to light, temperature, wounding which have proven to cause physiological effect on fruits and vegetables resulting in accumulation of phenolic compounds or secondary metabolites. Wounding is a one of physiological effect caused as a result of minimal processing. Salviet (1989), reported wounding produces a signal that migrates through the tissue and induces the synthesis of enzymes in metabolic pathway responsible for increased production of phenolic compound (Reyes et al., 2007). Moreover, recent research has shown that wounding has the tendency to increases the antioxidant capacity in lettuce (Kang and Saltveit., 2002), carrots (Heredia and Cisneros-Zevallos., 2002) and purple-flesh potatoes (Reyes and Cisneros-Zevallos., 2003). This increase was found to associate with the detected rise in total phenolic content after wounding.

Minimal processing has been used very firmly in developed countries and now it is majorly based on phytosanitary conditions inclusive of all the levels in the industrial hierarchy. In this adoption of HACCP/ GMP protocols, application of pre-cooling and modified atmosphere techniques and minimisation of manual handling during processing and packaging (Saxena et al., 2012). The latest technologies used in minimal processing are non-thermal techniques such as high-pressureprocessing, pulsed electric fields, pulsed UV light,ultrasonic etc.The application of minimal processing is primarily practiced on lettuce, strawberries, a variety of refrigerated products suchas salads, fruit pies, dressings, toppings and stuffing. Furthermore, to extend the shelf life of fruits and vegetables, this study is focused on developing a minimum processing packaging procedure with reduced undesired physicochemical reactions. Hence, the objective of the study is to conduct minimal processing studies on brinjal at different parameters, evaluating the shelf life of minimally processed brinjal under different storage conditions with packaging material, studying its browning index and finally optimizing variables like chemical treatments, packaging materials and storage conditions involved in minimal processing of brinjal.

MATERIALS AND METHODS

Materials

Fully ripened fruits of pomegranate were procured from local market and stored at refrigeration temperature until they were used for the juice extraction. All the chemicals and reagents used were of analytical grade (M/s. Loba Chemie Pvt. Ltd, Mumbai, India).

RESULTS AND DISCUSSION

Materials and methods

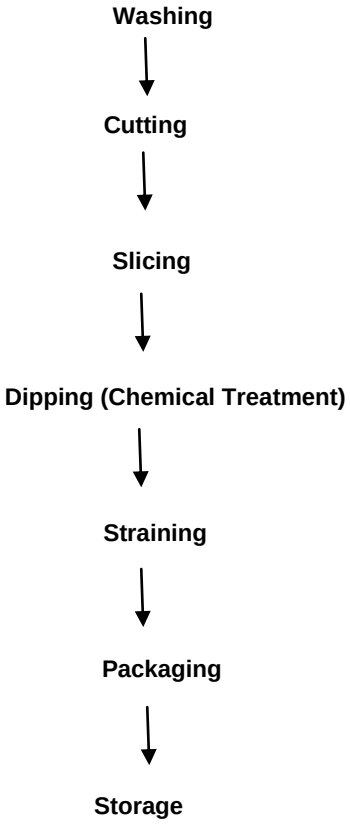
Different processing parameters like washing, trimming, cutting, packaging and analysis of browning index in minimally processed brinjal is briefed.

Procurement of Raw Material

Fresh eggplant was procured from the local market. Uniform matured fresh brinjal selected for study. The selected sample thoroughly washed with water to remove excess dirt.

Preparation of Minimally Processed Brinjal

The process flow chart for the preparation of minimally processed brinjal is shown below:



Washing and Cutting

The vegetables were washed with good quality water. The stem portion was removed from the vegetable with a sharp knife (food grade SS knife).

Slicing

Uniform slices of brinjal were made manually by using vegetable slicer.

Dipping (Chemical Treatment)

The combination and concentration of chemicals are listed in Table 1

Table 1: The combination and concentration of chemicals

SN	Treatments	Concentration
1	Ascorbic acid (AA)	0.1%
2	AA	0.5%
3	Citric acid (CA)	0.1%
4	CA	0.5%
5	AA+CA	0.1%+0.5%
6	AA+CA	0.3%+0.5%
7	AA+CA	0.5%+0.5%
8	AA+CA+$CaCl_2$	0.3%+0.3%+0.1%
9	Sodium Benzoate	0.5%

Straining

The treated brinjal slices were strained using SS strainers. The strained samples dried using blotting paper.

Packaging

The slices were then packed in perforated and non-perforated polypropylene bags and were sealed using hand sealing machine.

Storage

The packed samples were stored under atmospheric and refrigerated conditions.

Experimental Design

In the present study, experiment was designed to find the optimum storage condition for extending the shelf life of minimally processed brinjal. The details of the experiment are stated below:

Independent variables

The following are the independent factors:

Packaging material: PP – Perforated, PP – Non- perforated, storage condition: atmospheric storage, refrigerated storage, treatment parameters: chemicals, time, concentration

Dependent Variables

The shelf life and browning index of the minimally processed brinjal were taken dependent factors in this study.

Packaging and Storage

After the chemical treatment the samples were air dried for 5 min. Then, they were placed in different packaging materials. 50g of sample was stored in packaging materials under both atmospheric and refrigerated conditions.

Packaging Material

Polypropylene (PP) packaging materials were used in the packaging of the brinjal slices. These samples were packed in perforated and non-perforated bags. Perforations were made using hand punching machine. The number of perforation per bag is 8.

Browning Evaluation

Enzymatic Browning

Enzymatic browning of fruit is a well-known phenomenon caused by the oxidation of phenolic compounds into quinones. This reaction is mainly catalysed by polyphenol oxidase in the presence of oxygen (Mishra et al 2013), triggeringdark pigmentation. This brown discoloration leads to organoleptic and nutritional modifications in the plant tissues, thus causing unfavourable quality changes in the food products (Amiot et al 1997).

Browning Index (BI)

Browning Index can be defined as the intensity of brown coloration on the cut surface of fresh fruits and vegetables. The intensity of the colour can be studied by measuring the absorbency at 420nm (Lichapornet al., 2009).

Method to determine BI

Brinjal samples (2g) from each replicate were homogenised with 10ml of distilled water (5^{o}C). The homogenates were centrifuged at 2500 rpm for 25min and filtered through Whatman No 2-filter paper. The absorbance of the resulting clear juice was measured immediately at 420nm to determine the browning index.

Quality Analysis of Brinjal

The various dependent variables listed above were determined periodically for 2^{nd}, 3^{rd}, 4^{th} and 5^{th} day of storage. The measurement method is briefly described as follows.

Microbial Counts during Storage

The quality of fruits and vegetables are based on the numbers and the kind of microorganism's present, which can be assessed by serial dilution, and plating method for the differential enumeration of bacteria and fungi. Commonly used media for the enumeration of bacteria is nutrient agar media (Allen., 1959).

Enumeration of Fungi

In case of fruits and vegetables, post-harvest losses are observed. This can be due to diseases originating due to mechanical and physiological injuries in the vegetable surface during harvesting, marketing and distribution (Rais and Sheoran., 2015). Fungal pathogens like *Penicillium, Aspergillus, Rhizopus, Fusarium* enter through mechanical injury during harvest and the overall value of the commodity may be seriously impaired by unsightly superficial contamination, even though its palatability is not affected. Hence, the quantitative estimation of these organisms will provide a clear information on the quality which can be assessed by serial dilution and plating method using Martin's Rose Bengal Agar medium (Martin., 1950).The use of streptomycin sulphate arrests thegrowth of bacteria and the Rose Bengal acts as a fungistatic compound. It is an agent that inhibits rapid growth of fungi.

Experimental setup for the preparation of medium and analysis of microbial load

Materials required for the preparation of medium and analysis were chemicals, conical flasks, pH meter, 0.1N NaOH, autoclave, sample, nutrient medium agar, rose Bengal agar medium, sterile water blanks, sterile petri plates and sterile pipettes. Appropriate quantity of nutrients was dissolved one after another in 100ml of distilled water and pH was adjusted by using 0.1 NaOH and 0.1 HCl. After the pH was adjusted agar was added and the medium was sterilized at 121^{o}C for 15 min.

1g of the sample was taken and added to 10ml sterile water blank. Dilution was shacked well for 10-15 min to obtain homogenised suspension of microorganisms. This will give a dilution of 1:10 (10^{-1}). 1ml from (10^{-1}) dilution was transferred to 9 ml of sterile water blank with a sterile 1ml pipette, which gave a dilution of 10^{-2}. The process was repeated up to 10^{-8}dilutions with the sterilewater blank. Each time sterile 1ml aliquots from 10^{-3}, 10^{-6}, 10^{-8} dilutions were transferred to the sterile petridishes for the enumeration of coliforms, fungi and bacteria respectively. The experiments are maintained in triplicate for greater accuracy.

Approximately 15-20ml of molten and cooled medium (45^{o}C) for the respective organisms were added to each petri dish and rotated in the clockwise and anticlockwise direction to have a uniform dispersion of colonies. The plates are then incubated overnight at room temperature for 24-48hours in case of bacteria and three days for fungi and coliform respectively. After the incubation period, the colonies were counted and the number of organisms (bacteria, fungi and coliforms) per gram of sample was calculated by applying the formula.

Number of colony forming units (CFU's) per gram of the sample

$$= \frac{\text{Mean number of CFU's x Dilution factor}}{\text{Quantity of sample on weight basis}}$$

Sensory evaluation

In general, sensory quality of food is the consumer's reaction to the physical and chemical constituents of the food in its prepared and formulated form. Sensory evaluation of minimally processed brinjal was done on 5th day of storage. The samples were served to panellist (10) under ambient condition at one session and were asked to rate the product according to its desirability using the 9-point hedonic scale.

Results and Discussions

The present study has been taken up with the objectives of minimal processing of brinjal. The study is to investigate the influence of single or chemical treatment on controlling browning followed by shelf life evaluation and studies on browning index of treated and controlled samples. In order to optimize the above said parameters, measurements were taken at particular intervals (2nd, 3rd, 4th and 5th day). The results of the experiments conducted are presented and discussed here.

Effect of dipping (chemical) treatments on brinjal

The dipping treatments were carried out for brinjal (*Solanum melongena*) varying the chemical concentration and time (1, 3 and 5 min). Initially, the samples were named after the chemical treatments which were shown in Table 2

Table 2: Samples with percentage composition of chemical additives at different concentrations

Sample	Treatments	Concentration of chemical additives
S_1	Ascorbic Acid (AA)	0.1%
S_2	AA	0.5%
S_3	Citric Acid (CA)	0.1%
S_4	CA	0.5%
S_5	AA+CA	0.1%+0.5%
S_6	AA+CA	0.3%+0.5%
S_7	AA+CA	0.5%+0.5%
S_8	AA+CA+$CaCl_2$	0.3%+0.3%+0.1%
S_9	Sodium Benzoate	0.5%
C	Control	No treatment

The experiments were conducted on trial basis to standardize the procedure. Once the methodology was framed, the treatments were carried out effectively and all the samples were packed in polypropylene bags (perforated and non-perforated) and stored under atmospheric and refrigerated conditions. The samples were replicated to obtain the best result. Firstly, a comparative study was done on the colour and texture of the control and the treated samples. The above said parameters were found to vary as the number of days increased.

Evaluation of shelf life

Every 12h the samples were checked for spoilage and the readings were noted down in hours, as shown in Table 3

Table 3: Evaluation of Shelf Life (Hours)

Atmosphere Storage (h)							**Refrigerated Storage (h)**					
Sample	1Min		3 Min		5Min		1Min		3Min		5min	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
C	6	6	6	6	6	6	6	6	6	6	6	6
S1	24	24	42	42	48	42	42	42	96	96	116	116
S2	42	42	42	42	42	42	92	92	96	96	116	116
S3	24	24	42	42	42	42	38	36	86	82	94	94
S4	42	42	42	42	48	46	86	86	92	92	98	98
S5	42	42	42	42	48	42	72	66	84	78	96	90
S6	42	42	48	42	46	46	72	66	84	78	96	90
S7	42	42	48	42	46	46	72	66	84	78	100	100
S8	42	42	42	42	48	42	116	116	120	120	120	120
S9	42	42	48	42	46	46	72	72	98	86	102	98

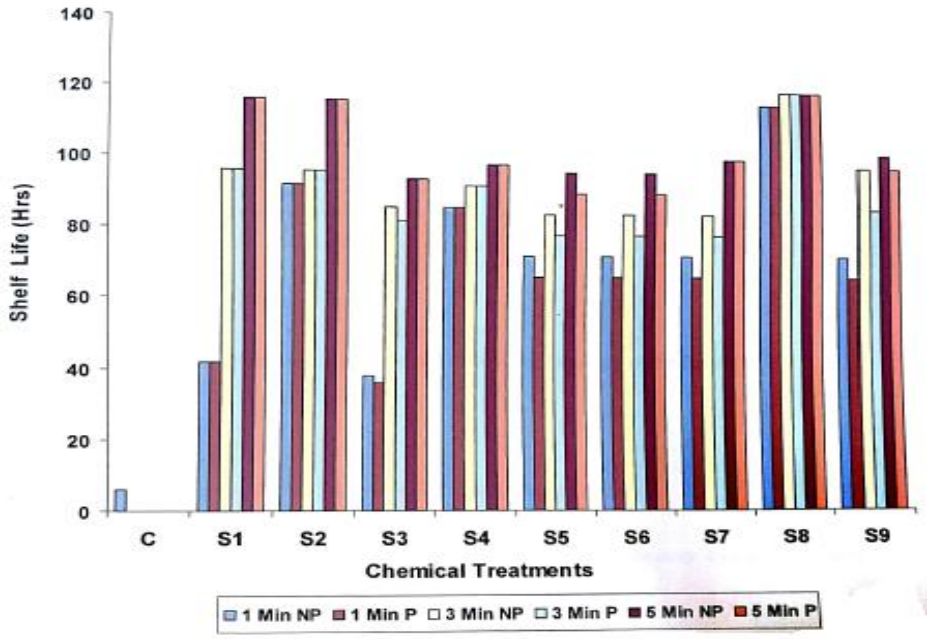
Where,

S_1 – 0.1% Ascorbic acid (AA) S_2 – 0.5% Ascorbic acid (AA)
S_3 - 0.1% Citric acid (CA) S_4 – 0.5% CA
S_5 – 0.1% AA + 0.5% CA S_6 – 0.3% AA + 0.5% CA
S_7 – 0.5% AA + 0.5% CA S_8 – 0.3% + 0.3% CA + 0.1% $CaCl_2$
S_9 – 0.5% Sodium benzoate NP – Non-perforated package
PP – Perforated package C – Control

*S_1, S_2, S_4, S_5 and S_8 – samples have exhibited better shelf life when stored under atmospheric and refrigerated conditions.

The tabulated results (Table 3) can be represented in a graphical view as given in Figure 1 for atmospheric storage and Figure 2 for refrigerated storage.

Figure 1: Shelf life Vs Chemical treatments during atmospheric storage



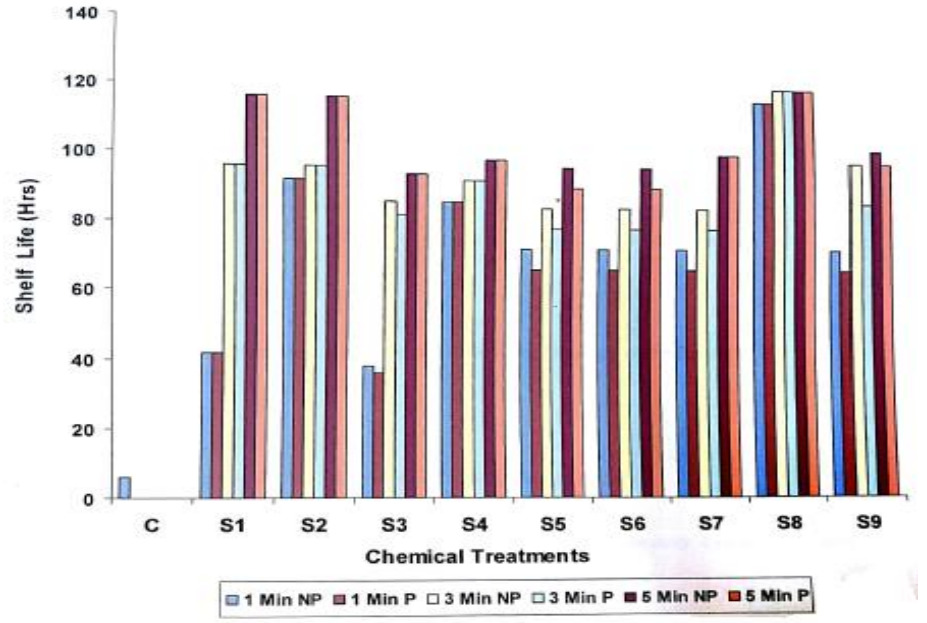


Figure 2: Shelf life Vs Chemical treatments during refrigerated storage

Evaluation of shelf-life during atmospheric condition

In case of atmospheric storage, the samples S_1^*, S_2^*, S_4^*, S_5^* and S_8^* were found to have a better shelf life i.e. 42 h to 48 h duration without any duration or damage. The acceptability level of the samples varied with respect to dipping time (1, 3 and 5 min).

Evaluation of shelf life during refrigerated condition

In case of refrigerated storage, the samples S_1^*, S_2^*, S_4^*, S_5^* and S_8^* were found to have a better shelf life i.e. 90h to 120h duration without any decay or damage. The acceptability level of the samples varied with respect to the dipping time (1, 3 and 5min).

Sensory Evaluation

The sensory evaluation was conducted using 9-point hedonic scale for all the samples with a trained panel consisting of 10 members. The results are depicted in Table 4.

Table 4: Sensory Evaluation

Sensory Attributes	Chemical Concentration combinations								
	S_1	**S_2**	**S_3**	**S_4**	**S_5**	**S_6**	**S_7**	**S_8**	**S_9**
Colour	6.95 (0.24)	7.12 (0.1)	5.45 (0.12)	6.01 (0.11)	5.98 (0.21)	4.98 (0.12)	5.65 (0.26)	6.98 (0.23)	5.35 (0.13)
Texture	7.21 (0.12)	7.38 (0.23)	6.23 (0.24)	6.30 (0.2)	5.64 (0.13)	5.12 (0.1)	6.01 (0.2)	7.01 (0.12)	5.68 (0.23)
Overall acceptability	7.11 (0.2)	7.46 (0.52)	6.56 (0.30)	6.00 (0.54)	5.46 (0.15)	5.00 (0.11)	6.25 (0.21)	7.00 (0.25)	6.00 (0.22)

Average of 5 determinations (SD)

From sensory evaluation the following samples were found to be acceptable:

S_1 -0.1% Ascorbic acid, S_2 – 0.5% ascorbic acid, S_8- 0.3% Ascorbic acid + 0.3% Citric acid + 0.1% calcium chloride. This is inferred from the fact that the sample S_1, S_2 and S_8 scored 7 which is designated as liking moderately. Hence, making these samples more inclined for their acceptability.

Optimization of the best treatment

The results obtained from shelf life evaluation and the sensory evaluation were discussed and analysed. Thus, the optimised treatments are as follows:

S_1- 0.1% Ascorbic acid
S_2- 0.5% Ascorbic acid
S_8- 0.3% Ascorbic acid + 0.3% Citric acid + 0.1% calcium chloride

Determination of browning index (BI)

The browning index was measured for the optimized treatments using spectrophotometer at 420nm (Lichaporn et al 2009).

Browning index for S_1

The results of browning index of sample S_1 i.e. treated with 0.1% ascorbic acid are presented both in Table 5 and graphical representation as Fig 3 and Fig 4

Table 5: Browning index for S_1

Atmosphere Storage (h)							Refrigerated Storage (h)					
No of Days	1Min		3 Min		5Min		1Min		3Min		5min	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
1	0.525	0.795	0.429	0.644	0.309	0.441	0.992	0.903	0.905	0.792	0.56	0.777
2	0.662	0.882	0.992	0.732	0.423	0.495	1.099	1.033	1.00	0.838	0.806	0.904
3	1.052	0.906	1.044	0.809	0.487	0.512	1.235	1.106	1.148	1.316	0.94	0.905
4	1.357	1.033	1.412	0.928	0.602	0.725	1.289	1.259	1.256	1.526	1.381	1.248

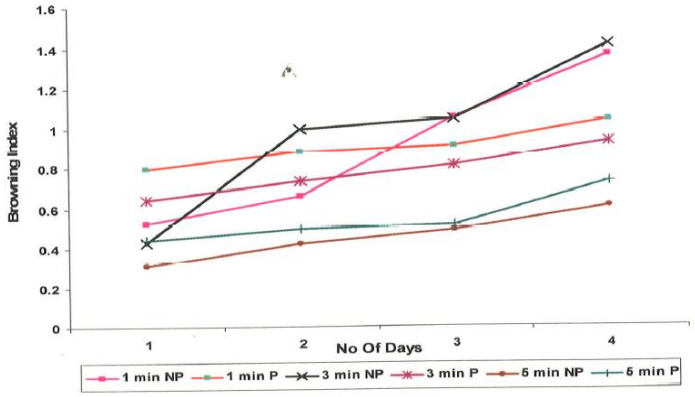


Fig 3 Browning index Vs No. of days during atmospheric storage

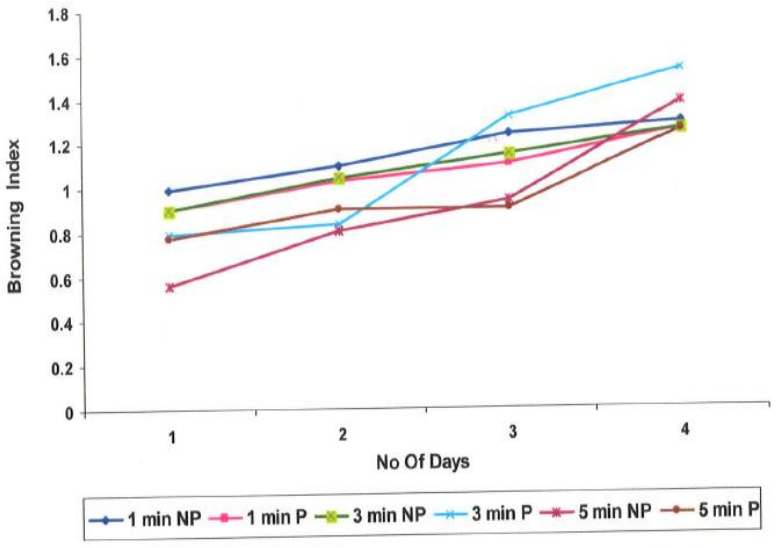


Figure 4: Browning index Vs No of days during refrigerated storage

Browning index for S_2

The results of browning index of sample S_2 i.e. treated with 0.5% ascorbic acid were presented both in Table 6 and graphical representation as Fig 5 and Fig 6.

Table 6 Browning index for S_2

Atmosphere Storage (h)							Refrigerated Storage (h)					
No of Days	1Min		3 Min		5Min		1Min		3Min		5min	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
1	0.705	1.077	0.491	0.618	0.842	1.086	0.732	0.712	0.667	0.639	0.741	0.467
2	0.884	1.083	0.974	0.918	0.868	1.232	0966	0.886	0.961	1.082	0.953	0.847
3	1.033	1.071	1.276	1.225	0.916	1.272	1.041	0.943	1.069	1.15	0.976	0.993
4	1.219	1.201	1.396	1.356	1.116	1.342	1.157	1.148	1.337	1.337	1.076	1.021

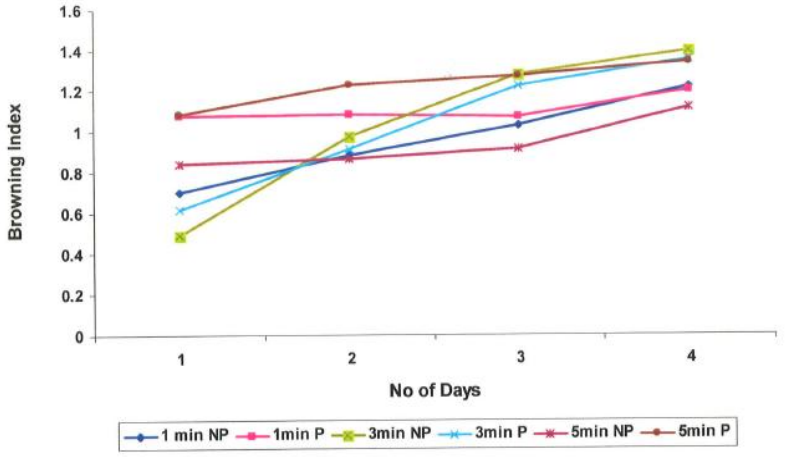


Figure 5: Browning index Vs No of days during atmospheric storage

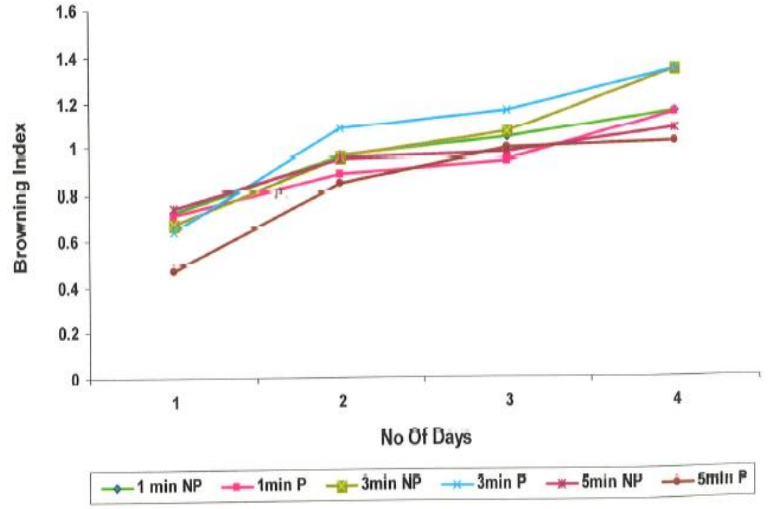


Figure 6: Browning index Vs No. of days during refrigerated storage

Browning index for S_8

The result for the browning index of sample S_8 i.e. treated with 0.3% ascorbic acid + 0.3% citric acid + 0.1% $CaCl_2$ is presented both in Table 7 and graphical representation as Fig. 7 and Fig. 8.

Table 7: Browning index for S_8

Atmosphere Storage (h)							Refrigerated Storage (h)					
No of Days	1Min		3 Min		5Min		1Min		3Min		5min	
	N	NP	N	NP	N	NP	N	NP	N	NP	N	NP
1	0.993	0.965	0.752	0.601	0.693	0.861	0.576	0.692	0.644	0.603	0.452	0.508
2	1.123	1.132	0.791	0.64	0.728	1.103	0.795	0.709	0.721	0.728	0.616	0.628
3	1.206	1.178	0.932	1.16	0.831	1.273	0.976	0.854	0.854	0.896	0.796	0.747
4	1.375	1.317	1.162	1.238	0.964	1.383	0.996	0.987	0.937	0.958	0.869	0.824

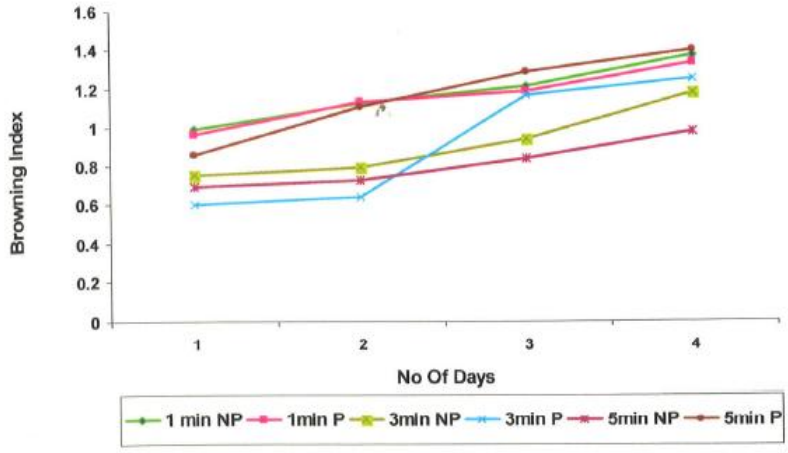


Figure 7: Browning index Vs No. of days during atmospheric storage

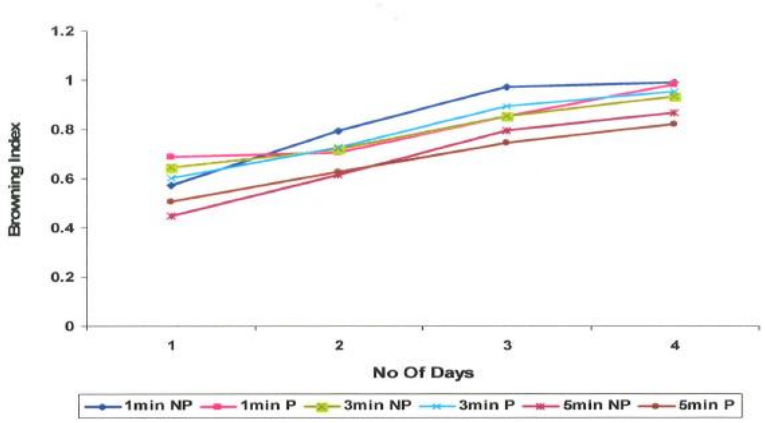


Figure 8: Browning index Vs No. of days during refrigerated storage

Optimization of the best sample

The best samples identified from the optimized treatments based on the acceptability and browning index values, later a graph was plotted for both atmospheric and refrigerated storage conditions.

Optimization of the best sample stored under atmospheric condition

In case of atmospheric condition, the samples S_1, S_2 and S_8 with a dipping time of 5 min and non-perforated packaging were found to have lower browning index values. The results are shown in Fig 9.

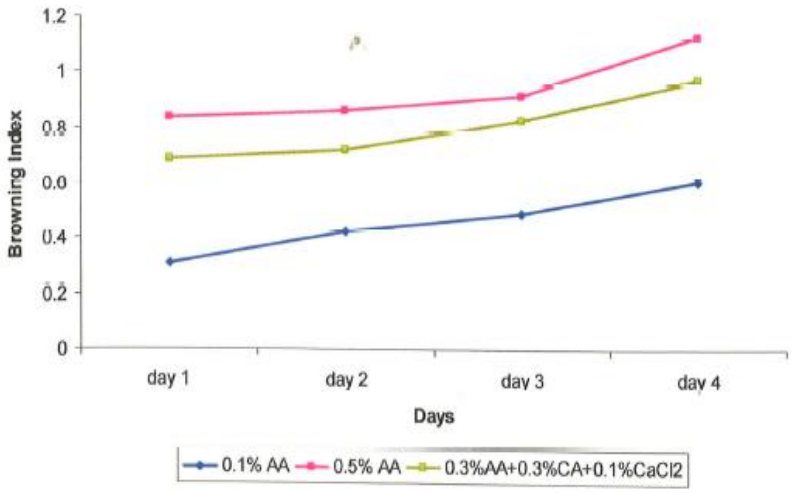


Figure 9: Browning index Vs No. of days during atmospheric storage

From the above figure 9 it is inferred that sample S_1 – 0.1% ascorbic acid with a dipping time of 5 min and non-perforated packaging had low browning index values when compared to other samples S_2 and S_8.

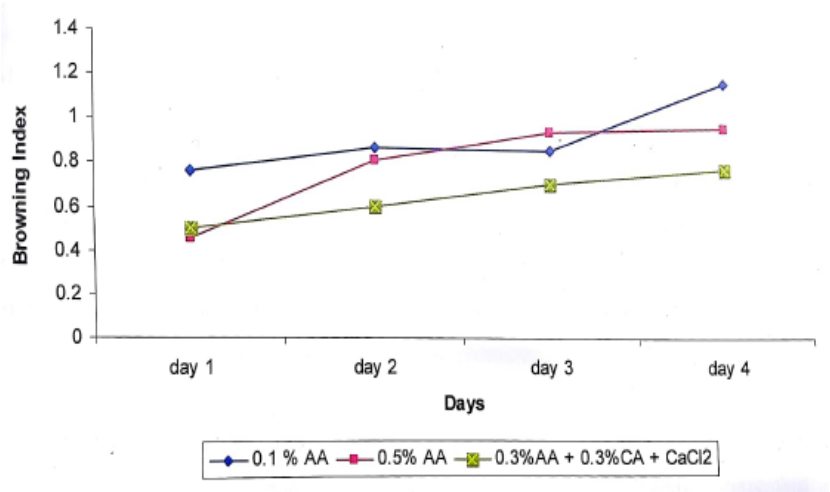


Figure 10: Browning index Vs No. of days during atmospheric storage

Optimization of the best sample stored under refrigerated condition

In case of atmospheric condition, the samples S_1, S_2 and S_8 with a dipping time of 5 min and perforated packaging were found to have lower browning index values. The results are shown in Fig. 10. From the shown graph as Fig 10, it is inferred that samples S_1 – 0.1% ascorbic acid with a dipping time of 5 min and perforated packaging had low browning index values when compared to other samples S_2 and S_8.

REFERENCES

Amiot, M. J., Fleuriet, A., Cheynier, V and Nicolas, J. 1997. Phenolic compounds and oxidative mechanisms in fruit and vegetables. In F. A. Toma´s-Barbera´nand R. J. Robins (Eds.), Phytochemistry of fruit and vegetables. Proceedings of the phytochemical society of Europe (Vol. 41, pp. 51–85). New York, NY: Oxford University Press.

Ambareesha, K. N. 2016. Standardization of minimal processing of amaranthus (Amaranthus tricolor L.). College of Agriculture, Vellayani. Kerala Agricultural University.

Fleming, M., Barnard, N. H and Allen L. A. 1959. Use of antibiotics in media for assessing bacterial contamination in food yeast. Journal of the Science of Food and Agriculture, 10, 12, 651-656.

FAOSTAT, 2017. www.fao.org accessed on April 1st, 2018.

Heredia, J. B and Cisneros-Zevallos, L. 2002. Wounding stress on carrots increases the antioxidant capacity and the phenolics content [abstract]. In IFT annual meeting book of abstracts (p. 180, Abstract 76C-14). Chicago, IL: Institute of Food Technologists.

Hong, I. S and Kim, D. M. 2004. The effect of packaging treatment on the storage quality of minimally processed bunched onions. Journal of Food Science and Technology, 39, 1033-1041.

Kang, H and Saltveit, M. E. 2003. Wound-induced increases in phenolic content of fresh-cut lettuce is reduced by a short immersion in aqueous hypertonic solutions. Postharvest Biology and Technology, 29, 271–277.

Lichaporn, I., Srilanong, V., Wongs-Aree, C and Kanlayanarat, S. 2009. Postharvest physiology and browning of longkong (Aglaia dookkoo Griff.) fruit under ambient conditions. Postharvest Biology and Technology, 52, 294-299.

Martin, J. P. 1950. Use of acid, rose bengal, and streptomycin in the plate method for estimating soil fungi. Soil Science, 6, 215-32.

Motey, R and Lele, S. 2003. Fresh cauliflower preservation technology. Journal of Food Science and Technology, 40, 419-422.

Passam, H. C and Karapanos, I. C. 2008. Eggplant, peppers and tomatoes: factors affecting the quality and storage life of fresh and fresh-cut (minimally processed) produce. The European journal of Plant Science and Biotechnology, 2, 1, 156-170.

Rais, M and Sheoran, A. 2015. Scope of supply chain management in fruits and vegetables. Indian Journal of Food Process Technology, 6:3 http://dx.doi.org/10.4172/2157-7110.1000427

Reyes, L. F and Cisneros-Zevallos, L. 2003. Wounding stress increases the phenolic content and antioxidant capacity of purple-flesh potatoes. Journal of Agricultural and Food Chemistry, 51, 5296–5300.

Reyes, F. L., Villarreal, E. J and Cisneros-Zevallos, L.2007. The increase in antioxidant capacity after wounding depends on the type of fruit or vegetable tissue. Food Chemistry, 101, 1254-1262.

Saltveit, M. E., and Avena-Bustillos, R. D. 1989. Water vapour resistance of red delicious apples and celery sticks coated with edible caseinate-acetylated monoglyceride films. Journal of Food Science,62, 351-354.

Saxena, A and Saxena, M. T. 2014. Novel Process Technologies for Preservation of Horticultural Crops. Indian food industry, 33, 3.

Toivonen, P.M.A and Brummell D.A. 2008. Biochemical bases of appearance and texture changes in fresh-cut fruit and vegetables. Postharvest Biology and Technology, 48, 1–14.

Whitaker, B. D and Stommel, J. R. 2003. Phenolic Acid Content and Composition of Eggplant Fruit in a Germplasm Core Subset. Journal of the American Society for Horticultural Science, 128, 704-710.