Plant Archives Volume 21, No 1, 2021 pp. 1405-1412 *e-ISSN:2581-6063 (online), ISSN:0972-5210*

Plant Archives

Journal home page: www.plantarchives.org

DOI Url: https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no1.188

PHYSICOCHEMICAL, SENSORIAL AND MICROBIOLOGICAL ANALYSIS OF MINIMALLY PROCESSED FRUITS OF PAPAYA AND PINEAPPLE

Rizwana[1], Ruchi Sharma[1], Eram Rao[1], Tanya Luva [2] and Aparna Agarwal*[3]

[1]Department of Food Technology, Bhaskaracharya College of Applied Sciences,(University of Delhi), Dwarka, New Delhi-110075, India

[2]Department of Food Science and Technology, National Institute of Food Technology Entrepreneurship and Management (NIFTEM), Kundli, Sonepat, Haryana – 131028, India

[3]Department of Food and Nutrition and Food Technology, Lady Irwin College,(University of Delhi), Sikandra Road, New Delhi110001, India

*Email: aparnadt@gmail.com

(Date of Receiving-26-01-2021; Date of Acceptance-07-04-2021)

ABSTRACT

The current study intended to discover the storage/shelf life of papaya and pineapple, minimally processed fruits, based on their physicochemical, sensorial, and microbiological analysis. They were stored at low temperature at 4ºC for 8 days. Methods: The papaya slices were dipped into 1000ppm citric acid solution and a solution of 150ppm ascorbic acid and 1000ppm citric acid. On other hand, pineapple slices were dipped into a solution of 1% sodium chloride and 1% calcium chloride and another solution of 150ppm ascorbic acid and 1000ppm citric acid. Both fruit samples were immersed into the respective solutions for around 2-3minutes. Results: From the results of treatments, it was revealed that the combination of 150ppm ascorbic acid and 1000ppm citric acid solution, in both the samples showed the best outcomes. Conclusion: It ultimately concludes that after this treatment the minimally processed papaya and pineapple can be stored effectively and safely in good conditions for 8 days at low temperature.

Keywords: Minimal Processing, Papaya, Pineapple, Refrigerated condition, Shelf life

INTRODUCTION

In today's scenario, consumers are more concerned about their health and their lifestyle pattern is also changing rapidly which turns them towards the healthy utilization of fruits and vegetables. Also, today consumers possess a busy lifestyle and they do not have so much time to spend upon various other activities related to the consumption of food products, so they are attracted towards more easily available along with a ready-to-eat form of food products which include fruits and vegetables that are minimally processed, as these saves their time and provide them sufficient nutrients which ultimately fulfill their needs and requirements. (GlasAnBord, 2002; Martin-Diana *et al.,* 2007).

As per the United States Department of Agriculture (USDA) and Food and Drug Administration (FDA), minimally processed fruits and vegetables are considered as fresh and healthy commodities which are cut, washed, treated with additives and preservatives, packaged, and then stored under refrigerated conditions. The fruits and vegetables which are to be minimally processed can be utilized in the raw state(FDA,1998). Due to the rise in the number of working women, modernized consumers which are mostly inclined towards their health, safety, quality, and nutrition, the consumers are shifting more towards minimally processed ready-to-eat fruits and vegetables (Baldwin *et al.,* 1995). And due to these reasons, minimally processed fruits and vegetables have become a crucial segment of many restaurants and food centers (Ponce *et al.,* 2008). Nowadays many of the restaurants and food centers are equipped with various dishes related to fresh fruits and vegetables which attract the consumers and its demand is increasing at a very faster rate. And also the purpose of introducing minimally processed fresh fruits and vegetables into restaurants as well as hotels is basically to decrease the work labor cost as well as to minimize the waste generation (Xu *et al.,* 2003). Minimal Processing of fruits and vegetables results in a product that provides all the necessary nutrients which a body requires to maintain its healthy condition(Shahnawaz *et al.,* 2013). Minimally processed fruits and vegetables possess various advantages in many ways. These include:

a) Minimally processed products such as fruits and vegetables must be supplied in fresh form without any spoilage to the consumers and with proper packaging so that the products would be able to provide necessary functions.

b) The minimally processed products which are to be supplied to the consumers should have a greater shelf life so that till the delivery of products to the consumers and up to consumption the products should remain in their fresh state and do not get stale (Garret E, 1994). Minimal processing can't be seen as it increases the storage stability of the finished products. Thus, it is also referred to as invisible processing. Also to keep the minimally processed product fresh up to consumption level, it should have a minimum shelf life of 7 days and a maximum of 21 days which depends upon the supply period and storage conditions. In addition to freshness, nutritional quality also possesses the capability to increase the storage/shelf life of minimally processed products and thus infers a crucial role, among which the primary factors which bound the nutritional quality are carotenes and ascorbic acid (Ahvenainen R, 1996; Wiley RC, 1994; Bhat, 2013). There are various advantages of minimal processing but still it contains some disadvantages. Many physical and chemical changes take place due to the cutting operation such as increased respiration occurs as well as the rate of production of ethylene increases which produces off-odors and slowly degrades the product. The fluid also comes out of the cut portion of the fruits and vegetables which favors the growth of bacteria and fungi that ultimately leads to the deterioration of the product (Latifah *et al.,* 1999). So, to reduce and eliminate these effects, proper treatments should be given to the fruits and vegetables by dipping them into the solutions which also helps in enhancing the storage/shelf life.

Processing of fruits and vegetables treated with chemicals is termed Pretreatment. Fruits and vegetables are often pretreated to enhance their storage stability or shelf life and also reducing the discoloration, growth of micro-organisms and enhance the color, flavor, texture, aroma, and overall acceptability of the commodities (Ediriweera *et al.,* 2012).

Among all the tropical fruits, pineapple is the most lovable and marketed ready-to-eat product because of its sensory characteristics, and also it is difficult to consume as a whole due to its structure. Duetocutting operations of minimally processed fruits, their cells got disintegrated which releases the enzymes along with substrates that ultimately increases the oxidation process catalyzed with the help of enzyme (Rolle *et al.,*1987). The enzymes responsible for the browning of tissue include polyphenoloxidase(PPO)and peroxidase (POD) enzyme (Gonçalves, 2000). Polyphenol oxidase causes multiple deteriorations which affect color, flavor, quality, the textureof minimally processed ready-to-eatfruitsandvegetables(Antoniolli *et al.,* 2012).

Papaya, scientifically known as *Caricapapaya L.* is a nutrient-rich tropical fruit that is a very important commodity worldwide as fresh fruit and in the form of minimally processed fruits (Sankat *et al.,* 1997). Papaya fruit is known for its various benefits and nutrition to human health. In India, papaya fruit is produced in a huge quantity but possesses the limitation of providing no primary processing at the farm level and is marketed without adequate packaging. Papaya is consumed worldwide and peeling, removing seeds, slicing is a very time-consuming process, so today consumers are in a need of time-saving, effort-less, nutritional, and good quality fruits which increases the demand for minimally processed papaya.Minimal processed raw fruits provide the fresh fruit with excellent quality to the consumers and also due to the changing lifestyle provide it in a convenient form (Javier *et al.,* 2005; Oliu *et al.,* 2008; Alam *et al.,* 2013).

Also, fruits possess very less storage/shelf life, therefore the treatment of minimal processing for fruits plays a very crucial role in enhancing the storage stability or shelf life of the fruits also with providing nutrition, freshness, prevent from diseases, and various other health benefits to the human body. The current research was conducted to enlighten and investigate the minimal processing of two fruits, i.e., papaya and pineapple.

MATERIALS AND METHODS

Materials

The experiment was carried out in the Food Technology Laboratory of Bhaskaracharya College of Applied Sciences, University of Delhi. Fresh, fully ripe, mature, and defect-free pineapple and papaya were procured from the market (New Delhi). Papaya and Pineapple were analyzed separately and thoroughly washed with clean water, peeled, seeds and core removed, and then cut into uniform cubes of $3.5\times3.5\times3.5cm^3$.The fruit slices were immersed into respective pre-treatment solutions for about 2-3 minutes as given in Table 1. The pretreated fruit slices were packaged into polystyrene bowls wrapped with PVC (Polyvinyl Chloride) films, stored at refrigerated conditions.

All chemicals required for analysis were of analytical grade.

Methods

Prepared samples were analyzed for their physicochemical properties, sensory and microbiological attributes throughout their storage period. The analysis was conducted at regular intervals of 4 days. Experiments were conducted in replicates.

Physicochemical Analysis

Total Soluble Solids (TSS) of papaya and pineapple

Total Soluble Solids of fruit samples were determined with the help ofa hand-heldrefractometer. It was measured following the method given by Jayathunge *et al.,* 2012.

Titrable Acidity (TA) of papaya and pineapple

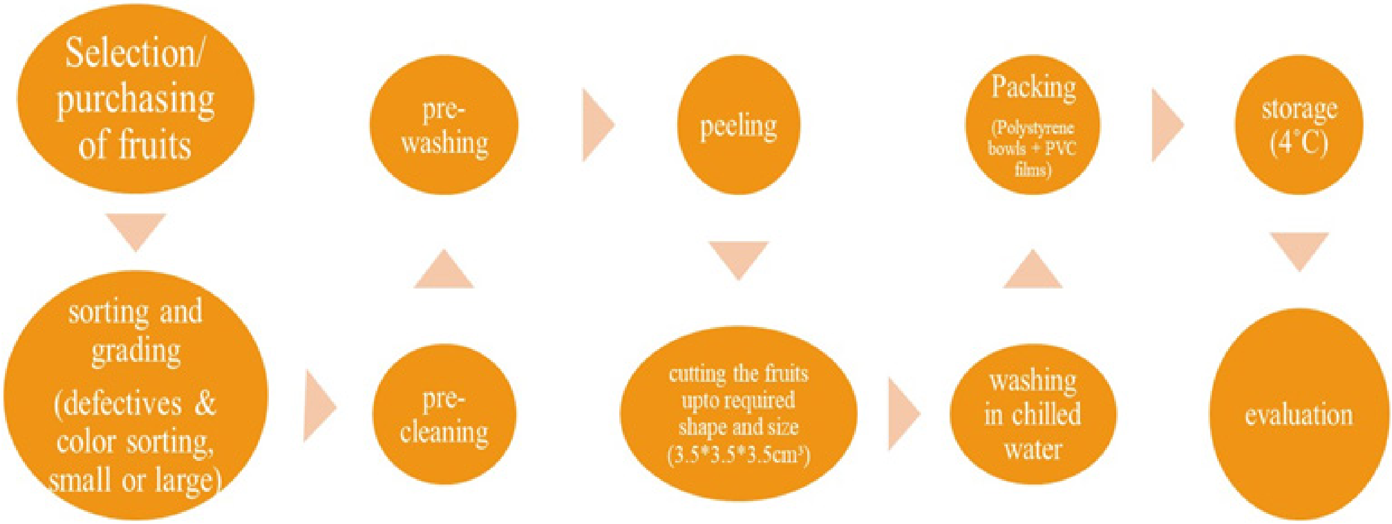

Fig. 1. Flowchart for minimal processing

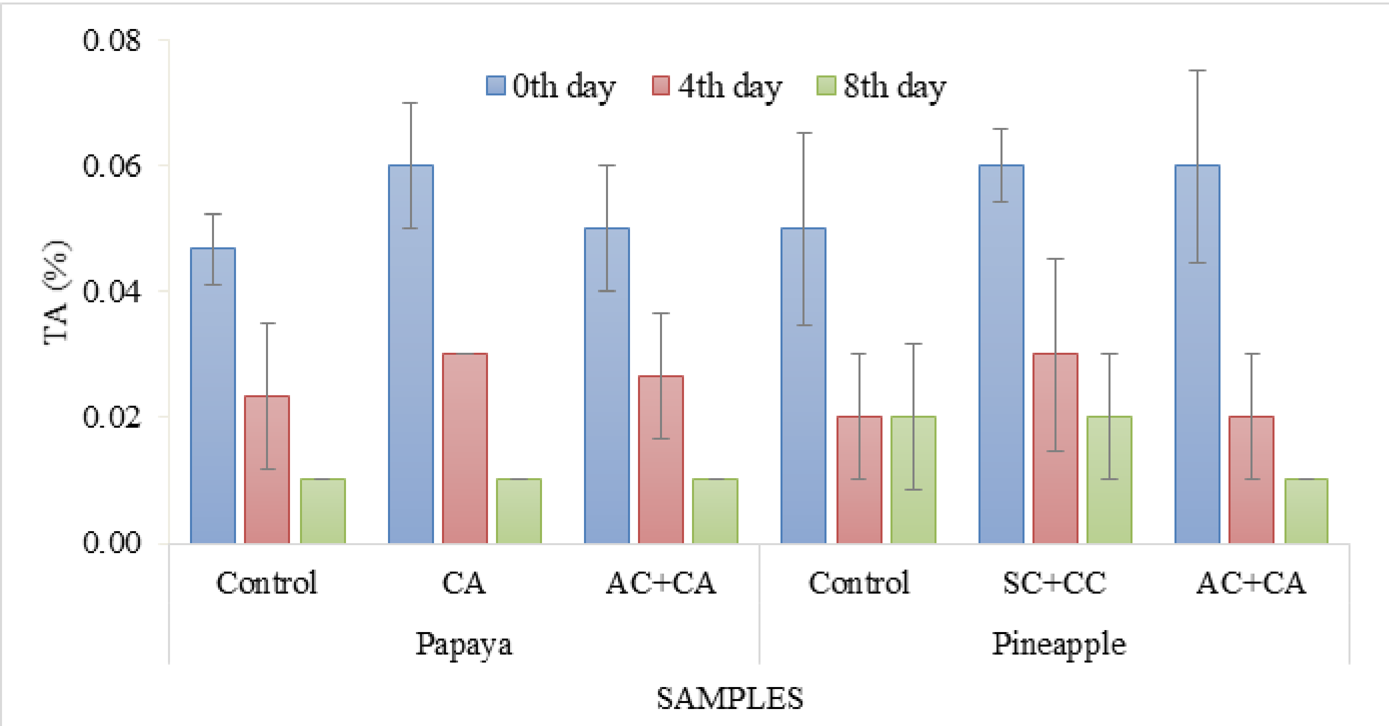

Fig 2. Titrable Acidity (%) of Papaya and Pineapple samples

The titrable Acidity of both the samples was analyzed following the method given byJayathunge *et al.,* 2012 and calculated as follows.

$$TA = \frac{T.V. \times N \times E \times 100}{1000 \text{ X } V}$$

where,

TA is the titrable acidity express in g/ 100ml

T. V. is the titre value that measures the volume of alkali required to neutralize the sample (ml)

E denotes the equivalent weight of the dominating acid in the sample (for citric acid 64.2)

V is the aliquot of the sample taken for analysis.

Sensory Analysis

The acceptability of the product throughout the storage period was analyzed in terms of organoleptic scoring by 10 semi-trained panelists based on a Seven-point Hedonic Scale. The Sensory Analysis was done periodically during the 0^{th}, 4^{th}, and 8^{th} day.

Microbiological Analysis

Total plate count (TPC)

Both the fruit samples were analyzed for the total plate count following the procedure given by Ediriweera *et al.,* 2012. Ten grams of pineapple and papaya were homogenized using sterile 0.9% NaCl followed by the preparation of dilution series up to 10^{-5}. Then plating was done using molten plate count agar in duplicates. Then the incubation of plated fruit samples was done at 30±1˚C for 72±1 h. The results were calculated in the form of the number of colony-forming units per gram (CFU/g) of the fruit samples.

Yeast and mold count (YMC)

Both the samples were analyzed for their yeast and mold count following the procedure given by Ediriweera *et al.,* 2012. Onemlaliquots from the dilution series prepared for enumerating the total plate count (TPC) of fruit samples were used and plated with 12 ml of potato dextroseagar (PDA) induplicates. After that incubation of plated sampleswas carried out at 25±1˚C for72±1 h and thereafter, results were calculated in the form of CFU/g of fruit samples (Aida *et al.,* 2007).

RESULTS AND DISCUSSION

Total Soluble Solids (TSS)

The results summarized in Table 2 revealed that the total soluble solids (TSS) of all the fruit samples were significantly affected by the type of commodity, storage time, and pre-treatment condition. Increasing the storage period significantly enhanced the TSS. These findings were in agreement with those given by Alam *et al.,* 2013 who demonstrated that the increase in the value of total soluble solids (TSS) was due to the loss of water that takes place in fruit samples. Also, the hydrolysis of starch and other polysaccharides present in fruits converts into a soluble form of sugar during storage which ultimately increases the total soluble solids in the fruit samples. Pre-treatment of both commodities increased the TSS. For papaya, both samples CA and AC+CA demonstrated higher TSS values (8.6±0.00 and 8.4±0.12, respectively) as compared to control (8.0±0.17). This trend remains constant throughout storage. On the contrary, the TSS of pineapple samples treated with AC+CA (6.7±0.15) was significantly lower than control (7.3±0.06) whereas CA treated pineapple demonstrated the highest TSS (7.4±0.00). However, with increasing storage period the TSS of control was observed to drastically increased and much higher than the treated samples.

Titrable Acidity (TA)

The effects of different treatments on the titrable acidity in the case of papaya as well as pineapple are well displayed in Figure 2. The results revealed that the fruit samples undergone minimal processing packaged in PVC films possess a linear decreasing behavior during the storage period of both the fruits. This declining nature of acidity among both fruits may be due to the utilization of organic acids in the form of respiratory substrates during the storage period of fruits at refrigerated conditions as well as the conversion of the acids present in the fruits into sugars (Jayathunge *et al.,* 2012).

Sensory Analysis

Sensory characteristics of fresh and minimally processed fruits play a very crucial role in determining the overall quality of the finished products including their appearance, texture, flavor, nutritional value, and safety (Table 3). The overall quality of fruits is usually assessed through the variety of plants, their ripening or maturitystage,along their harvesting condition. All of these factors undergo some fluctuations during thepostharvest storage. The results of the sensory analysis revealed that the acceptability of fresh-cut fruits during the initial period of storage was higher in comparison with the fruits (papaya and pineapple) stored for 8 days in terms of their color, texture, odor, and overall acceptability (Table 4). According to the results, all the pretreated fruit samples along with the control fruits sample possess acceptable sensory scores with no significant difference among them till the duration of 8days of storage. Thus, the minimally processed papaya and pineapple can be packaged in polystyrene bowls using PVC films at 4ºC for 8 days without any changes in the sensory attributes.

Jayathunge *et al.,* (2012) also conductedastudy in which they analyzed the shelf life of fruit salad prepared by using three fruits i.e. papaya, pineapple, and mango based on their physicochemical, sensorial, and microbiological analysis. The fruit salads were stored at low temperatures for 16 days in PVC containers and the sensory characteristics of the fruit salad during 16days of the storage period were compared with the fresh fruit salad. And according to the results of sensory evaluation, mango products can be stored in PVC containers with 15 micro-perforations for the duration of 16days at a temperature of 7±1ºC without any significant difference among the sensory attributes.

Also, Arganosa *et al.,* (2008) experimented to analyze the shelf life of papaya based on its physicochemical, sensorial, and microbiological analysis. The papaya samples were analyzed based on their different shapes which include cube-shaped, cylinder-shaped, parallel piped shaped, and sphere shaped and stored at 4ºC with a duration of 10 days. The results of the sensory evaluation showed an acceptable score for the minimally processed papaya at 4ºC up to 10days.

Microbiological Analysis

According to legal regulations, the maximum recommended limits for ready-to-eat fresh-cut minimally

Table 1. Pre-treatments conditions

S.No.	Commodity	Pre-treatment condition
1.	Papaya	No pre-treatment
		Dipped in 1000ppm citric acid solution for 2-3 minutes (CA)
		Dipped in mixture of 150ppm ascorbic acid and 1000ppm citric acid solution for 2-3 minutes (AC+CA)
2.	Pineapple	No pre-treatment
		Dipped in mixture of1%sodiumchlorideand1% calcium chloride solution for 2-3 minutes (SC+CC)
		Dipped in mixture of 150ppm ascorbic acid and 1000ppm citric acid solution for 2-3 minutes (AC+CA)

Table 2: TSS of Papaya and Pineapple (in o Bx)

Treatments	0th day	4th day	8th day
Papaya			
Control	$8.0\pm0.17^{c}_{r}$	$8.3\pm0.06^{b}_{r}$	$11.4\pm0.10^{a}_{r}$
CA	$8.6\pm0.00^{c}_{p}$	$8.8\pm0.06^{b}_{p}$	$12.1\pm0.17^{a}_{p}$
AC + CA	$8.4\pm0.12^{c}_{q}$	$8.5\pm0.10^{b}_{q}$	$11.9\pm0.00^{a}_{q}$
Pineapple			
Control	$7.3\pm0.06^{c}_{q}$	$11.4\pm0.10^{b}_{p}$	$11.9\pm0.06^{a}_{p}$
SC+CC	$7.4\pm0.00^{c}_{p}$	$11.0\pm0.10^{b}_{q}$	$11.2\pm0.06^{a}_{q}$
AC + CA	$6.7\pm0.15^{c}_{r}$	$10.4\pm0.12^{b}_{r}$	$11.0\pm0.00^{a}_{r}$

Values are given in mean ± SD (n=3); Samples with similar superscript (a-c) and subscript (p-r) among columns and rows, respectively, indicates non-significant differences ($p\leq0.05$).

Table 3: Quality Factors and their Parameters (Lin *et al.,* 2007)

Quality factor	Parameters
Appearance	Size, Shape, Color: intensity, uniformity, Gloss, Defects
Texture(mouth-feel)	Firmness/softness, Crispness, Juiciness, Toughness(fibrousness)
Flavor(taste,aroma)	Sweetness, Acidity, Astringency, Bitterness, Volatile compounds
Nutritional value	Vitamins, Minerals
Safety	Toxic substances, Chemical contaminants, Microbial contamination

processed products for total plate count enumeration method is 7.7log10CFU/g (Francis *et al.,*1999) andthe maximum recommended limit for ready-to-eat fresh-cut minimally processed products for yeast and mold counte numeration method is 5 log 10 CFU/g (Aida *et al.,* 2007; Ediriweera1 *et al.,* 2012).

Total plate count (TPC)

Results summarized in Table 5 revealed that thetotal platecount of papaya fruit samples varied from1-4 log10CFU/g, 2-6 log10CFU/g, and3-8log10CFU/gon day0, 4, and 8, respectively.Whereas in the case of pineapple, the total plate count varied from1-4log10CFU/g,2-6log10CFU/g, and4-7log10CFU/gonday 0, 4, and 8, respectively. It was observed that the total

Table 4: Sensory Analysis of Papaya and Pineapple samples

Treatments	0th day	4th day	8th day
Papaya			
Control	$7.00\pm0.00^{a}_{p}$	$6.33\pm1.15^{a,b}_{p}$	$5.33\pm1.15^{b}_{p}$
CA	$6.67\pm0.58^{a}_{p}$	$6.67\pm0.58^{a}_{p}$	$5.67\pm0.58^{a}_{p}$
AC+CA	$7.00\pm0.00^{a}_{p}$	$7.00\pm0.00^{a}_{p}$	$5.67\pm1.15^{b}_{p}$
Pineapple			
Control	$7.00\pm0.00^{a}_{p}$	$5.67\pm1.53^{a,b}_{p}$	$4.33\pm1.15^{b}_{p}$
SC+CC	$6.67\pm0.58^{a}_{p}$	$6.33\pm0.58^{a}_{p}$	$4.67\pm1.53^{a}_{p}$
AC+CA	$7.00\pm0.00^{a}_{p}$	$6.33\pm1.15^{a,b}_{p}$	$4.67\pm1.53^{b}_{p}$

Values are mean ± SD. Values in columns with different superscripts and rows with different subscripts are significantly ($p\leq0.05$) different.

Table 5: Total Plate Count (log10 CFU/g) of Papaya and Pineapple samples

Treatments	0th day	4th day	8th day
Papaya			
Control	$4.0\pm1.00^{b}_{p}$	$6.0\pm1.00^{a,b}_{p}$	$8.0\pm1.00^{a}_{p}$
CA	$3.0\pm1.00^{b}_{p}$	$3.0\pm1.00^{b}_{q}$	$6.0\pm1.00^{a}_{p}$
AC+CA	$1.0\pm0.00^{a}_{q}$	$2.0\pm1.00^{a,b}_{q}$	$3.0\pm1.00^{a}_{q}$
Pineapple			
Control	$4.0\pm1.00^{b}_{p}$	$6.0\pm1.00^{a,b}_{p}$	$7.0\pm1.00^{a}_{p}$
SC+CC	$2.0\pm1.00^{b}_{p,q}$	$4.0\pm1.00^{a,b}_{p,q}$	$6.0\pm1.00^{a}_{p,q}$
AC+CA	$1.0\pm0.00^{b}_{q}$	$2.0\pm1.00^{a,b}_{q}$	$4.0\pm1.00^{a}_{q}$

Values are given in mean ± SD (n=3); Samples with similar superscript (a-c) and subscript (p-r) among columns and rows, respectively, indicates non-significant differences ($p\leq0.05$).

Table 6: Yeast and Mould Count (log10 CFU/g) of Papaya and Pineapple samples

Treatments	0th day	4th day	8th day
Papaya			
Control	$4.0\pm1.00^{a}_{p}$	$4.0\pm1.00^{a}_{p}$	$5.0\pm1.00^{a}_{p}$
CA	$3.0\pm1.00^{a}_{p,q}$	$3.0\pm1.00^{a}_{p,q}$	$4.0\pm1.00^{a}_{p,q}$
AC+CA	$2.0\pm1.00^{a}_{q}$	$2.0\pm1.00^{a}_{q}$	$3.0\pm1.00^{a}_{q}$
Pineapple			
Control	$4.0\pm1.00^{b}_{p}$	$5.0\pm1.00^{a,b}_{p}$	$6.0\pm1.00^{a}_{p}$
SC+CC	$2.0\pm1.00^{b}_{p,q}$	$4.0\pm1.00^{a,b}_{p,q}$	$5.0\pm1.00^{a}_{p,q}$
AC+CA	$1.0\pm0.00^{b}_{q}$	$2.0\pm1.00^{a,b}_{q}$	$3.0\pm1.00^{a}_{q}$

Values are given in mean ± SD (n=3); Samples with similar superscript (a-b) and subscript (p-q) among columns and rows, respectively, indicates non-significant differences ($p\leq0.05$).

plate count was increased in all the treatments by day 8 of the storage period and during the 8th day, control samples showed the highest plate count of8log10 CFU/g in papaya samplesand7log10 CFU/g in pineapple samples.

Yeast and Mould Count (YMC)

Table 6 revealed that the yeast and mold count enumerated for papaya varied from 2-4 log10 CFU/g, 2-4 log10 CFU/g, 3-5 log10 CFU/g on day 0, 4, and 8, respectively. Whereas in the case of pineapple, the yeast and mold count varied from 1-4 log10 CFU/g, 2-5 log10 CFU/g, 3-6 log10 CFU/g on day 0, 4, and 8. During the 8th day, control samples showed the highest total plate count of 5 log10 CFU/g in papaya and 6 log10 CFU/g in pineapple.

CONCLUSION

Rapid urbanization, decreasing joint family system, increasing number of working women in society, and rise in the income of people, lead to the change in lifestyle and demand patterns. And now the modern customer is demanding more healthy, fresh, and natural ready-to-eatfoods and this can be achieved through minimally processed food products. Minimally processed products are popular because of their ease of consumption and their nutritional content but on the other hand, they are highly perishable. In treated samples, no significant difference between the sensory attributes among papaya and pineapple was observed. The total soluble solids (TSS) increased during the storage period in both fruits. Whereas the titrable acidity reduced in both the samples during the storage period. Pre-treating of both the fruits (papaya and pineapple) with 150 ppm ascorbic acid and 1000 ppm citric acid results in a decreased value of total plate countas well as yeast and mold count. It is concluded that pretreatmen tof papaya and pineapple in a combination of 150 ppm ascorbic acid and 1000 ppm citric acid solution, for 2-3minutes and packaged in polystyrene bowls using PVC films is effective to enhance the storage stability or shelf-life of fresh-cut minimally processed fruits, i.e., papaya and pineapple stored at refrigerated conditions at 4ºC for 8 days.

ACKNOWLEDGMENT

The senior author would like to express sincere gratitude to Dr. BalaramPani, Principal, Bhaskaracharya College of Applied Sciences, University of Delhi for the research facilities provided, which relates to the Dissertation submitted in partial fulfilments for the degree, B.Tech Food Technology, Department of Food Technology, Bhaskaracharya College of Applied Sciences, Dwarka, New Delhi, India.

AUTHOR CONTRIBUTIONS

Rizwana and Ruchi Sharma conceived the study. Rizwana, EramRao, and Aparna Agarwal guided and assisted in the manuscript preparation. Tanya LuvaSwer helped in the preparation of the manuscript and statistical analysis of the recorded data. Ruchi Sharma wrote the manuscript. Rizwana supervised the recording of experimental data. All the authors approved the manuscript.

REFERENCES

Ahvenainen, R. (1996). New approaches in improving the shelf life of minimally processed fruit and vegetables. *Trends in Food Science & Technology*, *7*(6), 179-187.

Alam, M. S., Kaur, B., Gupta, K., & Kumar, S. (2013). Studies on refrigerated storage of minimally processed papaya (Carica papaya L.). *Agricultural Engineering International: CIGR Journal*, *15*(4), 275-280.

Antoniolli, L. R., Benedetti, B. C., Souza Filho, M. D. S. M. D., Garruti, D. D. S., & Borges, M. D. F. (2012). Shelf life of minimally processed pineapples treated with ascorbic and citric acids. *Bragantia*, *71*(3), 447-453.

Argañosa, A. C. S., Raposo, M. F. J., Teixeira, P. C., &Morais, A. M. (2008).Effect of cut-type on quality of minimally processed papaya. *Journal of the Science of Food and Agriculture*, *88*(12), 2050-2060.

Artes, F., & Allende, A. (2014).Minimal processing of fresh fruit, vegetables, and juices.In *Emerging technologies for food processing* (pp. 583-597).Academic Press.

Baldwin, D. A. (1995).Understanding the link between joint attention and language. *Joint attention: Its origins and role in development*, *131*, 158.

Ediriweera, S., Abeywickrama, K., &Latifah, M. (2012). Effect of chemical pretreatments on the quality of minimally processed pineapple stored in polystyrene packages. *Ceylon Journal of Science (Bio. Sci.)*, *41*(2), 151-155.

FDA, (1998).Code of Federal Regulations Title-21, Food and Drugs, Part 101 Food Labelling, part 95.Silver Spring, *U.S. Food and Drug Administration.*

Francis, G. A., Thomas, C., &O'beirne, D. (1999).The microbiological safety of minimally processed vegetables. *International Journal of Food Science & Technology*, *34*(1), 1-22.

Garret E., (1994). Challenges and Opportunities in Marketing Fresh-cut Produce in Modified Atmosphere Food Packaging (Brady, A.L., ed.). *Institute of Packaging Professionals*, Herndon, VA, USA, (pp. 31-34).

Glas.AnBord, (2002). Available from http://www.bordglas.ie/facts/production.htm. Accessed 04.04.04

GONÇALVES, N.B., (2000). Pineapple: postharvest. *Brasília: Embrapa-SCT*. 45p.

Jayathunge, K. G. L. R., Fazy, M. R., Illeperuma, D. C. K., Thilakarathne, B. M. K. S., Fernando, M. D., &Palipane, K. B. (2012). Suitability of micro-perforated PVC containers for modified atmosphere packaging of minimally processed fruit salad containing pineapple, papaya and mango. As. J. *Food Ag-Ind*, *5*(06), 554-566.

Latifah, M. N., Abdullah, H., Selamat, M. M., Habsah, M., Talib, Y., Rahman, K. M., & Jabir, H. (2000).Shelf life of minimally processed pineapple. *Journal of Tropical Agriculture and Food Science*, *28*(1), 79-85.

Lin, D., & Zhao, Y. (2007).Innovations in the development and application of edible coatings for fresh and minimally processed fruits and vegetables. *Comprehensive reviews in food science and food safety*, *6*(3), 60-75.

Martin-Diana, A. B., Rico, D., Frias, J. M., Barat, J. M., Henehan, G. T. M., & Barry-Ryan, C. (2007). Calcium for extending the shelf life of fresh whole and minimally processed fruits and vegetables: a review. *Trends in Food Science & Technology*, *18*(4), 210-218.

Nur Aida, M. P., Zaulia, O., Hairiyah, M., Che Omar, D., &Habsah, M. (2007).Effect of washing treatment on microbial and sensory of mung bean sprouts. In *Proceedings of the National Horticulture Conference 2007, Malaysia* (pp. 283-288).

Ponce, A. G., Roura, S. I., del Valle, C. E., & Moreira, M. R. (2008). Antimicrobial and antioxidant activities of edible coatings enriched with natural plant extracts: in vitro and in vivo studies. *Postharvest biology and technology*, *49*(2), 294-300.

Ranganna, S. (1986). *Handbook of analysis and quality control for fruit and vegetable products*.Tata McGraw-Hill Education.

Rivera-López, J., Vázquez-Ortiz, F. A., Ayala-Zavala, J. F., Sotelo-Mundo, R. R., & González-Aguilar, G. A. (2005). Cutting shape and storage temperature affect overall quality of fresh-cut papaya cv.'Maradol'. *Journal of food science*, *70*(7), s482-s489.

Rolle, R. S., & CHISM III, G. W. (1987).Physiological consequences of minimally processed fruits and vegetables. *Journal of Food Quality*, *10*(3), 157-177.

Sankat, C. K. and R. P. Maharaj.(1997). Postharvest physiology and storage of tropical and subtropical foods.In *Mitra SK, editor, New York,* 167–189.

Shahnawaz, M., Wali, A., &Abbass, S. (2013). A Study on the Shelf Life of Minimally Processed Apple with Edible Coatings. *Chem. J*, *1*(1), 20-22.

Shanky, B. (2013).Minimal processing and preservation of fruits and vegetables by active packaging. *International Journal of Herbal Medicine*, *1*(2), 131-138.

Wiley RC, (1994).Minimally Processed Refrigerated Fruits and Vegetables.*Chapman & Hall.*

Xu, S., Da Xu, L., & Chen, X. (2003).Determining optimum edible films for kiwifruits using an analytical hierarchy process. *Computers & Operations Research*, *30*(6), 877-886.