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Influence of Ascorbic Acid and Calcium Chloride on Physical Parameters and Microbial Count of Firm Flesh Jackfruit Bulbs during Refrigerated Storage

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A B S T R A C T

The present investigation on Influence of ascorbic acid and calcium chloride on physical parameters and microbial count of firm flesh jackfruit bulbs was carried out during 2014-15 at College of Agriculture, DBSKKV, Dapoli. A known quantity of jackfruit bulbs were treated with 12 different combinations of ascorbic acid (0.0, 0.5, 1.0 and 1.5 %) and calcium chloride (0.0, 0.5 and 1.0 %) along with 100 ppm KMS, 0.5 percent citric acid and packed in thermocole tray, covered with permissible film and refrigerated. The treated jackfruit bulbs were analyzed for different physical parameters at two days interval. The treatment of 1.5 percent ascorbic acid, 0.5 percent calcium chloride with 100 ppm KMS, 0.5 percent citric acid and surface sterilized with chlorine water (30 ppm) resulted in extending the storage life of jackfruit bulbs upto 6 days with minimum PLW, colour change, moisture content, microbial count and spoilage in refrigerated condition (6-7ºC).

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) one of the unexploited nutritious fruit indigenous to the rainforests of Western Ghats of India (Reddy *et al.*, 2004). It was probably taken by Arab traders to the East African coast. Major producers are Bangladesh, India, Myanmar, Thailand, Vietnam, China, Philippines, Indonesia, Malaysia and Sri Lanka. India is the second biggest producer of the fruit in the world and is considered as the motherland of jackfruit. Jackfruit belongs to family Moraceae which encompasses about 1000 species in 67 genera, mostly tropical shrubs and trees, but also a few vines and herbs (Bailey, 1942; Merill, 1912).

The jackfruit, *Artocarpus heterophyllus* Lam. is also called as jack-fruit, jak and jaca. In Malaysia and Philippines called as *nangka*; in Thailand, *khanun;* in Combodia, *Khnor;* in Laos, *mak mi* or *may mi* and in Vietnam, *mit.* An edible portion of 100 g of (fresh weight) ripe jackfruit contains 72.0-94.0 g water, 1.2-1.9 g protein, 0.1-0.4 g fat, 16.0-25.4 g carbohydrate, 1.0-1.5 g fibre, 0.87-0.9 g total minerals, 20.0-37.0 mg calcium, 175-540 IU vitamin A, 88-410 Kj energy (Gunasena *et al.*, 1996 and Azad, 2000).

Jackfruit is climacteric fruit having high degree of perishability. To minimize the postharvest losses and extend shelf life of

jackfruit bulbs, minimal processing of jackfruit bulbs and provision of chemical treatment for bulbs is necessary. This will help to provide fresh bulbs in the hands of consumers. Minimal processing with chemicals like potassium metabisulphite (KMS), citric acid, calcium chloride and ascorbic acid helps to extend shelf life of fruits. Hence, the present study i.e., Influence of ascorbic acid and calcium chloride on physical parameters and microbial count of firm flesh jackfruit bulbs during refrigerated storage was undertaken to investigate the physical parameters and microbial count of minimally processed jackfruit bulbs.

Materials and Methods

For this study, ripe jackfruits of firm flesh type were collected and were kept for ripening at ambient temperature. All the chemicals used in this investigation were of analytical grade Thermocole tray and permissible film was used for packaging of jackfruit bulbs.

The ripe fruits were surface sterilized with 100 ppm chlorinated water for 5 minutes and then cut opened. The jackfruit bulbs without removal of seeds were separated and whole, sound bulbs were used for experimentation. These bulbs were treated with 30 ppm chlorinated water for 5 minutes. Again these bulbs were dipped in solution containing 100 ppm KMS, 0.5 percent citric acid, along with ascorbic acid (0.0, 0.5, 1.0 and 1.5%) and calcium chloride (0.0, 0.5 and 1.0 %)treatment combination, for 5 minutes.

These bulbs were blotted dry and 9 bulbs were packed per thermocole tray and covered with permissible plastic film. The packed bulbs were kept at refrigerated condition (6-7ºC) and observed for changes in physical and microbial count (bacterial and fungus) at two days interval (i.e., at every 3rd day).

Physical parameter of jackfruit bulbs during storage

Change in colour

Change in colour of jackfruit bulbs was recorded by visual observations.

Physiological loss in weight (PLW)

For this study, the packaging materials were marked for studying physiological loss in weight from each treatment. The progressive loss in weight was noted at two days interval and percent loss in weight was calculated by using following formula.

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

Moisture (%)

The per cent moisture in jackfruit bulbs was estimated by cabinet drying a known weight of sample. The sample was kept at 55-60 ºC till constant weight was obtained.

The loss in weight per 100 g edible portion was calculated and reported as per cent moisture (A.O.A.C., 1975).

Spoilage

Each bulb from tray was thoroughly examined for any visible symptoms of spoilage during storage and spoilage percentage was calculated. The observations were recorded at two days interval.

Shelf-life

The shelf-life of jackfruit bulbs under study was computed on the basis of extent of spoilage of bulbs. The shelf life of bulbs was considered to be over when they showed

spoilage upto an extent of 15 percent and above. Shelf life was recorded in days.

Microbial Count of jackfruit bulbs during storage

To estimate the bacterial and fungal growth in jackfruit bulbs stored at refrigeration condition, serial dilution and spread plate technique was followed using nutrient agar medium and potato dextrose agar medium, respectively. After 48 hours bacterial and fungal colonies were counted.

Statistical analysis

The data obtained during the present investigation were analyzed statistically in Factorial Completely Randomized Design (F.C.R.D) as per the method described by Panase and Sukhatme (1985).

Results and Discussion

Change in colour

It was revealed from the data (Table 1) that colour of jackfruit bulbs changes from yellow to yellowish brown with advancement of storage period. The bulbs of different treatments stored at refrigerated storage remain yellow up to 3 days of storage then the colour of treatments change to light yellow at 6^{th} day of storage. Further at 9^{th} day of storage all the treatments turn yellowish brown, which was an indication of severe spoilage.

Physiological loss in weight (%)

The PLW of jackfruit bulbs (Table 2) increased throughout the storage period from 0.0 percent (0 days) to 8.02 percent (9 days), irrespective of ascorbic acid and calcium chloride treatments.With respect to ascorbic acid treatment, significant PLW was found to be decreased with increase in ascorbic acid concentration till A_3 treatment and then increased at A_4 (3.31 % and 8.22 %) treatment at 6 and 9^{th} day, respectively. In case of calcium chloride treatment, PLW of jackfruit bulbs does not showed fixed trend with increase in calcium chloride concentration. Significant variation in PLW of jackfruit bulbs was shown by interaction of ascorbic acid and calcium chloride treatments. At 6^{th} day of storage lowest PLW was observed in A_3C_3 (2.99 %) interaction and was at par with A_1C_3 (3.46 %), A_2C_3 (3.50 %), A_3C_2 (3.07 %), A_4C_1 (3.05 %), A_4C_2 (3.58 %) and A_4C_3 (3.31 %) interactions. At 9^{th} day of storage lowest PLW was recorded in A_3C_2 (7.04 %) interaction and was at par with A_1C_1 (7.72 %) interaction.

Moisture content

The result presented in Table 3 revealed that, moisture of jackfruit bulbs decreased from 0 day (72.74 %) to 9^{th} day (67.30 %) of storage, irrespective of ascorbic acid and calcium chloride treatments. With respect to ascorbic acid treatment, the moisture content was found to be increased till A_2 treatments and then decreased till A_4 treatment at 3, 6 and 9^{th} day of storage. In case of calcium chloride treatments, moisture of jackfruit bulbs increased till C_2 treatment and then decreased at C_3 treatment during 6^{th} day of storage. At 9^{th} day of storage moisture decreased with increase in calcium chloride concentration, irrespective of ascorbic acid treatments. At 6^{th} day of storage, highest moisture was recorded in A_2C_2 (71.50 %) and was at par with A_2C_1 (69.95 %), A_2C_3 (70.80 %) and A_3C_1 (69.95 %) in case of interaction.

Spoilage (%)

The data (Table 4) revealed that spoilage increased from 0.0 percent to (0 day) to 79.38 percent (9^{th} day), during refrigerated storage. In case of ascorbic acid treatment, spoilage decreased with increase in ascorbic acid

concentration, except A_3 treatment at 6th day of storage and at 9th day of storage. In case of calcium chloride treatment, with increase in calcium chloride treatment spoilage decreased at 6th day of storage. At 9th day of storage spoilage decreased till C_2 (76.08 %) and then increased in C_3 (80.72 %) treatment, irrespective of ascorbic acid treatments. Significantly lowest spoilage was recorded in A_4C_2 (5.37 %) interaction at 6th day of storage and was superior over other interactions. At 9th day of storage significantly lowest spoilage was observed in A_2C_1 (69.44 %) interaction and was at par with A_1C_2 (75 %), A_2C_3 (70.83 %), A_4C_1 (75 %) and A_4C_2 (71.00 %) interactions.

Shelf-life (days)

The data presented in Table 5. Shelf life is calculated on the basis of spoilage percentage (Table 3). Significantly highest shelf-life (4.33 days) was recorded by A_4 treatment and was significantly superior over other treatments in case of ascorbic acid treatment. In case of calcium chloride treatment, shelf-life of jackfruit bulbs increased till C_2 (3.75 days) treatment and decreased at C_3 (3.25 days) treatment. In case of interaction, it is evident from the data that maximum shelf life (6 days) was recorded in bulbs treated with combination of 1.5 percent of ascorbic acid and 0.5 percent of calcium chloride concentration i.e., A_4C_2 interaction and significantly superior over rest of the interactions. As far as effect of ascorbic acid and calcium chloride treatments at refrigerated condition on colour, PLW, spoilage and shelf life of firm flesh jackfruit bulbs is concerned, interaction A_4C_2 was found to be best.

Bacterial and fungal count

Bacterial (Table 6) and fungal count (Table 7) of fresh cut jackfruit bulbs increased throughout the storage period (upto 9th day). At 9th day of storage bacterial load decreased with increase in ascorbic acid treatment, except at A_4 (15×10^{-5}) treatment, irrespective of calcium chloride treatments.

Lowest bacterial count was recorded in A_4 treatment at 9th day of storage and results were non significant at 0, 3 and 6th day of storage. At 9th day of storage bacterial load decreased till C_2 (10.81×10^{-5}) treatment and thereafter increased at C_3 (15.62×10^{-5}) treatment, irrespective of ascorbic acid treatments.

Lowest bacterial count was observed in C_2 (10.81×10^{-5}) treatment.In case of interactions, A_2C_3 interaction recorded significantly lowest bacterial count at 9th day of storage and results were non significant at other days of storage.

In case of fungal count results were non significant during entire storage period.

As far as effect of ascorbic acid and calcium chloride on microbial count is concerned, interaction A_2C_3 recorded lowest bacterial count followed by A_3C_2 and A_4C_2 at 9th day of storage. In case of fungal count results were non significant.

Change in colour

The colour of jackfruit bulbs changes from yellow to yellowish brown with advancement of storage period was in accordance with the findings of Sexena *et al.,* (2008) and Boodia *et al.,* (2009) in jackfruit. Colour change may be indication of severe spoilage.

Physiological loss in weight (%)

Increase in PLW with increase in storage period may be due to loss of moisture due to respiration and transpiration during storage.

Table.1 Influence of ascorbic acid and calcium chloride on colour change of jackfruit bulbs during refrigerated storage

Storage Days												
Treatments	**0**			**3**			**6**			**9**		
	C_1	**C_2**	**C_3**	**C_1**	**C_2**	**C_3**	**C_1**	**C_2**	**C_3**	**C_1**	**C_2**	**C_3**
A_1	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Light Yellow	Light Yellow	Light Yellow	Yellowish brown	Yellowish brown	Yellowish brown
A_2	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Light Yellow	Light Yellow	Light Yellow	Yellowish brown	Yellowish brown	Yellowish brown
A_3	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Light Yellow	Light Yellow	Light Yellow	Yellowish brown	Yellowish brown	Yellowish brown
A_4	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Light Yellow	Light Yellow	Light Yellow	Yellowish brown	Yellowish brown	Yellowish brown

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Table.2 Influence of ascorbic acid and calcium chloride on PLW (%) of jackfruit bulbs during refrigerated storage

Storage Days																
Treatments	**0**				**3**				**6**				**9**			
	C_1	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
A_1	0.00	0.00	0.00	0.00	1.60	2.75	1.64	1.99	5.25	3.90	3.46	4.20	7.72	7.88	8.58	8.06
A_2	0.00	0.00	0.00	0.00	1.52	2.49	1.68	1.90	4.56	3.77	3.50	3.94	7.36	8.74	8.77	8.29
A_3	0.00	0.00	0.00	0.00	2.10	1.48	1.41	1.66	3.68	3.07	2.99	3.24	7.84	7.04	7.69	7.52
A_4	0.00	0.00	0.00	0.00	1.50	1.36	1.75	1.53	3.05	3.58	3.31	3.31	7.89	8.16	8.61	8.22
Mean	0.00	0.00	0.00	0.00	1.68	2.02	1.62	1.77	4.13	3.58	3.31	3.67	7.70	7.95	8.41	8.02
	SEm±		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**	
Ascorbic Acid	-		-		0.090		0.262		0.135		0.395		0.135		0.395	
Calcium Chloride	-		-		0.077		0.227		0.117		0.342		0.117		0.342	
AxC	-		-		0.155		0.455		0.234		0.684		0.234		0.684	

A1: 0.0% Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0% Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 %Calcium Chloride

Table.3 Influence of ascorbic acid and calcium chloride on moisture (%) of jackfruit bulbs during refrigerated storage

Storage Days																
Treatments	**0**				**3**				**6**				**9**			
	C_1	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
A_1	73.40	71.05	71.05	71.83	71.90	70.95	70.05	70.96	69.30	69.55	69.45	69.43	67.65	67.51	67.55	67.57
A_2	71.20	74.25	76.55	74.00	70.50	71.50	71.45	71.15	69.95	71.50	70.80	70.75	69.85	67.80	68.50	68.71
A_3	73.75	72.05	70.90	72.23	71.80	70.95	70.60	71.11	69.95	71.05	66.10	69.03	68.05	68.20	64.60	66.95
A_4	71.20	74.25	73.25	72.9	70.65	72.65	69.95	71.08	68.75	69.65	67.90	68.76	67.70	65.90	64.35	65.98
Mean	72.38	72.90	72.93	72.74	71.21	71.51	70.51	71.07	69.48	70.43	68.56	69.49	68.31	67.35	66.25	67.30
	SEm±		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**	
Ascorbic Acid	0.372		1.087		0.372		NS		0.374		1.087		0.337		0.985	
Calcium Chloride	0.356		NS		0.322		NS		0.323		0.945		0.292		0.853	
AxC	0.713		2.082		0.645		NS		0.647		1.884		0.584		1.707	

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Table.4 Influence of ascorbic acid and calcium chloride on spoilage (%) of jackfruit bulbs during refrigerated storage

Storage Days																
Treatments	**0**				**3**				**6**				**9**			
	C_1	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
A_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.38	40.97	33.33	41.89	100.0	75.00	83.33	86.11
A_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.47	34.72	22.22	28.47	69.44	81.94	70.83	74.07
A_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.02	51.38	29.16	38.19	81.25	76.38	81.25	79.62
A_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	51.38	5.37	17.36	24.70	75.00	71.00	87.50	77.83
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.31	33.11	25.51	33.31	81.42	76.08	80.72	79.38
	SEm±		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**	
Ascorbic Acid	-		-		-		-		1.524		4.448		1.395		3.954	
Calcium Chloride	-		-		-		-		1.319		3.852		1.208		3.424	
AxC	-		-		-		-		2.639		7.705		2.417		6.849	

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Table.5 Influence of ascorbic acid and calcium chloride on Shelf life (Days) of jackfruit bulbs during refrigerated storage

Treatments	Shelf life (Days)			
	C_1	C_2	C_3	Mean
A_1	3	3	3	3
A_2	3	3	3	3
A_3	3	3	3	3
A_4	3	6	4	4.33
Mean	3	3.75	3.25	3.33
	SEm±		C.D. at 1%	
Ascorbic Acid	0.166		0.486	
Calcium Chloride	0.144		0.421	
AxC	0.288		0.842	

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Table.6 Influence of ascorbic acid and calcium chloride on Bacterial count (10^{-5}) of jackfruit bulbs during refrigerated storage

Storage Days																
Treatments	0				3				6				9			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
A_1	0.00	0.00	0.00	0.00	1.50	0.00	0.50	0.66	2.00	0.50	2.50	1.66	21.00	6.25	25.50	17.58
A_2	0.00	0.50	0.00	0.16	1.00	0.50	0.00	0.50	1.50	1.00	1.00	1.16	16.50	15.00	7.00	12.83
A_3	0.00	0.00	0.00	0.00	0.50	0.50	0.50	0.50	1.75	1.00	1.00	1.25	17.00	10.50	17.50	15.00
A_4	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.33	1.50	0.50	2.50	1.50	14.00	11.50	12.50	12.66
Mean	0.00	0.12	0.00	0.04	0.87	0.25	0.37	0.50	1.68	0.75	1.75	1.39	17.12	10.81	15.62	14.52
	SEm±		C.D. at 1%		SEm±		C.D. at 1%		SEm±		C.D. at 1%		SEm±		C.D. at 1%	
Ascorbic Acid	0.048		NS		0.166		NS		0.312		NS		0.277		0.809	
Calcium Chloride	0.041		NS		0.144		NS		0.270		NS		0.240		0.701	
AxC	0.083		NS		0.288		NS		0.541		NS		0.480		1.402	

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Table.7 Influence of ascorbic acid and calcium chloride on fungal count (10^{-4}) of jackfruit bulbs during refrigerated storage.

Storage Days																
Treatments	**0**				**3**				**6**				**9**			
	C_1	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**	**C_1**	**C_2**	**C_3**	**Mean**
A_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.75	1.00	0.91	3.00	1.75	1.00	1.91
A_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.16	1.50	0.50	0.50	0.83
A_3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.50	0.33	1.00	3.00	1.00	1.66
A_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	1.00	0.50	0.91
Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.31	0.37	0.35	1.68	1.56	0.75	1.33
	SEm±		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**		**SEm±**		**C.D. at 1%**	
Ascorbic Acid	-		-		-		-		0.146		0.427		0.335		NS	
Calcium Chloride	-		-		-		-		0.126		NS		0.290		NS	
AxC	-		-		-		-		0.253		NS		0.580		NS	

A1: 0.0 % Ascorbic Acid A2: 0.5 % Ascorbic Acid A3: 1.0 % Ascorbic Acid A4: 1.5 % Ascorbic Acid
C1: 0.0 % Calcium Chloride C2: 0.5 % Calcium Chloride C3:1.0 % Calcium Chloride

Observation analogous to present finding was reported by Phutankar (2013) in jackfruit bulbs. Singh *et al.,* (2014) reported that PLW of guava decreased significantly with the increase in concentration of ascorbic acid from 25 ppm to 100 ppm. Lowest PLW at higher concentration (C_3) of calcium chloride at 3rd and 6th day of storage may be due to calcium application, which has been reported to be effective in terms of membrane integrity maintenance with lower losses of phospholipids and proteins and reduced ion leakage which could be responsible for the lower weight loss. Mahajan *et al.,* (2011) used calcium chloride concentration of 1 per cent, 2 percent and 3 percent in guava fruits and found similar results. At 6th day of storage lowest PLW was observed in A_3 C_3 (2.99 %) interaction and was at par with A_1 C_3 (3.46 %), A_2 C_3 (3.50 %), A_3 C_2 (3.07 %), A_4 C_1 (3.05 %), A_4 C_2 (3.58 %) and A_4 C_3 (3.31 %) interactions. At 9th day of storage lowest PLW was recorded in A_3 C_2 (7.04 %) interaction and was at par with A_1 C_1 (7.72 %) interaction.

Moisture content

Moisture loss may be due to respiration and transpiration of jackfruit bulbs during storage. Observation analogous to present findings have been reported by Phutankar (2013) and Khude (2012) in jackfruit.

Spoilage (%)

Increase in spoilage during storage may be due to increase in microbial contamination which can also confirmed from the results presented in Tables 6 and 7, regarding bacterial and fungal counts. Spoilage increased with increase in storage period was observed by A. Abd-elghany (2012) in pomegranate fruits.

Singh *et al.,* (2014) reported decrease in spoilage of guava fruits with increase in ascorbic acid concentration from 25 ppm to 100 ppm. Microbial load decrease with increase in acidic condition, hence spoilage decreased with increase in ascorbic acid concentration.

In case of calcium chloride treatment, decrease in spoilage at 6th day of storage may be due to their positive role in delaying the senescence of fruits by maintaining cell wall integrity and thus lowering the spoilage. Similar findings have been reported by Mahajan *et al.,* (2011) when calcium concentration of 1, 2 and 3 percent used in guava fruits. Rajkumar *et al.,* (2005) when used calcium chloride of 1, 2, 3 and 4 percent in papaya fruits noticed that, spoilage decreased at 2 percent calcium chloride concentration and then increased at 3 percent of calcium chloride concentration.

In case of interaction significantly lowest spoilage was recorded in A_4 C_2 (5.37 %) interaction at 6th day of storage and was superior over other interactions.

Shelf-life (days)

Significantly maximum shelf life at C_2 may be due to good cell wall integrity as a consequence of influx of calcium that could have helped in thickening of calcium pectate in the cell wall that assisted in prolonged shelf life.

Similar finding was noticed by Rajkumar *et al.,* (2005) in papaya fruit.

In case of interaction, it is evident from the data that maximum shelf life (6 days) was recorded in bulbs treated with combination of 1.5 percent of ascorbic acid and 0.5 percent of calcium chloride concentration i.e., A_4 C_2 interaction and significantly superior over rest of the interactions. This result is in agreement with Asrey (2006) in strawberry.

Bacterial count

Increase in bacterial count may be due to increase in aerial microbes with increase in storage period. In case of ascorbic acid treatment, it is revealed from the data that, at 0, 3 and 6th day of storage non-significant results were found. Decrease in bacterial load with increase in ascorbic acid concentration may be due to increase in acidity and decrease in pH with increase in ascorbic acid concentration which results in unfavourable conditions for the growth of bacteria. Observations identical to present findings were also recorded by Boodia *et al.*, (2009) and Acedo *et al.*, (2013) in jackfruit.

In case of calcium chloride treatment, non-significant results were found at 0, 3 and 6th day of storage. At 9th day of storage lowest bacterial count was observed in C_2 ($10.81\times10^{-}$) treatment and was significantly superior over other treatments.

In case of interaction of ascorbic acid and calcium chloride treatments it was that, minimum bacterial load was recorded in A_4 C_2 ($0.50\times10^{-}$) interaction, however it showed non-significant result and A_2 C_3 ($7\times10^{-}$) interaction recorded minimum load at 9th day of storage and was significantly superior over other treatments.

Fungal count

Result revealed that, fungal count of fresh cut jackfruit bulbs increased throughout the storage period, irrespective of ascorbic acid and calcium chloride treatments.

Decrease in fungal count with increase in ascorbic acid may be the effect of increased concentration of ascorbic acid which affected the growth of fungus. Acedo *et al.*, (2013) found reduced yeast and mould count in jackfruit by using ascorbic acid at 1.5 per cent.

In case of, effect of calcium chloride treatment and interaction of ascorbic acid and calcium chloride treatments non-significant results were found at 0, 3, 6 and 9th day of storage.

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