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Changes in quality of frozen custard apple pulp kept under ambient condition

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Abstract

This study was carried out to evaluate the quality of packed frozen custard apple pulp when it kept at ambient condition. The pulp was extracted from custard apple with the help of Dr. PDKV deseeding machine. For experiment the pulp was packed in LDPE bags and preserved with four different treatments *viz* Blast freezing + Potassium metabisulphite (KMS 0.1 %), Blast freezing + Control, Without Blast freezing + Potassium metabisulphite (KMS 0.1 %) and Without Blast freezing + Control stored at frozen storage (-18 °C). The frozen pulp was kept at ambient condition and monitored TSS, acidity, pH, ascorbic acid and L Value continuously at an interval of 1 hr for 8 hr. The results revealed that the pH and L- value, ascorbic acid were decreased while total soluble solids and acidity were increased with increased storage time up to 8 hr at ambient condition. The pulp treated with blast freezing along with KMS (0.1%) (T_1) and without blast freezing along with KMS (0.1%) (T_3) were found in good condition up to 8 hr however, the pulp treated with blast freezing and without KMS (T_2) and without blast freezing and without KMS (T_4) were spoiled after 4 hr.

Keywords: Blast freezing, potassium meta-bisulphite, ascorbic acid, L value

Introduction

Custard apple (*Annona squamosa* L.), popularly known "sitaphal" in India. Custard apple (*Annona squamosa* L.) is a most delicious and favorite fruit of the tropics. It is popular fruit crop growing on Deccan and some part of Central India. It is notified as a non-conventional, climacteric and highly perishable tropical type fruit. It is one of the most delicious arid fruits and known mostly for its dessert and confectionary values (Soliva-Fortuny, 2002) [24]. This fruit is sometimes considered as poor man's rich food in the arid zones of India. In India, it is most commonly found in Andhra Pradesh, Maharashtra, Tamil Nadu, Orissa, Assam, Uttar Pradesh, Bihar and Rajasthan.

Custard apple yields about 40% pulp having TSS 26.4°brix, pH 5.5 and tannins 0.5% (Nanjundaswamy and Mahadeviah, 1990) [15]. Fruit skin is rich in phenols and causes rapid browning and strong off flavor during storage and processing. The seeds, leaves and young fruits can be used as insecticidal. It is considered as beneficial for cardiac disease, diabetes hyperthyroidism and cancer. The fruits are generally eaten fresh, or used to make juice beverages, nectars, drinks, sherbet, ice-cream, confectionary and certain milk products (Nieva *et al* 1970; Rao 1974) [17, 20]. The seed cake can be used as manure. The processed products and byproducts of custard apple are nutritionally important.

As a fresh fruit, custard apples have short postharvest life of less than two weeks. One way to extend the storage life, stored the fruit in the form of pulp at frozen condition. However, the pulp exposed to air undergoes discoloration due to polyphenol oxidase activity. Discoloration occurs during storage in the frozen state and continues throughout thawing, and causes loss of quality and value. The fruit has an immense potential in processing industry but commonly susceptible to enzymatic browning catalyzed by polyphenol oxidase (PPO) affecting its sensory and nutritional qualities. Oxygen removal or enzyme inhibition is necessary to prevent or decrease enzymatic browning and antioxidants can be used to control enzymatic browning (Pareek *et al*., 2011) [18].

Since custard apple pulp is susceptible to enzymatic browning during thawing at ambient condition. Prospero (1993) [19] found that frozen pulp without antioxidant displayed discoloration after 2 h exposure to air at ambient condition. The meta-bisulphite was the most effective antioxidant for preventing discoloration. Ascorbic acid (0.1%) can also control discoloration, provided the pulp is thawed in sealed pack at a maximum temperature of 10 °C. Concern over adverse effects of sulphite for some consumers makes more attractive the use of non-sulphite anti-browning agents (Bauernfeind and Pinkert 1970) [3].

Fruit pulp preservation is an economic business practice and the countries enriched with fruit resources are giving emphasis over establishment of storage and preservation systems to enhance shelf-life and quality of fruits so as to assure their availability during off-season. The initiation of heat sterilization, refrigerated storage and drying has given a great impulsion to modern method of food preservation. Although many preservatives have been recommended for use in foods, sulphur dioxide and benzoic acid dominate the scene, and find wide spread applications.

The most practical preservation method of custard apple pulp is freezing of pulp at -18 to -20°C. During thawing of stored frozen pulp browning is the main problem. There is no literature available on the quality of packed frozen custard apple pulp after removing from frozen condition. Therefore the efforts have been made to study the quality of packed frozen custard apple pulp when it kept at ambient condition for its further utilization.

Material and methods

Fresh fully ripened and uniform sized fruits of custard apple were procured from fruit market. The fruits were split into two halves and pulp was scooped out manually under hygienic conditions. The PDKV deseeding machine was used for de-seeding of custard apple pulp. The pulp was treated with anti-oxidant potassium meta-bisulphite (0.1%).This pulp were packaged in LDPE bags having thickness of 350 gauge and sealed with heat sealing machine. After packaging, the custard apple pulp was given air blast freezing treatment at -40 °C for 4 hr for quick freezing of the pulp (Marin *et al*., 1992) [14]. It was stored in deep freezer at -18 °C for 6 months (Bakane *et al*., (2015) and Sravanthi *et al*., (2014) [4, 25]. The treatments comprised of Blast Freezing and KMS (T_1), Blast Freezing and Without KMS (T_2), Without Blast Freezing and KMS (T_3) and Without Blast Freezing and Without KMS (T_4) at frozen storage. The frozen custard apple pulp sealed with LDPE bags was removed from deep freezer and kept at ambient condition. The custard apple pulp was subjected to biochemical analysis and L Value at an interval of 1 hr up to 8 hr. The biochemical analysis of custard apple pulp was carried out following standard method to determine the quality of pulp.

Chemical analysis of frozen custard apple pulp at ambient condition

pH

The pH of custard apple pulp was determined by using pH meter.

TSS (° Brix)

The total soluble solids were determined by using Erma hand refractometer and expressed as percent total soluble solids (°Brix) (Ranganna, 1997) [21].

Acidity (%)

The acidity of the samples was determined by diluting an aliquot of the sample with distilled water and titrating with 0.1 N NAOH using phenolphthalein indicators. The calculated acidity was expressed as percent anhydrous citric acid (Ranganna, 1997) [21].

Ascorbic acid (mg/100g)

The ascorbic acid content was estimated by using the method described by Ranganna (1997) [21].

L value

Color of pulp in terms of L (Lightness) value was determined by Konica Minolta chromameter (CR-400). The L* is the lightness coefficient, ranging from 0 (black) to 100 (white) on a vertical axis. L-value, which denotes the degree of whiteness, was chosen to represent the color value of sample (Anantheswaran *et al*., 1986) [2].

Sensory Evaluation

The sensory evaluation of pulp i.e. color, odor, texture and taste were carried out by using 9-point hedonic scale.

Statistical design

The experiment was laid in Factorial completely randomized design (FCRD) with four treatments replicated four times. The data were statistically analyzed pair wise based on critical difference at 1% probability levels as given by Panse and Sukhatme (1984).

Result and discussion

Frozen custard apple pulp samples were removed from deep freezer and kept at ambient condition to determine the browning time and quality of pulp. The biochemical analysis and sensory evaluation were carried out at an interval of every 1 hr for 8 hr.

Changes in biochemical analysis of custard apple pulp

Total Soluble Solids

The data pertaining to change in TSS of packed frozen custard apple pulp after kept at ambient condition are presented in Table 1 and 2. The TSS of fresh custard apple pulp was (22.85 °Brix) higher as compared to frozen custard apple pulp. There was slight increase in TSS of custard apple pulp at ambient condition. Average maximum TSS was found in T_2 i.e. blast freezing and without KMS (21.82 °Brix) and T_4 i.e without blast freezing and without KMS (22.06 °Brix) which was significantly higher among all treatments. Minimum increase in T_1 i.e blast freezing and KMS (21.30 °Brix) and T_3 i.e without blast freezing and KMS (21.43 °Brix) with increasing storage time. This might e due to addition of KMS had significantly improved TSS level of stored fruit pulp which may be due to prevalence of acidic medium created by sulphuric acid, formed by release of SO_2 from KMS. This may have resulted in the acid hydrolysis of complex insoluble compounds into simple soluble ones. The TSS was reported to get increased with increase in storage time. The significant increase in TSS was reported with 20.15 °Brix at 0 hr to 23.13 °Brix at 8 hr in ambient storage condition as shown in Table 2. The increase in TSS might be due to the increase in soluble solids content and total sugars caused by hydrolysis of polysaccharides into simple sugar during storage. Similar observations have been made by Geeta, (2002) and Shweta *et al*., (2017) [26]. TSS increase with increase in storage in both treated as well as untreated samples. This increase in TSS with storage might be due to solubilization of fruit constituents during storage (Shah *et al*., 1975). Similar results were also reported by Kumhar *et al.* (2014) [10] in custard apple pulp, Sharma *et al.* (2013) in Kiwi apple juice, and Muhammad *et al*. (2011) in apple pulp. The interaction effects of treatments and storage time on TSS was found not significant.

Table 1: Effect of treatments on various biochemical parameters of packaged frozen custard apple pulp at ambient condition

Treatments	Parameters				
	TSS (°Brix)	pH	Acidity (%)	Ascorbic acid (mg/100g)	L value
T_1	21.30^b	5.24^a	0.996^b	37.95^a	57.72^a
T_2	21.82^a	4.79^b	1.080^a	16.66^b	54.94^b
T_3	21.43^b	5.13^a	1.032^b	36.88^a	54.96^b
T_4	22.06^a	4.72^b	1.079^a	15.70^b	53.51^b
SE (m)±	0.092	0.081	0.042	0.088	0.578
CD at 1%	0.259*	0.229*	NS	0.250*	1.634*

Table 2: Effect of storage time on various biochemical parameters of packaged frozen custard apple pulp at ambient condition

Storage time (hr)	Parameters				
	TSS (°Brix)	pH	Acidity (%)	Ascorbic acid (mg/100g)	L value
0	20.15	5.39	0.667	29.30	58.80
1	20.51	5.28	0.718	28.37	57.92
2	20.87	5.18	0.809	27.69	56.75
3	21.27	5.09	0.942	27.10	55.97
4	21.67	4.97	1.078	26.63	54.96
5	22.08	4.86	1.207	26.23	54.60
6	22.41	4.78	1.282	25.67	53.82
7	22.77	4.71	1.333	25.36	52.89
8	23.13	4.48	1.386	24.84	51.85
SE (m)±	0.137	0.122	0.062	0.133	0.868
CD at 1%	0.388*	0.344*	0.176*	0.374*	2.451*

pH

The data of pH of packed frozen custard apple pulp at ambient condition is presented in Table 1. The pH of fresh custard apple pulp was 5.57 higher as compared to frozen custard apple pulp. Comparison of average pH at four treatments showed significant decrease of T_1 (5.24), T_2 (4.79), T_3 (5.13) and T_4 (4.72) as shown in Table 1. The maximum pH was observed in treatments T_1 (5.24) and T_3 (5.13) comprised of blast freezing and without KMS. This might be due to presence of KMS (potassium metabisulphite) which maintain acidic conditions and further conversion of complex compounds. Similar results found in Zakaria *et al*. (2017) studied that the maximum drop was observed in without preservative sample as compare to all treatments besides lowest decline of pH in black mulberry pulpy juice. The pH of custard apple pulp was found to decrease in all treatments at ambient condition. The minimum pH was observed in treatments T_2 (4.79) and T_4 (4.72) comprised of blast freezing and without KMS under ambient storage condition. This might be due to absence of KMS. The effect of storage time on pH is presented in Table 2. The pH of custard apple pulp significantly decreased with increasing in storage time from 5.39 to 4.48 as shown in Table 2. The pH of fruit juice is negative function of natural acidity in the juice during storage. An increase in titrable acidity and decrease in pH during storage at ambient condition are reported earlier (Sawant and Dongre, 2014) [22] in some fruits. Similar results were reported by Geeta (2000) [6] and Mohite (2002) [13], Muhammad *et al*. (2011) in apple pulp. At ambient condition and when no preservative was added, reduction of pH of pulp was faster due to accelerate microbial quality (more specifically due to fermentation). Since preservation and refrigerated condition very much retarded the microbial activity, decrease in pH was either very slow. The interaction effects of treatments and storage time on pH was found not significant.

Acidity

The data pertaining to acidity of packed frozen custard apple pulp after kept at ambient condition are presented in Table 1 and 2. Acidity and pH are interdependent and correlated properties, and lower the pH, higher is the acidity during storage time at room temperature. The acidity of fresh custard apple pulp was 0.45 % was lower as compared to frozen custard apple pulp. It has been observed that the total acidity of custard apple pulp increased with the storage duration for all treatments. There was slight increase in acidity of custard apple pulp at ambient condition.

The effects of treatments on acidity of custard apple pulp at ambient condition were found not significant. An increase in acidity and simultaneous decrease in pH were seen in untreated as well as treated samples. A similar trend of slight increase in titrable acidity with storage has been reported by Durrani *et al.* (2010) [5] in apple pulp during storage up to 90 days at ambient temperature, Akhtar *et al.* (2010) in mango pulp. The acidity was reported to get increased with increase in storage time. The significant increase in acidity was reported with 0.667 % at 0 hr to 1.386 % at 8 hr in ambient storage condition as shown in Table 2. The interaction effects of treatments and storage time on acidity was found not significant.

Ascorbic acid

The data of ascorbic acid of packed frozen custard apple pulp at ambient condition is presented in Table 1. The ascorbic acid of fresh custard apple pulp was 19.62 mg/100 g lower as compared to frozen custard apple pulp. Comparison of average ascorbic acid contents at four treatments showed significant decrease of T_1 (37.95 mg/100g), T_2 (16.66 mg/100g), T_3 (36.88 mg/100g) and T_4 (15.70 mg/100g) as shown in Table 1. The maximum ascorbic acid content was observed in treatments T_1 (37.95 mg/100g) and T_3 (36.88 mg/100g) comprised of blast freezing and without KMS. This might be due to presence of KMS (potassium metabisulphite). Similar results reported by Sumaya *et al*. (2018) for storage stability of grape juice preserved with sodium benzoate and KMS. They reported that highest percent decrease in control sample and lowest in preservative samples. Also Negi and Roy (2000) [16] reported that the application of KMS to reduce the loss of ascorbic acid during the storage of leafy vegetables. The minimum ascorbic acid content was observed in treatments T_2 (16.66 mg/100g) and T_4 (15.70 mg/100g) comprised of blast freezing and without KMS. This might be due to absence of KMS.

The effect of storage time on ascorbic acid content is presented in Table 2. The ascorbic acid of custard apple pulp significantly decreased with increasing in storage time from 29.30 mg/100g to 24.84 mg/100g. This reduction might be due to gradual oxidation of ascorbic acid into dehydroascorbic acid by oxygen and then further degraded to 2, 3 diketo-gluconic acid by the action of ascorbic acid oxidase enzyme. Similar results were reported by Pareek *et al*, (2014) [10] and Sravanti *et al* (2014) in custard apple pulp. The interaction effects of treatments and storage time on ascorbic acid content of custard apple pulp was found significant. In four treatments the ascorbic acid of custard apple pulp decreased with increasing in storage time at ambient condition is shown in fig 1. The maximum reduction of ascorbic acid content was found in treatments T_2 and T_4 as compared to T_1 and T_3 with increase in storage time.

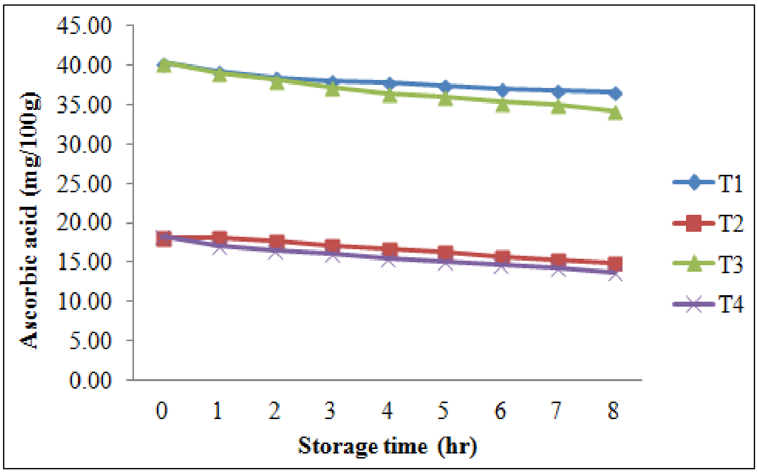

Fig 1: Effect of storage time on ascorbic acid content of custard apple pulp at ambient condition

L Value

The data of L (Lightness) Values of packed frozen custard apple pulp at ambient condition is presented in Table 1. The L Value of fresh custard apple pulp (60.41) which was higher as compared to frozen custard apple pulp. Among treatment blast freezing and KMS treated samples have maximum average L-Value was reported in T_1 (57.72) and T_3 (54.96) at ambient storage condition. And the minimum L Value was reported in T_2 (54.94) followed by T_4 (53.51) at ambient storage condition.

The maximum L value of custard apple pulp was found in treatment T_1 at par with T_3 during storage time. There was no browning in treatment T_1 and T_3 during storage period due to addition of potassium metabisulphite. Potassium metabisulphite (KMS) are commonly used as preservatives for long-term storage of fruit pulp because of their better antimicrobial activity and prevention of browning (Lueck, 1990; Manganelli & Casolari, 1983) [11, 12]. There was browning (decreasing in L Value) in untreated samples T2 and T4 after 4 hour at ambient condition as shown in Table 2.

Change in L Value of custard apple pulp is mainly due to enzymatic browning. There was change in color of frozen pulp with increase in storage period at ambient condition. Change in color of apple pulp during storage is primarily attributed to enzymatic browning, in which polyphenols are converted into brown compounds by the action of polyphenol oxidase (Wickramarachchi & Ranamukhaarachchi, 2005) [28]. Similar results were observed in Prospero (1993) [19] has observed that frozen custard apple pulp without any additives displayed discoloration in 2 hour after exposure to ambient temperature. The L Value of custard apple pulp at ambient condition decreased significantly with increasing storage time. The interaction effects of treatments and storage time on L Value of custard apple pulp was found significant. In four treatments the L value of custard apple pulp decreased with increasing in storage time at ambient condition is shown in fig 2. The maximum reduction of L value was found in treatments T_2 and T_4 as compared to T_1 and T_3 with increase in storage time.

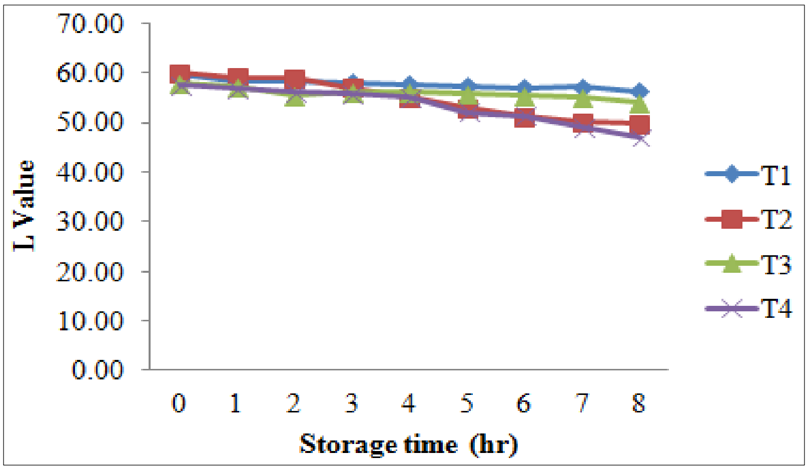

Fig 2: Effect of storage time on L Value of custard apple pulp at ambient condition

Sensory Evaluation

The packed frozen custard apple pulps subjected to treatments were evaluated for sensorial properties by semi- trained panel. The effect of blast freezing and KMS stored at -20 °C for six months kept at ambient condition up to 8 hour was analyzed and interpreted. It is known fact that the quality of custard apple pulp at ambient condition such as color, taste, flavor and overall acceptability value was generally reduced with increase in storage period. In the present study organoleptic score of pulp decreased more in treatments (T_2) and (T_4) as compared to treatments (T_1) and (T_3) as the storage time increased at ambient temperature. The treatments (T_2) and (T_4) were spoiled after 5 hr due to absence of chemical preservative.

The maximum color score of custard apple pulp at the end of storage time was found in treatment T_1 (7.25) followed by T_3 (7.20) as shown in Table 3. The minimum color score of custard apple pulp at the end of storage was found in treatment T_2 (4.12) followed by T_4 (3.99) as shown in Table 3 which are untreated sample. The color score showed decreasing trend during storage that might be due to the action of acidity that enhances the hydrolytic reaction causes browning. After 4 hrs the treatment T_2 and T_4 displayed browning and discoloration also flavor and taste changed. Therefore the overall score of treatments decreased fastly and the samples spoiled whereas treatment T_1 and T_3 does not display discoloration. The maximum taste score of custard apple pulp at the end of storage time was found in treatment T_1 (7.45) followed by T_3 (7.40) as shown in Table 3 that were treated with chemical preservatives. The minimum taste score of custard apple pulp at the end of storage was found in treatment T_2 (4.42) followed by T_4 (4.05) as shown in Table 3. The maximum flavor score of custard apple pulp at the end of storage time was found in treatment T_1 (7.15) followed by T_3 (7.10) as shown in Table 3 that were treated with chemical preservatives. The minimum flavor score of custard apple pulp at the end of storage was found in treatment T_2 (4.52) followed by T_4 (4.21) as shown in Table 3. Similar decrease in sensory quality during storage of the pulp reported by Pareek *et al*., (2014) [10] in custard apple, Gamage *et al*, (1997) [7] in custard apple, Hasmi *et al*. (2007) in mango pulp, Akhtar *et al*. (2009) [1] in mango, Durrani *et al*. (2010) [5] in apple pulp, Kamble and Soni (2010) [9] in custard apple pulp.

From the sensory evaluation it was observed that up to 4 hr there was negligible change in color of custard apple pulp in all treatments. But after 4 hr with increasing the storage time the control samples (T_2) and (T_4) started browning from corners of the packet. In KMS treated samples (T_1) and (T_3) there was no browning occurs. Up to 8 hr the treatments (T_1) and (T_3) remain in good quality and consumable for human. In without KMS treated samples (T_2) and (T_4) and the discoloration occurred after 5 hr. Hence the packed KMS treated samples remain in good condition i.e. no discoloration occurred during 8 hr. Similar results were reported by Paradede (1994) and they stated that thawing inside the package gives the best retention of quality as assessed by discoloration and total ascorbic acid content of frozen custard apple pulp. No significant discoloration occurred during 6 h thawing of fresh pulp and discoloration was noticeable after 6 h thawing.

Table 3: Effect of organoleptic score on quality of frozen custard apple pulp at ambient condition

Color	Storage time (hr)								
	0 hr	**1 hr**	**2 hr**	**3 hr**	**4 hr**	**5 hr**	**6 hr**	**7 hr**	**8 hr**
Temp. (°C)	-20	-4	12.9	20	23.9	24.9	25.3	26.5	26.8
T_1	8.09	8.09	8	7.72	7.54	7.54	7.38	7.30	7.25
T_2	7.81	7.27	6.99	6.75	5.26	4.12	*	*	*
T_3	8.45	8.36	8.36	8	7.63	7.63	7.36	7.28	7.20
T_4	8.36	8.09	7.81	6.51	5.01	3.99	*	*	*
Taste									
T_1	8.36	8.27	8.27	7.72	7.72	7.72	7.63	7.55	7.45
T_2	8.36	8.27	7.72	7.15	6.01	4.42	*	*	*
T_3	8.27	8.09	8.09	8	7.72	7.72	7.72	7.55	7.40
T_4	8.27	8.18	7.45	6.92	5.91	4.05	*	*	*
Flavor									
T_1	7.9	7.9	7.81	7.72	7.27	7.27	7.25	7.25	7.15
T_2	8.36	8.09	7.51	6.91	5.98	4.52	*	*	*
T_3	8.45	8.36	8.36	7.72	7.54	7.54	7.27	7.15	7.10
T_4	8.18	7.59	7.05	6.61	5.75	4.21	*	*	*
OAA									
T_1	8	7.9	7.72	7.63	7.63	7.63	7.55	7.45	7.39
T_2	8.45	7.91	7.45	6.75	6.14	4.99	*	*	*
T_3	8.45	8.36	8.45	7.9	7.45	7.45	7.38	7.30	7.25
T_4	8.27	7.85	7.24	6.75	6.21	4.62	*	*	*

*Samples spoiled

Summary and Conclusion

The custard apple pulp in treatment (T_1) and (T_3) has good quality up to 8 hr after removing from deep freezer and kept at ambient condition whereas treatment (T_2) and (T_4) has good quality up to 4 hr after removing from deep freezer and kept at ambient condition. From above results we conclude that the frozen 0.1% KMS treated custard apple pulp when it kept at ambient condition for thawing it can be used for consumption up to 8 hr in good condition. Also from the experiment it was observed that treatments (T_1) and (T_2) has blast freezing but there was no any effect on quality of custard apple pulp if there was no any preservative added. Hence preservative or anti-browning agent is the most important for storage of custard apple pulp at both frozen and ambient condition.

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