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Quality and Shelf Life Evaluation of Minimally Processed Papaya Using Chemical Pretreatments

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ABSTRACT

A study was conducted to evaluate the best chemical treatment to enhance the quality and shelf life of minimally processed papaya .The papaya fruits sliced into cubes and were treated with different combinations of anti browning and anti softening chemicals viz., Calcium chloride and Citric acid . The result revealed that the least physiological loss in weight was observed in the cubes treated by calcium chloride 2% + citric acid 5% and the maximum weight loss was recorded in control. Besides, the mean loss in weight increased from 4th day to 12th day of storage but enormously between 8th and 12th day of storage. Further, the chemical pretreatments significantly improved the quality characters of the minimally processed papaya cubes. The mean values of sugars, ascorbic acid, total carotenoids and organoleptic score were highest in the cubes treated with calcium chloride 2% + citric acid 5%.. The minimum browning of the cubes was also noticed in pretreatments with 2% of calcium chloride + 5% of citric acid. The microbial count was found to be at highest on 12th day in the control samples whereas those treated by the above combination of chemicals recorded least microbial count on the same day among all the treatments. Similarly maximum shelf life (14.70 days) was obtained with the cubes treated with calcium chloride 2% + citric acid 5% whereas the lowest shelf life was recorded by the untreated control samples.

Key word: *Papaya, Shelf-life, Calcium chloride, Citric acid, Browning*

INTRODUCTION

Papaya (*Carica papaya* L.) belongs to the family of caricaceae is an evergreen herbaceous commercial fruit crop of tropical and subtropical regions of the world. It has occupied a unique place in the diet of people worldwide because of striking nutritional, health benefits and medicinal value of fruits which are rich sources of carbohydrates, minerals and vitamins (Carotene, riboflavin, vitamin A and C). Ripe papaya fruits are used for table purpose. India ranks fourth among papaya producing countries in the world after Brazil, Thailand and Mexico. The crop is cultivated in an area of 1.38 lakh hectares with a production of 61.45 lakh tonnes[9]. Andhra Pradesh shares about 16 per cent of papaya production in the country.

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The state had a record of 19,910 hectares area under its cultivation with a production of 15,44,770 tonnes.

It is a common observation that because of extremely delicate nature of papaya fruits, heavy spoilage is of frequent occurrence before they reach consumers. In India the estimated loss of papaya is 10-25% in ripe and 5-10% in green fruits. Production of more fruits may not be always beneficial for a grower, but production of more long standing fruits becomes very important in the light of sustaining them in wholesome freshness for a prolonged period of time till it is purchased and consumed by the end users.

Increased demand for fresh papayas is met in the form of cubes as a morning breakfast for most of the people. Papaya cubes are treated with sanitizing agents, antioxidants and kept under low temperature to increase their storability[10]. Slicing the fruits into cubes and associated practices like cleaning, washing, trimming, coring and shredding of fruits and vegetables is termed as 'minimal processing'. This technology provides an advantage to the user since it renders the fruits 'ready-to-eat'. Fresh cut fruits have a marked additional advantage of weight reduction for transport, since bulky inedible crown and peel tissues are removed. However, minimal processing of fruits may increase their perishability. Chemical treatments were reported as helpful in extending the shelf life in minimally processed fruits so as to reduce the percentage of damage and maintain freshness for a reasonable duration/period, till it reaches consumer. Pretreatment with sanitizing and antioxidative agents is not only a way of extending shelf life and visual appearance of food but also rinse off enzymes and substrates released by disrupted cells, thus reducing microbial spoilage, excessive tissue softening and tissue browning[6]. In light of above the information, an experiment entitled "quality and shelf life evaluation of minimally processed papaya using chemical pretreatments" was conducted.

MATERIAL AND METHODS

The present investigation was carried out at College of Horticulture, Anantharajupeta, during the years 2013-14 and 2014-15. Anantharajupeta, which is located in the Rayalaseema region of Andhra Pradesh and situated at 13.98° N latitude and 79.40° E longitude. Full ripe papaya fruits were made into cubes of size 4 × 2 × 1 cm, were treated with sanitizing agent (Sodium hypochlorite @100 ppm dipped for 5 min.) and imposed with treatments (soaking for 30 s) and packed in polyethylene film. For each treatment ten packets each of 100 g material were used and were kept at 5^{o}C. The treatment consists of different combinations of anti browning and anti softening chemicals viz., Calcium chloride 1 %, Calcium chloride 2%, Citric acid 2.5% ,Citric acid 5% ,Calcium chloride 1% + Citric acid 2.5% ,Calcium chloride 1 % + Citric acid 5% ,Calcium chloride 2% + Citric acid 2.5% and Calcium chloride 2% + Citric acid 5% and a control. The storage life parameters viz, Physiological loss in weight, P^{H}, Acidity, Total soluble solids (°Brix), Reducing sugar, (%), Non Reducing sugars (%), Total Sugar (%), Ascorbic acid content (mg 100^{-1} g pulp), Total carotenoids , Lycopene content , Browning ,Organoleptic scoring and Spoilage were estimated. The microbes present in the minimally processed papaya slices were counted at 4^{th}, 8^{th} and 12^{th} day of its storage life. A Quebec colony counter was used to count the number of colonies. The number of colony forming units (CFU) per milliliter sample was calculated by dividing the number of colonies by the dilution factor multiplied by the amount of specimen sample added. Shelf life of cut cubes of papaya were expressed as the total number of days taken from fruit slicing to till it became unfit for consumption. The data was subjected to statistical analysis of variance technique as described in "Statistical procedure for Agriculture Research" by Gomez and Gomez[4].

RESULTS AND DISCUSSION

Physiological loss in weight of papaya cubes has recorded significant differences among the treatments, storage intervals and interactions (Table1). The physiological loss in weight was found to increase during the storage period in

minimally processed papaya from 4 days after storage (11.34%) to 12 days after storage (15.79%). The minimum weight loss (12.16%) was noticed in minimally processed papaya cubes treated with 2% of calcium chloride + 5% of citric acid which was on par with all the chemical treatments except calcium chloride 1% (14.90%) and untreated control (14.92%). The highest amount of reducing sugars (14.38%) , non-reducing sugars (0.94%) and total sugars (15.32%) (Table 1) were noticed in the minimally processed papaya cubes treated with 2% calcium chloride + 5% citric acid and the lowest amount of sugars was noticed in control .

However, there was not any significant difference was recorded with respect to percentages of total soluble solids (Table 2). During the storage period, the TSS were decreased from 14.17°B (4 days after storage) to 13.13 °B (12 days after storage). Among the treatments, the highest amount of TSS (15.29 °B) was noticed in papaya cubes treated with 2% calcium chloride + 5% citric acid (T_8) and the least amount of TSS (12.07 °B) was noticed in control. The sensory score (Table 2) was decreased during the storage period from 8.49 (4 days after storage) to 7.82 (12 days after storage). The maximum sensory score (9.03) was obtained by the minimally processed papaya cubes treated with 2% calcium chloride + 5% citric acid and the minimum score (7.11) was obtained by control.

There was a significant difference with respect to the content of ascorbic acid and total carotenoids content among different treatments, storage intervals and the interaction among them (Table 2). It is evident from the trends on the contents of sugars, ascorbic acid and carotenoids that the treatment with 2% calcium chloride + 5% citric acid (T_8) resulted in better protection of sugars and other quality constituents as evident from the lesser decay in these during the course of storage. This could be attributed to the reason that these antibrowning and anti softening chemicals could maintain better cellular integrity, keep respiration and activity of oxidising enzymes at lower level and were successful in postponing the decay or delaying it thus maintaining the levels of quality constituents over an extended period of time in the cut cubes of papaya. Similar treatment with chemicals was found to increase quality parameters of minimally processed products from cabbage[2] mango[4] and Chestnut[7].

There was significant differences with respect to the shelf life of different treatments (Table 3). The maximum shelf life (14.70 days) was attained by the minimally processed papaya cubes treated with 2% of calcium chloride + 5% citric acid (T_8) which was on par with the papaya cubes treated with 2% calcium chloride + 2.5% citric acid (T_7) (14.60 days), the papaya cubes treated with 1% calcium chloride + 5% citric acid (T_6) (14.03 days) and the papaya cubes treated with 1% calcium chloride + 2.5% citric acid (T_5) (13.94 days). The minimum shelf life (7.45 days) was attained by control (T_9).

The occurrence of undesirable physiological changes in the minimally processed fruit products is a major drawback during storage. Loss of cellular integrity at the cut surface of the fruits prevents compartmentalization of enzymes and substrates. Senescence may accelerate and off flavour may develop due to increased ethylene production and respiration near cut surface. The exudates from the cut surface are also a favourable medium for growth of fungi and bacteria. Pre treatment by immersing the cut produce in chemical solutions was found helpful to overcome such undesirable physiological changes[8]. Any chemical treatment that is helpful to maintain cellular integrity, post pone senescence, reduce ethylene production and respiration can definitely act as either anti browning agent or anti softening agent both of which are helpful to extend the value of a cut fruit over additional time. In the present study as compared to control, chemical treatments could show lesser physiological loss in weight (%), lesser browning and more shelf life. The highest benefit was derived by the treatment with 2% calcium chloride + 5% citric acid as

compared to the same chemicals used alone and at lower concentrations.

The browning was significantly increased during the storage period in minimally processed papaya from 4 days after storage (0.82) to 12 days after storage (4.15). The minimum browning (1.47) was noticed in minimally processed papaya cubes treated with 2% of calcium chloride + 5% of citric acid (T_8)

Contact of enzymes and substrates lead to biochemical injuries such as browning, off-flavours and texture break down. Enzymatic browning and textural defects reduce product quality and shelf life[1]. Reduction in degree of browning in the cubes treated by 2% calcium chloride + 5% citric acid (T_8) can be attributed to the reduced activity of polyphenol oxidase activity and oxygen concentration which might be due to the effect of chemicals used in pre-treatments[3].

There was a significant difference with respect to the microbial count among different treatments during their 12 days of storage (Table 4). During the storage period, the microbial count was going on increased from15.88 (4 days after storage) to 17.23 (12 days after storage) in the minimally processed papaya cubes treated with 2% calcium chloride + 5% citric acid (T_8) which was on par with the minimally processed papaya cubes treated with 2% calcium chloride + 2.5% citric acid (T_7) (14.02). The highest microbial count (27.28) was noticed in control (T_9). The reduced microbial growth might be as a result of high osmotic pressure[6] which might have 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 preferable as pre-treating chemicals[2].

There was no spoilage in all the treatments of minimally processed papaya cubes except the control (T_9) (Table 5). In control 5.00% spoilage was noticed in 4 days after storage and 10.00% spoilage up to 8 days after storage. At 12 days after storage the spoilage was observed in all the treatments. Among all the treatments, the least spoilage (10.00%) was observed in the minimally processed papaya cubes treated with 2% calcium chloride + 5% citric acid (T_8) and with 2% calcium chloride + 2.5% citric acid (T_7). The highest spoilage (30.00%) was noticed in control (T_9).The chemical pre treatments rinse off enzymes and substrates released by disrupted cells, thus reducing microbial spoilage, excessive tissue softening and tissue browning[6].

Table 1: Physiological loss in weight, Reducing sugars, Non-reducing sugars and Total sugars as influenced by chemicals on minimally processed papaya cv. Arka Prabhat during storage

Treatments	Physiological loss in weight (%)Mean	Reducing sugars(%) Mean	Non-reducing(%) sugars Mean	Total sugars(%)Mean
T_1 : Calcium chloride 1%	14.90 22.70	11.72 (20.01)	0.68 (4.73)	12.40 (20.61)
T_2 : Calcium chloride 2%	13.99 21.96	11.85 (20.13)	0.69 (4.76)	12.54 (20.73)
T_3 : Citric acid 2.5%	13.87 21.86	12.33 (20.55)	0.75 (4.97)	13.08 (21.19)
T_4 : Citric acid 5%	13.63 21.66	12.60 (20.78)	0.76 (5.00)	13.36 (21.43)
T_5 : Calcium chloride 1% + Citric acid 2.5%	13.24 21.33	13.38 (21.45)	0.84 (5.26)	14.22 (22.15)
T_6 : Calcium chloride 1% + Citric acid 5%	12.55 20.74	13.61 (21.64)	0.85 (5.29)	14.46 (22.34)
T_7 : Calcium chloride 2% + Citric acid 2.5%	12.29 20.51	14.07 (22.02)	0.93 (5.53)	15.00 (22.78)
T_8 : Calcium chloride 2% + Citric acid 5%	12.16 20.40	14.38 (22.28)	0.94 (5.56)	15.32 (23.03)
T_9 : Control	14.92 22.71	11.29 (19.63)	0.66 (4.66)	11.95 (20.22)
Mean	12.06 (21.54)	12.80 (20.94)	0.79 (5.08)	13.59 (21.61)
Factors	CD at 5%	CD at 5%	CD at 5%	CD at 5%
Treatments	2.25	0.44	0.08	0.35
Storage period	2.73	1.19	0.04	0.50
T × S	4.59	1.58	0.13	0.78

Note: Figures in the parentheses indicates transformed values

Table 2: Total Soluble solids, Ascorbic acid, Total carotenoids and Organoleptic score as influenced by chemicals on minimally processed papaya cv. Arka Prabhat during storage

Treatments	Total Soluble solids(°Brix)	Ascorbic acid(mg $100g^{-1}$)	Total carotenoids (mg $100g^{-1}$)	Organoleptic score
T_1 : Calcium chloride 1%	12.53	62.71	1.50	7.58
T_2 : Calcium chloride 2%	12.67	64.48	1.56	7.74
T_3 : Citric acid 2.5%	13.21	66.01	1.58	7.98
T_4 : Citric acid 5%	13.50	67.88	1.65	8.15
T_5 : Calcium chloride 1% + Citric acid 2.5%	14.36	69.49	1.66	8.40
T_6 : Calcium chloride 1% + Citric acid 5%	14.58	71.45	1.73	8.58
T_7 : Calcium chloride 2% + Citric acid 2.5%	14.99	73.14	1.75	8.84
T_8 : Calcium chloride 2% + Citric acid 5%	15.29	75.21	1.82	9.03
T_9 : Control	12.07	61.67	1.32	7.11
Mean	*13.69*	68.01	1.62	8.15
Factors	CD at 5%	CD at 5%	CD at 5%	CD at 5%
Treatments	0.35	2.90	0.56	0.42
Storage period	0.50	7.14	1.21	0.57
T × S	0.78	9.52	1.68	0.87

Table 3: Shelf life as influenced by chemicals on minimally processed papaya cv. Arka Prabhat during storage

Treatments	Shelf life
T_1 : Calcium chloride 1%	12.10
T_2 : Calcium chloride 2%	12.17
T_3 : Citric acid 2.5%	12.45
T_4 : Citric acid 5%	13.53
T_5 : Calcium chloride 1% + Citric acid 2.5%	13.94
T_6 : Calcium chloride 1% + Citric acid 5%	14.03
T_7 : Calcium chloride 2% + Citric acid 2.5%	14.60
T_8 : Calcium chloride 2% + Citric acid 5%	14.70
T_9 : Control	7.45
CD at 5%	0.92

Table 4: Browning and Microbial count(CFU's x 10^6)as influenced by chemicals on minimally processed papaya cv. Arka Prabhat during storage

Treatments	Browning	Microbial count(CFU's x 10^6)
T_1 : Calcium chloride 1%	2.53	16.43
T_2 : Calcium chloride 2%	2.40	16.04
T_3 : Citric acid 2.5%	2.28	15.94
T_4 : Citric acid 5%	2.17	15.46
T_5 : Calcium chloride 1% + Citric acid 2.5%	2.13	15.18
T_6 : Calcium chloride 1% + Citric acid 5%	1.53	14.98
T_7 : Calcium chloride 2% + Citric acid 2.5%	2.07	14.02
T_8 : Calcium chloride 2% + Citric acid 5%	1.47	13.64
T_9 : Control	2.63	27.28
Mean	2.06	16.55
Factors	CD at 5%	CD at 5%
Treatments	0.25	1.43
Storage period	0.73	2.17
T × S	0.95	3.24

Table 5: Spoilage (%) as influenced by chemicals on minimally processed papaya cv. Arka Prabhat

Treatment	Spoilage		
	4th Day	8th Day	12th Day
T_1 : Calcium chloride 1%	No spoilage	No spoilage	20.00 26.55
T_2 : Calcium chloride 2%			20.00 26.55
T_3 : Citric acid 2.5%			18.00 25.09
T_4 : Citric acid 5%			18.00 25.09
T_5 : Calcium chloride 1% + Citric acid 2.5%			15.00 22.78
T_6 : Calcium chloride 1% + Citric acid 5%			15.00 22.78
T_7 : Calcium chloride 2% + Citric acid 2.5%			10.00 18.43
T_8 : Calcium chloride 2% + Citric acid 5%			10.00 18.43
T_9 : Control	5.00	10.00	30.00 33.20
Mean	5.00 (1.44)	10.00 (2.05)	17.33 (24.32)

Factors	S.Em(±)	CD at 5%
Treatments (12 th day)	0.89	2.55
Storage period		
T × S		

Note: Figures in the parentheses indicates transformed values

CONCLUSION

Treatment with 2% calcium chloride in combination with 5% citric acid was significantly better in the present study to reduce browning, spoilage, microbial count and more effectively reduced the rate of decay in important quality constituents like ascorbic acid, total carotenoids and sugars. This combination of chemicals when used as a pre treatment over the surface of the cubes could have rinsed off the browning enzymes that would otherwise decoloured the produce. Besides it also maintained all important carbohydrate forms i.e. reducing, non- reducing sugars at a higher level for considerably prolonged period of time thus ensured eatability and deferred fragility or perishability. The harmful action by the dangerous microbes was also kept in check by this treatment.

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