PREPARATION OF CUSTARD APPLE POWDER AND ITS PACKAGING FOR STORAGE

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ABSTRACT

An experiment was carried out to prepare the custard apple powder using freeze drying method at the Department of Agricultural Process Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh during 2008-2009. The experiment was carried out with two factors using completely randomized design (CRD) with three replications. It was mainly consisting selection of custard apple fruits, freeze drying of custard apple pulp, preparation of custard apple powder, stored in different kinds of packaging materials with and without vacuum and quality evaluation of stored powder on the basis of physical, bio-chemical and organoleptic parameters at the interval of 45 days. Physical (Weight, Bulk density), bio-chemical parameters (Total sugar, reducing sugar, titrable acidity and ascorbic acid) and organoleptic parameters (Taste, flavour, colour, overall acceptance) were observed. Results concluded that the best quality storage powder on basis of physical, bio-chemical and organoleptic parameters was obtained in treatment T_4 (vacuum packed powder in polyethylene bag).

KEY WORDS: Custard apple power, vacuum packed, polyethylene bag

INTRODUCTION

Custard apple fruit is high in calories and is a good source of iron. is the most important tropical fruit and widely distributed among the annonaceous fruits. It is hardy and thrives well under adverse climatic conditions. In India, it is most commonly found in Andhra Pradesh, Maharashtra, Tamil Nadu, Orissa, Assam, Uttar Pradesh, Bihar and Rajasthan, with a production 165 thousand tones and over an area of 22 thousand hectares during 2013-14 (Anonymous, 2015). Custard apple is juicy and creamy fruit; it has a white pulp that contains about 40 black seeds. The exterior is rough, knobby and grayish-green. Custard apple contains no sodium, are high in carbohydrates and rich in calcium, vitamin C and phosphorus, and with a sugar content of about 50-50 (glucose and sucrose). This fruit is also considered as a good tonic in Ayurveda. It enriches blood and is known to increase muscular strength. Presently, many processors and industrialists diverts towards the processing of custard apple. However,

custard apple fruits are mainly consumed as a fresh fruit, but some of them can be processed and used in the preparation different value added products *viz*., nectars, drinks, sherbets, ice cream, syrup, RTS, Shrikhand, beverages and cakes. Custard apple pulp mixed with milk results in a delicious drink and can also be frozen into ice cream, which is the main type of processing for this fruit.

Freezing is a processing method that provides a significantly extended shelf life and has been successfully used for the long-term preservation of many types of foods. Successful freezing will only retain the inherent quality present initially in a product without bringing about any improvement in quality characteristics. There are many advantages of freeze drying over other drying methods as mentioned by Ratti (2001).Custard apple fruit is having high initial moisture content of about 72-77 % (wb), there are more chances of the fruit getting spoiled or deteriorated. Also, custard apple is a highly perishable fruit, it has very short shelf life and marketing of fresh fruits to different places is very difficult. Therefore, it is necessary to convert it into value added products which retain colour, flavour and nutrients with longer shelf life. So to increase the shelf life of custard apple, the fruit is converted into various processed products like powder, dried slices, pulp, juice, RTS, beverages, etc. Custard apple powder is used in ice-cream, flavored milk, shrikhand, chocolates. Looking to the above facts, the research work were taken with an objectives to study freeze drying characteristics of custard apple pulp, to study the storage life of freeze dried custard apple powder with or without vacuum packaging and glass bottle, and to evaluate the quality parameters of freeze dried custard apple powder during storage.

MATERIALS AND METHODS

The experiment was carried out with two factors following completely randomized design (CRD) with three replications. It was mainly consisting selection of custard apple fruits, freeze drying of custard apple pulp, preparation of custard apple powder, stored in different kinds of packaging materials with and without vacuum and quality evaluation of stored powder on the basis of physical, bio-chemical and organoleptic parameters at the interval of 45 days. The details of treatments are as follows for custard apple pulp.

Freeze drying of pulp

- Pretreatment : 4 levels (5,10, 15 and20%Maltodextrin)
- Temperatures : 2 levels (-40^0 C and -60^0 C)
- Replication : 3
- Treatments : 8
- Experimental design : CRD
- Treatment combinations : 8

Storage of freeze dried powder

- Freeze dried powder : 8 levels
- Packaging : 3 levels (with and without vacuum)
- Packaging materials : Polyethylene bags & Glass bottle
- Replication : 3
- Treatments : 24
- Experimental design : CRD
- Treatment combinations : 24

Freeze drying of custard apple pulp

Freeze drying of custard apple pulp was carried out by using freeze dryer (Lyophilizer) Model IRI-033. The homogenized custard apple pulp was uniformly spread on three stainless steel plates attached one above another by three legged adjustable stand in the freeze drying chamber and loaded in the freeze dryer. The freeze drying of the custard apple pulp was carried out at -40 and -60^{0}C. The vacuum pressure of 1 torr (760mm Hg) was maintained throughout the experiment. The moisture content of custard apple pulp at the interval of three hour was recorded as per Ranganna (2000) method. The freeze drying of custard apple was continuing till it attains moisture level of 3 to 4 % (wb). As the pulp reaches at desired moisture content i.e., 3 to 4 % (wb), the freeze drying was stopped and pulp was taken for grinding operation.

Freeze Drying Parameters

Measurement of moisture content

The initial moisture content of custard apple slices before drying was determined by oven drying method as described by Ranganna (2000). The fresh custard apple slices were placed in thoroughly washed and dried pre weighed Petri dishes. The initial weight of each sample was recorded. The Petri dishes were put in the oven at 110º C for 36 hour. The weight of dry matter in the sample was determined as follows:

Weight of Petri dish	= W_1 (g)
Weight of Petri dish + custard apple slices before drying	= W_2 (g)
Weight of Petri dish + oven dried custard apple slices	= W_3 (g)
Weight of moisture evaporated, Ww	= W_2-W_3 (g)
Weight of dry matter, Wd	= W_3-W_1 (g)

The Moisture of custard apple on wet basis (w.b.) and dry basis (d.b.) were computed as follows follow:

$$\text{Moisture content, \% w.b.} = \frac{Ww}{Ww + Wd} \times 100$$

$$\text{Moisture content, \% d.b.} = \frac{Ww}{Wd} \times 100$$

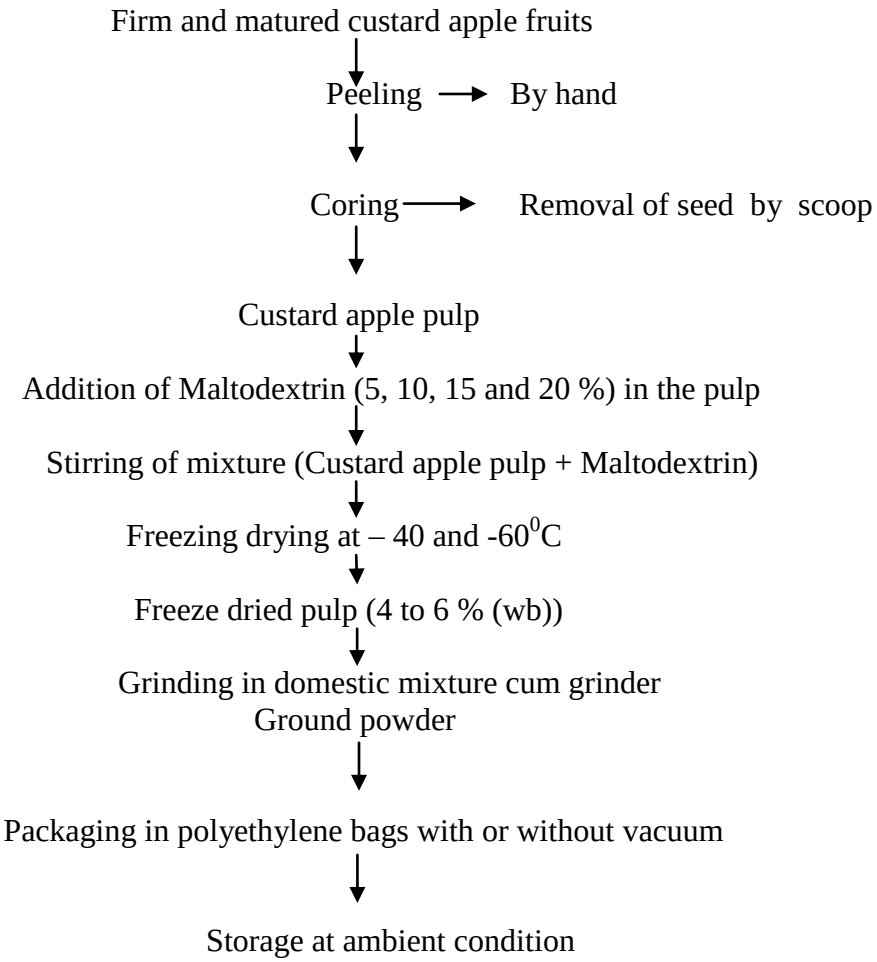
Freeze drying constant

The dehydration characteristics of custard apple slices in terms of variation in moisture content and moisture ratio with respect to time was studied for different methods and treatments of drying considered for the study. The effects of various operational parameters such as thickness, air flow rate and drying air temperature etc. on drying behavior were also studied. In order to predict the time required to dry the custard apple for given drying method and treatment, the relationship were established by using the empirical equation given by Broker *et al.* (1974). The moisture ratio was calculated by using equation:

$$MR = \frac{M_1 - Me}{Mi - Me} = c \exp(-kt)$$

Where, M_1 = moisture content at any time t, per cent (d.b)
Mi = initial moisture content, per cent (d.b)
Me = equilibrium moisture content, per cent (d.b)
K = drying constant, hr -1
c = coefficient of equation
t = drying time, hr

Process flowchart for the preparation of Custard apple powder



RESULS AND DISCUSSION

The observations of custard apple pulp and its freeze drying characteristics, packaging of freeze dried custard apple powder in different packaging materials and quality evaluation of freeze dried powder on the basis of various physical and organoleptic parameters of the custard apple powder were taken at the interval of 45 days.

Freeze drying of custard apple pulp

Freeze drying of custard apple pulp was carried out using freeze dryer (Lyophilizer) Model IRI-033 at -40 and -60^{0}C. The vacuum pressure of 1 torr (760mm Hg) was maintained throughout the experiment. The

moisture content of custard apple pulp at the interval of three hour was recorded as per Ranganna (2000) method. The freeze drying of custard apple was continuing till it attains moisture level of 3 to 4 % (wb). Data pertaining to the treatment were recorded and are given in Table 1 to 8.

Effect of freeze drying temperature

It was observed that as the freeze drying temperature decreased from – 40^0C to -60^0C, the drying time also decreased. At 5% Maltodextrin level, freeze drying temperature decreased from – 40^0C (Treatment T_1) to -60^0 C (Treatment T_5), the freeze drying time was decreased from 41 h to 39 h. Similarly, kinds of results were obtained for other Maltodextrin levels i.e., 10, 15 and 20 %. The maximum (41 h) and minimum (30 h) values of freeze drying time were obtained in treatment T_1 (-40^0C freeze drying temperature) and T_8 (-60^0C freeze drying temperature), respectively.

Effect of different levels of Maltodextrin

It was observed that increased in Maltodextrin level from 5 % to 10 % at the same freeze drying temperature, the drying time decreased. At – 40^0 C freeze drying temperature, increased in Maltodextrin level from 5 % (Treatment T_1), 10 % (Treatment T_2), 15 % (Treatment T_3) and 20 % (Treatment T_4), freeze drying time was decreased from 41, 39, 36 and 33 hours, respectively. Similarly, at –60^0C freeze drying temperature, increased in Maltodextrin level from 5 % (Treatment T_5), 10 % (Treatment T_6), 15 % (Treatment T_7) and 20% (Treatment T_8), freeze drying time was decreased from 39, 36, 33 and 30 hours, respectively.

It was observed that very negligible increase (i.e., non-significant difference) in weight of custard apple powder during storage in all the three packaging treatments and for the bulk density of the powder, the highest increase in bulk density of the custard apple powder was obtained in polyethylene bag without vacuum followed by packed with vacuum (Table 9). However, lowest increase of bulk density was obtained in custard-apple powder packed in glass bottle. These variations of bulk densities in plastic bags were due to permeability of plastic film with the surrounding air. This permeability of film increase migration of heat or moisture from outside air, which slightly increase weight of the custard apple powder kept inside the polyethylene bag. However, in case of glass bottle little variation in bulk density was observed due to impermeability of glass material.

Biochemical parameters of custard apple powder during storage

It is extremely important to know the sorption characteristics of various dried materials as reported by Iglesias and Chirife (1982), Tsami *et al.* (1999), Debnath *et al.* (2002), Durakova and Menkov (2005) and Moraga *et al.* (2007). The freeze dried custard apple powder prepared by different treatments was packed in polyethylene bags (50 µ) with and without vacuum as well as in glass bottle was stored at room temperature The biochemical parameters such as ascorbic acid, total sugar, titrable acidity and reducing sugar at the interval of 45 days were measured by using different instruments. To enhance shelf life of freeze dried product dyes are used on specific packages on the market that display enhanced shelf life through packaging (Sacharow, 2006).

Ascorbic acid of custard apple powder

It was observed that ascorbic acid content of powder decreased with increased in storage period for all the

treatments (Table 10). Minimum reduction of ascorbic acid was found in all the treatments packed in polyethylene bag with vacuum, which is followed by powder packed in glass bottle.

Total sugar of custard apple powder

It was observed that total sugar content of powder increased with increased in storage period for all the treatments (Table 11). Minimum increase of total sugar was found in all the treatments packed in polyethylene bag with vacuum, which is followed by powder packed in glass bottle. Maximum increase of total sugar was found in all the treatments packed in polyethylene bags without vacuum. This shows the best total sugar retention of custard apple powder in all the treatments (T_1 to T_8) packed in polyethylene bags (50 µ) with vacuum stored at room temperature.

Titrable acidity of custard apple powder

It was observed that titrable acidity content of powder decreased with increased in storage period for all the treatments, but there was no significant difference between treatments (Table 12). However, minimum increase of titrable acidity was found in all the treatments packed in polyethylene bag with vacuum, which is followed by powder packed in glass bottle.

Reducing sugar of custard apple powder

It was observed that reducing sugar content of custard apple powder increased with increased in storage period for all the treatments (Table 13). Minimum increase of reducing sugar was found in all the treatments packed in polyethylene bag with vacuum, which is followed by powder packed in glass bottle. Maximum increase of reducing sugar was found in all the treatments packed in polyethylene bags without vacuum. This shows the best reducing sugar retention of custard apple powder in all the treatments (T_1 to T_8) packed in polyethylene bags (50 µ) with vacuum stored at room temperature.

Organoleptic evaluation

Organoleptic evaluation in terms of colour, odour, flavour, taste, and overall acceptability of custard apple powder is carried out by 10 point hedonic method at 0 and 90^{th} days of storage as reported in Table 14 and 15, respectively. The overall acceptability of different characters such as colour, odour, taste and flavour of different treatments on the sensory characteristics of custard apple powder are presented in Table 14. It was observed that among all treatments, highest ranking point of overall acceptability (8.5) was obtained in treatment T_4 at 0 day of storage (Table 14), which was followed by treatment T_3 (7.5). However, lowest ranking point of overall acceptability (5.5) was obtained in treatment T_8 at 0 day of storage. Observed data (Table 15) revealed that among all treatments, highest ranking point of overall acceptability (8.0) was obtained in treatment T_4 (vacuum packed powder in polyethylene bag) at 90^{th} day of storage. However, lowest ranking point of overall acceptability (4.0) was obtained in treatment T_8 powder packed in polyethylene bag without vacuum at 90^{th} day of storage.

CONCLUSION

Based on the results, it can be concluded that all the eight treatments (i.e., T_1 to T_8) have combined effects of freeze drying time as well as Maltodextrin level i.e., drying time decreased with decreased in freeze drying temperature and increased in Maltodextrin level. Highest ranking points of overall acceptability (8.5) was obtained in treatment T_4 at 0 day

of storage, which was followed by treatment T3 (7.5). However, lowest ranking point of overall acceptability (5.5) was obtained in treatment T_8 at 0 day of storage. Highest ranking point of overall acceptability (8.0) was obtained in treatment T_4 (vacuum packed powder in polyethylene bag) at 90^{th} day of storage. However, lowest ranking point of overall acceptability (4.0) was obtained in treatment T_8 (powder packed in polyethylene bag without vacuum) at 90^{th} day of storage. The considering all the packaging method, the best quality powder in terms of physical, bio-chemical and organoleptic parameters was obtained in all the treatment powder packed with vacuum in 50 µ polyethylene bags followed by glass bottle.

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Table 1: Treatment T_1 (-40^{0}C freeze drying temp. & 5% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	71.34		1.000
2	3	46.49	8.28	0.633
3	6	24.96	7.18	0.315
4	9	13.79	3.72	0.150
5	12	11.34	0.82	0.114
6	15	9.13	0.74	0.081
7	18	8.05	0.36	0.065
8	21	7.13	0.31	0.052
9	24	6.25	0.29	0.037
10	27	5.40	0.28	0.026
11	30	4.90	0.17	0.019
12	33	4.42	0.16	0.012
13	36	4.08	0.11	0.007
14	39	3.82	0.09	0.003
15	41	3.63	0.05	

Table 2: Treatment T_2 (-40^{0}C freeze drying temp. & 10% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	70.35		1.000
2	3	45.41	8.31	0.625
3	6	23.78	7.21	0.301
4	9	12.51	3.76	0.132
5	12	9.96	0.85	0.094
6	15	7.82	0.71	0.062
7	18	6.81	0.34	0.047
8	21	5.96	0.28	0.034
9	24	5.15	0.27	0.021
10	27	4.57	0.19	0.013
11	30	4.12	0.15	0.006
12	33	3.93	0.06	0.003
13	36	3.79	0.05	0.001
14	39	3.67	0.04	

Table 3: Treatment T_3 (-40^{0}C freeze drying temp. & 15% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	71.81	8.81	1.000
2	3	45.38	7.31	0.611
3	6	23.45	3.76	0.289
4	9	12.16	0.85	0.124
5	12	9.61	0.71	0.086
6	15	7.48	0.34	0.055
7	18	6.45	0.28	0.040
8	21	5.61	0.23	0.028
9	24	4.92	0.17	0.018
10	27	4.42	0.12	0.010
11	30	4.05	0.06	0.005
12	33	3.86	0.05	0.002
13	36	3.71	8.81	

Table 4: Treatment T_4 (-40^{0}C freeze drying temp. & 20% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	71.35		1.000
2	3	44.47	8.96	0.602
3	6	20.89	7.86	0.254
4	9	11.44	3.15	0.114
5	12	8.50	0.98	0.071
6	15	6.10	0.80	0.036
7	18	5.35	0.25	0.025
8	21	4.82	0.18	0.017
9	24	4.37	0.15	0.009
10	27	3.93	0.15	0.004
11	30	3.79	0.05	0.003
12	33	3.69	0.03	0.000

Table 5: Treatment T_5 (-60^{0}C freeze drying temp. & 5% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	70.94		1.000
2	3	45.50	8.48	0.621
3	6	23.60	7.30	0.295
4	9	12.20	3.80	0.126
5	12	9.68	0.84	0.089
6	15	7.58	0.70	0.057
7	18	6.62	0.32	0.043
8	21	5.90	0.24	0.032
9	24	5.24	0.22	0.023
10	27	4.64	0.20	0.014
11	30	4.36	0.09	0.010
12	33	4.11	0.08	0.006
13	36	3.87	0.08	0.002
14	39	3.72	0.05	

Table 6: Treatment T_6 (-60^{0}C freeze drying temp. & 10% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	70.95		1.000
2	3	44.70	8.75	0.609
3	6	22.83	7.29	0.284
4	9	11.61	3.74	0.117
5	12	9.12	0.83	0.080
6	15	7.02	0.70	0.049
7	18	6.03	0.33	0.034
8	21	5.22	0.27	0.022
9	24	4.44	0.26	0.011
10	27	4.23	0.07	0.007
11	30	4.04	0.06	0.005
12	33	3.86	0.06	0.002
13	36	3.73	0.04	

Table 7: Treatment T_7 (-60^{0}C freeze drying temp. & 15% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	70.45		1.000
2	3	43.30	9.05	0.593
3	6	19.90	7.80	0.242
4	9	9.40	3.50	0.085
5	12	7.75	0.55	0.061
6	15	6.22	0.51	0.038
7	18	5.31	0.30	0.024
8	21	4.62	0.23	0.014
9	24	4.28	0.11	0.009
10	27	4.00	0.09	0.004
11	30	3.82	0.06	0.002
12	33	3.70	0.04	

Table 8: Treatment T_8 (-60^{0}C freeze drying temp. & 20% Maltodextrin level)

Sr. No.	DT (h)	MC, % (wb)	DR, %/h	MR
1	0	71.1		1.000
2	3	43.94	9.05	0.597
3	6	20.89	7.68	0.255
4	9	11.44	3.15	0.114
5	12	7.41	1.34	0.055
6	15	5.85	0.52	0.031
7	18	5.05	0.27	0.020
8	21	4.48	0.19	0.011
9	24	4.21	0.09	0.008
10	27	3.95	0.09	0.003
11	30	3.73	0.07	0.000

Where (Table 1 to 7), DT= Drying Time, MC= Moisture Constant, DR= Drying Rate, and MR= Moisture Ratio

Table 9: Effect of different packaging material on Bulk density (g/cc) of Custard apple powder during storage.

Treatments	Polyethylene Bags Without Vacuum		Polyethylene Bags With Vacuum		Glass Bottle	
	Weight of Custard Apple Powder During Storage, g					
	45	90	45	90	45	90
T_1	26.50	27.25	26.25	26.69	26.05	26.26
T_2	26.45	27.85	26.13	26.52	25.91	26.10
T_3	26.58	27.88	26.26	26.61	26.07	26.28
T_4	26.35	27.68	26.03	26.38	25.84	26.05
T_5	26.95	27.9	26.63	26.98	26.44	26.65
T_6	26.85	27.78	26.61	26.96	26.40	26.22
T_7	27.05	27.96	26.81	27.13	26.60	26.42
T_8	26.75	27.86	26.51	26.83	26.30	26.53
S. Em $\pm$	0.60	0.60	0.60	0.60	0.60	0.60
C.D. at 5%	NS	NS	NS	NS	NS	NS
C.V. %	3.87	3.72	3.74	3.86	3.88	3.92

Table 10: Ascorbic acid content of custard apple powder during storage period

Treatments	Ascorbic Acid Content of the Custard Apple Powder During Storage Period, mg/100 g								
	Polyethylene Bags Without Vacuum			Polyethylene Bags With Vacuum			Glass Bottle		
	Storage Period			Storage Period			Storage Period		
	0	45	90	0	45	90	0	45	90
T_1	18.18	16.6	15.02	18.18	17.83	17.48	18.18	17.21	16.24
T_2	17.20	15.6	14.00	17.20	16.9	16.6	17.20	16.75	16.3
T_3	16.28	14.98	13.68	16.28	15.68	15.08	16.28	15.52	14.76
T_4	15.15	13.14	11.13	15.15	14.98	14.81	15.15	13.29	11.43
T_5	17.10	14.98	12.86	17.10	16.21	15.32	17.10	15.6	14.1
T_6	15.15	13.75	12.35	15.15	14.21	13.27	15.15	13.75	12.35
T_7	14.21	11.19	8.17	14.21	13.21	12.21	14.21	12.52	10.83
T_8	13.55	10.14	6.73	13.55	12.44	11.33	13.55	11.60	9.65
S. Em ±	0.09	0.15	0.09	0.09	0.15	0.15	0.09	0.15	0.15
C.D. at 5%	0.27	0.45	0.27	0.27	0.45	0.45	0.27	0.45	0.45
C.V. %	0.98	1.87	1.32	0.98	1.70	1.78	0.98	1.78	1.95

Table 11: Total sugar content of custard apple powder during storage period

Treatments	Total Sugar Content (%) of the Custard Apple Powder During Storage Period								
	Polyethylene Bags Without Vacuum			Polyethylene Bags With Vacuum			Glass Bottle		
	Storage Period			Storage Period			Storage Period		
	0	45	90	0	45	90	0	45	90
T_1	60.15	65.25	71.75	60.15	62.45	63.85	60.15	62.28	63.86
T_2	59.50	62.44	65.38	59.50	60.64	61.78	59.50	61.48	63.96
T_3	57.70	61.62	65.54	57.70	58.83	59.96	57.70	59.73	62.26
T_4	61.20	64.35	67.50	61.20	61.85	62.50	61.20	57.55	61.25
T_5	59.65	62.80	65.95	59.65	60.30	61.25	59.65	60.73	62.31
T_6	58.10	61.04	63.98	58.10	59.24	60.38	58.10	60.08	62.56
T_7	56.80	60.72	64.64	56.80	57.93	59.06	56.80	58.83	61.36
T_8	55.45	60.25	65.05	55.45	57.38	59.31	55.45	58.65	62.35
S. Em ±	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
C.D. at 5%	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
C.V. %	0.27	0.25	0.24	0.27	0.26	0.26	0.27	0.26	0.25

Table 12: Tritable acidity of custard apple powder during storage period

Treatments	Titrable acidity (%) of the Custard Apple Powder During Storage Period								
	Polyethylene Bags Without Vacuum			Polyethylene Bags With Vacuum			Glass Bottle		
	Storage Period			Storage Period			Storage Period		
	0	45	90	0	45	90	0	45	90
T_1	0.62	0.54	0.46	0.62	0.60	0.50	0.62	0.58	0.54
T_2	0.60	0.52	0.44	0.60	0.55	0.50	0.60	0.53	0.46
T_3	0.61	0.49	0.37	0.61	0.56	0.51	0.61	0.54	0.47
T_4	0.60	0.48	0.36	0.60	0.54	0.53	0.60	0.52	0.44
T_5	0.63	0.51	0.39	0.63	0.59	0.52	0.63	0.55	0.47
T_6	0.62	0.48	0.34	0.62	0.53	0.44	0.62	0.52	0.42
T_7	0.64	0.50	0.36	0.64	0.58	0.52	0.64	0.54	0.44
T_8	0.59	0.46	0.33	0.59	0.57	0.55	0.59	0.51	0.43
S. Em $\pm$	0.02	0.06	0.06	0.02	0.06	0.06	0.02	0.06	0.06
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	5.05	20.76	27.09	5.05	18.28	20.01	5.05	19.26	22.51

Table 13: Reducing sugar content of custard apple powder during storage period

Treatments	Reducing Sugar (%) of Custard Apple Powder During Storage Period								
	Polyethylene Bags Without Vacuum			Polyethylene Bags With Vacuum			Glass Bottle		
	Storage Period			Storage Period			Storage Period		
	0	45	90	0	45	90	0	45	90
T_1	28.45	31.4	34.35	28.45	28.95	29.45	28.45	29.33	30.21
T_2	27.33	30.07	32.81	27.33	28.27	29.21	27.33	29.11	30.89
T_3	25.85	29.57	33.29	25.85	26.18	26.51	25.85	26.68	27.51
T_4	24.68	28.28	31.88	24.68	25.10	25.52	24.68	25.38	26.08
T_5	26.6	28.88	31.16	26.6	27.54	28.48	26.6	27.75	28.9
T_6	25.48	27.53	29.58	25.48	26.45	27.42	25.48	26.57	27.66
T_7	24.00	26.62	29.24	24.00	24.85	25.7	24.00	25.12	26.24
T_8	22.83	25.22	27.61	22.83	23.63	24.43	22.83	23.95	25.07
S. Em $\pm$	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
C.D. at 5%	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
C.V. %	0.60	0.54	0.50	0.60	0.59	0.57	0.60	0.58	0.56

Table 14: Organoleptic sheet for freeze dried custard apple powder (0 day storage)

Treatments	Properties				
	Colour	Odour	Taste	Flavour	Acceptibility
T_1	7.0	6.5	6.5	6.5	6.5
T_2	6.5	7.0	7.5	6.5	7.0
T_3	7.5	7.0	7.5	7.5	7.5
T_4	8.5	8.5	8.0	8.5	8.5
T_5	7.0	7.0	6.5	6.0	6.5
T_6	6.5	5.5	6.5	6.0	6.0
T_7	6.5	6.0	5.5	6.0	6.0
T_8	6.0	5.5	5.0	5.0	5.5

Table 15: Organoleptic sheets for Freeze dried custard apple powder packed in different packaging materials on 90th day of storage.

Treatments	Properties														
	Polyethylene Bags Without Vacuum					Polyethylene Bags With Vacuum					Glass Bottle				
	C	O	T	F	A	C	O	T	F	A	C	O	T	F	A
T_1	5.5	5.0	5.5	5.0	5.5	6.5	6.5	6.0	6.5	6.5	6.0	5.5	6.0	5.5	6.0
T_2	5.0	5.5	6.0	5.0	5.5	6.0	6.5	7.0	7.0	7.0	5.5	6.0	6.5	6.0	6.5
T_3	6.0	5.5	6.0	6.0	6.0	7.0	6.5	7.0	7.0	7.0	6.5	6.0	6.5	6.5	6.5
T_4	7.0	7.0	6.5	7.0	7.0	8.0	8.0	7.5	8.0	8.0	7.5	7.5	7.0	7.5	7.5
T_5	5.5	5.5	5.0	4.5	5.0	6.5	6.5	6.0	5.5	6.0	6.0	6.0	5.5	5.0	5.5
T_6	5.0	4.0	5.0	4.5	4.5	6.0	5.0	6.0	5.5	5.5	5.5	4.5	5.5	5.0	5.0
T_7	5.0	4.5	4.0	4.5	4.5	6.0	5.5	5.0	5.5	5.5	5.5	5.0	4.5	5.0	5.0
T_8	4.5	4.0	3.5	3.5	4.0	5.5	5.0	4.5	4.5	5.0	5.0	4.5	4.0	4.0	4.5

Where, C = Color, O = Odour, F = Flavour, T = Taste, and A = Acceptability

[MS received: August 23, 2016] *[MS accepted: September 22, 2016]*