Ceylon Journal of Science (*Bio. Sci.*) 41 (2): 151-155, 2012

SHORT COMMUNICATION

Effect of Chemical Pretreatments on the Quality of Minimally Processed Pineapple Stored in Polystyrene Packages

S. Ediriweera[1], K. Abeywickrama[1]* and M. Latifah[2]

[1] Department of Botany, University of Kelaniya, Sri Lanka
[2] Horticulture Research Centre, Malaysian Agricultural Research and Development Institute (MARDI), Serdang, Malaysia
Accepted 11 December 2012

ABSTRACT

Minimally processed pineapple (*Ananas comosus* L.) cv. Mauritius stored at cold temperature for seven days were evaluated for physicochemical, sensory and microbiological qualities. Pineapple pieces were treated with 1% sodium chloride, 1% calcium chloride, a combination of 1% sodium chloride and calcium chloride, 1% ascorbic acid, 1% citric acid, 0.1% chitosan and distilled water (control) and packed in polystyrene packages before storage. Pretreatments did not significantly affect the physicochemical properties studied. Many sensory attributes in minimally processed pineapple decreased after seven days of storage. However, sodium chloride (1%) and a combination of 1% sodium chloride and calcium chloride pretreatments resulted in maintaining a better flavour in pineapple after a seven day storage period than the rest of the treatments. Microbial counts for all treatments and the control were within safe-to-consume limits while *Salmonella* was not detected in any sample.

Keywords: physicochemical properties, sensory properties, microbial content, Mauritius pineapple

INTRODUCTION

Minimal processing technology involves cleaning, washing, trimming, coring, slicing and shredding of fruits and vegetables. This technology provides an advantage to the user since it renders the fruits 'ready-to-eat' (Dharmabandu *et al*., 2007). Fresh cut pineapple has a marked additional advantage of weight reduction for transport, since bulky inedible crown and peel tissues are removed (Budu and Joyce, 2003). However, minimal processing of fruits and vegetables may increase their perishability (Dharmabandu *et al*., 2007) and therefore, stabilization is usually required with minimally processed food. Hence, food processing techniques are widely used to stabilize the products and extend the storage and shelf life of fruits and vegetables (Dharmabandu *et al*., 2007).

One major drawback of minimal processing of fresh fruits and vegetables is the occurrence of undesirable physiological changes in them. Loss of cellular integrity at the cut surface of the fruits or vegetables prevents compartmentalization of enzymes and substrates. Senescence may accelerate and off flavour may develop due to increased ethylene production and respiration near the cut surface. The exudates from the cut surface are also a favorable medium for growth of fungi and bacteria (Latifah *et al*., 1999). To overcome such undesirable physiological changes, cut produce are immersed in chemical solutions (as a pretreatment) at the final stage of the handling operations.

Thus, pretreatment is not only a way of extending shelf-life and visual appearance of food, but a way to rinse off enzymes and substrates released by disrupted cells, thus reducing microbial spoilage, excessive tissue softening and tissue browning (Hui *et al*., 2006).

Chemical pretreatments are reported as helpful in lengthening the shelf life in minimally processed fruits such as *Solanum surattense* (Dharmabandu *et al*., 2007). Budu and Joyce (2003) have used 1-methylcyclopropene treatment which reduced the rate of respiration and browning and maintained more acceptable visual quality in fresh cut pineapple stored at 4.5

*Corresponding author's email: kris@kln.ac.lk

^{o}C for 12 days. Fresh pineapple contains citric acid as the major organic acid which may act as a natural pretreatment once it is minimally processed. However, the possibility of using other chemicals for minimal processing of pineapple is needed to be investigated.

The aim of this study was to investigate whether pretreatment is necessary for processed pineapple and to detect the physicochemical, sensory and microbiological properties of minimally processed pineapple subjected to pretreatments with sodium chloride, calcium chloride, a combination of sodium chloride and calcium chloride, ascorbic acid, citric acid and chitosan followed by storage at 5-7 ^{o}C for over seven days.

MATERIALS AND METHODS

Preparation of pineapple samples

Pineapple (*Ananas comosus* L.) cv. Mauritius, at quarter ripe stage, of which about 25% of the eyes were yellowish orange (Latifah *et al.*, 2000), was purchased from retail outlets in Balummahara, Sri Lanka and transported to the laboratory at the Department of Botany, University of Kelaniya. Shells of fruits were removed and samples were washed in distilled water and thereafter, dipped in chilled distilled water for 2 minutes. Pineapple was cut into cubes (2x2x2 cm^3) using a sharp stainless steel knife under aseptic conditions. Cubes were separately dipped in pretreatment solutions, *i.e.*, 1% (w/v) sodium chloride (T_1), 1% (w/v) calcium chloride (T_2), a combination of 1% (w/v) sodium chloride and 1% (w/v) calcium chloride (T_3), 1% (w/v) ascorbic acid (T_4), 1% (w/v) citric acid (T_5), 0.1% (w/v) chitosan (T_6), and distilled water (T_7 – control experiment) for 2-3 minutes. Samples were drained and air dried for 10 minutes and cubes (8-12) were packed in polystyrene packages of 150 g capacity and fastened with clip-on lids (Latifah *et al.*, 2000). Four replicate packages were used for each treatment. All packages were placed on plastic trays of 30×40 cm (8 packages per tray) and stored in a cold room under 5-7 ^{o}C and 80-85% relative humidity.

Determination of physicochemical properties

Samples were removed on day 0, 4 and 7 and subjected to physicochemical analyses. The pineapple sample (10 g) was homogenized with distilled water (40 ml) in a blender (Black & Decker, BX 250, Hunt Valley, USA) for 2 minutes. The homogenate was filtered through a muslin cloth. Few drops of the filtrate were used to measure total soluble solids (TSS) using a hand-held Refractometer (ATAGO Co. Ltd., Japan). The actual TSS content was calculated by multiplying each reading with the dilution factor (Abeywickrama *et al*., 2004). Four replicate samples were used per treatment. Titratable acidity (TA) was detected by taking a 10 ml samples from each prepared filtrate which was diluted with 20 ml distilled water and titrated against 0.1 M NaOH with phenolphthalein as the pH indicator (Abeywickrama *et al*., 2004). TA was calculated by multiplying the NaOH volume by the dilution factor and the citric acid factor (citric acid factor = 0.0064 g). TA was expressed as % citric acid. pH of the filtrates was measured using a Digital pH meter (Hanna Instruments, Portugal). Four replicate samples were used per treatment.

Assessment of sensory properties

Samples were subjected to sensory evaluation on day 0 and 7 by serving in randomly chosen 10 member taste panel along with a questionnaire. Sensory evaluation for appearance, colour, odour, flavour, taste and overall acceptability was done using a 7 point ranking system.

Determination of microbiological properties

Pineapple samples removed on 0 and 7 days after storage were subjected to microbiological assessment.

Total aerobic plate count

Twenty grams of pineapple was homogenized with sterile 0.9% NaCl (180.00 ml) in a blender for 2 minutes and a dilution series was prepared up to 10^{-5}. One ml aliquots from 10^{-3}, 10^{-4} and 10^{-5} dilutions were plated with 12 ml of molten plate count agar (PCA) in duplicate, incubated at 28±2 ^{o}C for 72 hours and the number of bacterial colonies was counted. The colony forming units (CFU) were determined using the equation described by Sri Lanka Standard 516: Part 1 (1991). Eight replicate samples were used per each treatment.

Determination of yeast and mould count

One ml aliquots from above 10^{-3}, 10^{-4} and 10^{-5} dilutions which were used for enumerating total aerobic plate count were separately plated along with 12 ml of molten yeast and mould agar (YMA) in duplicate. Plates were incubated at 28±2 ^{o}C for 72 hours and CFU were determined (Aida *et al*., 2007). Eight replicate samples were used per treatment.

Detection of *Salmonella*

A 2 g sample of pineapple from each treatment on day 0 and 7 was separately added to flasks containing 20 ml of Selenite broth and incubated at 37 ^{o}C for 24 hours. A loopful from each treatment was sub-cultured onto MacConkey agar medium in duplicate. Plates were incubated at 37 ^{o}C and examined for the presence of colourless colonies after 24 hours. (Rall *et al*., 2005). Four replicate samples were used per treatment.

Experimental design and analysis

All experiments were arranged in completely randomized designs (CRD). The data were analyzed using MINITAB 14 statistical program. Data obtained for sensory properties were subjected to Kruskal Wallis non-parametric statistical test whereas the data for physicochemical properties and microbial contents were analyzed by one-way ANOVA. Mean separation was performed using Tukey's multiple comparison test.

RESULTS AND DISCUSSION

Studied physicochemical parameters (*i.e*., TSS, pH and TA) showed a little variation among experimental treatments. However, these variations were not statistically significant (p>0.05, Table 1). Although, the fruits of similar maturity status were selected for this study, there could be slight variations in their maturity status which might have resulted in slight variations in post harvest behaviour of fruits in different treatments.

A slight variation in pH of the extracts was observed with time but the values remained within 4-5 pH range (Table 1). In general, pH is dependent on both total quantity and strength of acids present in fruits (Schmidl and Labuza, 2000) and variations of these over time may be the reason for this change with time. However, pH of extracts were not significantly different among treatments within the same day (p>0.05). TSS content in pineapple extracts in all treatments varied from 11.50-14.88 ^{o}Brix throughout the storage period . In all treatments, TA values varied from 0.59-0.78% citric acid and maintained within this range throughout the storage period (Table 1). The highest acidity level (0.78%) was recorded in samples pretreated with citric acid by day 7. However, there was no significant difference in TA among the different treatments within the same day (Table 1), indicating the low usage of organic acids and slow senescence process in pineapple irrespective of the chemical treatment.

Our results indicate that the sensory attributes are acceptable in all pretreated samples and in the control even after 7 days (ranked 'neither good nor bad' by taste panelists). However, a decrease in all the sensory attributes was evident after the 7-day storage period in all experimental treatments except in sodium chloride treated and sodium chloride + calcium chloride treated samples. Overall acceptability of pineapple varied among treatments from 5.75-6.44 on day 0 whereas it declined to 4.00-5.38 by day 7. The highest overall acceptability (5.38) was recorded for sodium chloride treated and sodium chloride + calcium chloride treated pineapple on the 7th day while the lowest value of 4.00 was recorded for the control.

Moreover, treating with a combination of sodium chloride and calcium chloride may give added advantages of reducing microbial growth. According to Hui *et al*., (2006), when sodium chloride and calcium chloride are incorporated as a pretreatment, resulting high osmotic pressure may lead to dehydration and plasmolysis of microbial cells and inhibition of their growth. The chloride ion is toxic to microbes and therefore, sodium chloride and calcium chloride concentrations between 1-4% are commonly used as pretreatments (Hui *et al*., 2006).

The total plate count (TPC) enumerated varied from 4.76 – 5.08 $\log_{10}$ CFU/g on day 0 and 4.74 – 5.38 $\log_{10}$ CFU/g by day 7. Total plate count has increased by day 7 in all treatments except in ascorbic acid and chitosan treatments where the bacterial growth was controlled to a certain extent. During the 7th day after storage, the highest total plate count of 5.40 $\log_{10}$ CFU/g was observed in the control and the lowest plate count of 4.74 $\log_{10}$ CFU/g was observed for ascorbic acid treated samples. However, there were no significant differences in TPC among pretreatments and control samples within the same day. The yeast and mould count (YMC) in extracts varied from 1.89- 4.38 $\log_{10}$ CFU/g from day 0 to 7 which also indicated no statistically significant difference among all treatments within the same day. The yeast and mould count in ascorbic acid treated samples was slightly low on 7th day, compared to value of day 0. Yeast and mould count of 4.38 $\log_{10}$ CFU/g was observed for the control on the 7th day after storage and this was a little higher than in other treatments.

Table 1. Effects of different pretreatments on physico-chemical characteristics of minimally processed pineapple cv. Mauritius.

Storage time (days)	Treatment						
	T_1	T_2	T_3	T_4	T_5	T_6	T_7
				TSS (^{0}Brix)			
0	$13.13^a \pm 0.55$	$12.75^a \pm 0.66$	$13.13^a \pm 0.77$	$14.13^a \pm 0.52$	$12.50^a \pm 0.35$	$14.50^a \pm 0.29$	$12.38^a \pm 0.63$
4	$14.25^{ab} \pm 0.95$	$13.25^{ab} \pm 0.83$	$14.63^{ab} \pm 0.69$	$13.38^{ab} \pm 0.69$	$11.75^a \pm 0.66$	$13.25^{ab} \pm 0.43$	$14.88^b \pm 0.24$
7	$14.00^a \pm 0.71$	$13.50^a \pm 0.65$	$13.88^a \pm 1.26$	$13.50^a \pm 0.65$	$11.50^a \pm 0.65$	$12.38^a \pm 0.24$	$12.38^a \pm 1.13$
				pH			
0	$4.25^a \pm 0.21$	$4.23^a \pm 0.16$	$4.25^a \pm 0.20$	$4.83^a \pm 0.18$	$4.83^a \pm 0.25$	$5.00^a \pm 0.23$	$4.68^a \pm 0.31$
4	$4.08^a \pm 0.19$	$4.05^a \pm 0.21$	$4.18^a \pm 0.22$	$4.75^a \pm 0.21$	$4.85^a \pm 0.20$	$4.88^a \pm 0.25$	$4.60^a \pm 0.33$
7	$4.10^a \pm 0.23$	$4.15^a \pm 0.20$	$4.15^a \pm 0.26$	$4.85^a \pm 0.18$	$4.95^a \pm 0.20$	$4.98^a \pm 0.18$	$4.70^a \pm 0.35$
				Titratable acidity (% Citric acid)			
0	$0.66^a \pm 0.02$	$0.62^a \pm 0.05$	$0.59^a \pm 0.04$	$0.70^a \pm 0.19$	$0.71^a \pm 0.07$	$0.60^a \pm 0.08$	$0.60^a \pm 0.05$
4	$0.74^a \pm 0.05$	$0.69^a \pm 0.03$	$0.65^a \pm 0.08$	$0.78^a \pm 0.03$	$0.75^a \pm 0.05$	$0.78^a \pm 0.04$	$0.66^a \pm 0.07$
7	$0.66^a \pm 0.03$	$0.67^a \pm 0.04$	$0.77^a \pm 0.07$	$0.76^a \pm 0.04$	$0.78^a \pm 0.03$	$0.75^a \pm 0.03$	$0.70^a \pm 0.03$

T_1 - 1% (w/v) Sodium chloride, T_2 - 1% (w/v) Calcium chloride, T_3 - 1% (w/v) Sodium chloride + 1% (w/v) Calcium chloride, T_4 - 1% (w/v) Ascorbic acid, T_5 - 1% (w/v) Citric acid, T_6 - 0.1% (w/v) Chitosan, T_7 - Distilled water (control)
Each data point represents the mean of four replicates ± standard error.
Means sharing a common letter (s) within the same row are not significantly different according to Tukey's multiple comparison test.

The microbial counts reported in this study were well within the accepted 'safe-to-consume' limits. The legal regulations on minimally processed fresh vegetables have been established at a maximum total limit for total plate count of 7.7 $\log_{10}$ CFU/g (Francis *et al*., 1999) and the recommended limit for total yeast and mould count of fresh cut produce is 5 $\log_{10}$ CFU/g (Aida *et al*., 2007). Furthermore, *Salmonella* was not detected in any of the treatments or in the control set either on day 0 or 7.

CONCLUSION

Chemical pretreatments have not significantly affected the physicochemical and microbiological properties of pineapple at day 0 or after a seven-day storage period. Moreover, the microbial counts did not exceed the recommended values by day 7. Hence, all chemically treated and untreated final products could be considered as safe-to-consume. However, after seven days, the flavor of pineapple treated with 1% sodium chloride or a combination of 1% sodium chloride and 1% calcium chloride was found to be higher than that in the control and other chemical treatments. Thus, it is recommended to use either 1% sodium chloride or a combination of 1% sodium chloride and 1% calcium chloride if processed pineapple is stored for seven days.

ACKNOWLEDGEMENTS

We acknowledge the financial assistance given by the University of Kelaniya, Sri Lanka (Research grant: RP/03/02/01/01/2009).

REFERENCES

Abeywickrama, K., Kularathna, L., Sarananda, K. and Abeygunawardena, D. (2004). *Cymbopogon citratus* (lemongrass) and citral a+b spray treatments alone or in combination with sodium bicarbonate in controlling crown rot in Embul banana (*Musa acuminata* AAB). *Tropical Agricultural Research and Extention* **7**: 104-111.

Aida, M.P.N., Zaulia, O., Hairiyah, M., Che Omar, D. and Habsah, M. (2007). Effect of washing treatment on microbial changes and

sensory of mung bean sprouts. *Proceedings of the National Horticulture Conference, Malaysia*, Pp. 283-288.

Budu, A.S. and Joyce, D.C. (2003). Effect of 1-methylcyclopropane on the quality of minimally processed pineapple fruit. *Australian Journal of Experimental Agriculture* **43**: 177-184.

Dharmabandu, P.T.S., De Silva, S.M., Wimalasena, S., Wijesinghe, W.A.J.P. and Sarananda, K.H. (2007). Effect of pre-treatments on extending the shelf life of minimally processed "Ela Batu" (*Solanum surattense*). *Tropical Agricultural Research and Extension* **10**: 61-66.

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

Hui, Y. H., Barta, J., Cano, M.P., Gusek, T., Sidhu, J.S. and Sinha, K.S. (2006). *Handbook of Fruits and Fruit Processing*. Blackwell publishers, USA, Pp. 115-124.

Latifah, M.N., Abdulla, H., Selamat, M.M., Talib, Y. and Rahman, K.M. (1999). Quality evaluation of minimally processed pineapple using two packing systems. *Journal of Tropical Agriculture and Food Science* **27**(1): 101-107.

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

Rall, V. L. M., Rall, R., Argon, L. C. and Silva, M. G. (2005). Evaluation of three enrichment broths and five plating media for *Salmonella* detection in poultry. *Brazilian Journal of Microbiology* **36**: 147-150.

Schmidl, M.K. and Labuza, T.P. (2000). *Essentials of functional foods*. Aspen Publishers Inc., USA, Pp. 108.

Sri Lanka Standard 516: Part 1 (1991). General guidance for enumeration of microorganisms, colony count technique at 30 ^{o}C. *Microbiological test methods, Sri Lanka Standards Institution, Sri Lanka.*