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Microencapsulation of Custard Apple Powder through Spray Drying

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ABSTRACT: Custard apple is a highly perishable and seasonal crop that cannot be stored for more than three days. Discoloration and microbial spoilage are major problems in preserving the pulp. As a result, processing of custard apple through spray drying is crucial in increasing the availability of the product during the off-season. Thus, an attempt was made to optimise the processing variables *viz*., inlet temperature (175, 180 and 185°C) and outlet temperature (70, 80 and 90°C). The results powder recovery ranged from 17.23-20.42%, moisture content 7.42-4.92%, water activity 0.39-0.27, ascorbic acid ranged from 17.16-12.03 mg/100g and non enzymatic browning 0.001-0.005 OD. In conclusion, the high quality spray dried custard apple powder can be obtained at inlet temperature of 185°C and outlet temperature of 90°C resulted maximum recovery (20.42%), minimum moisture content (4.92%) and water activity (0.27) that could be stable for the storage.

Keywords: Spray drying, ascorbic acid, water activity and moisture content.

INTRODUCTION

Custard apple (*Annona squamosa* L.) also known as Sitaphal, is a tropical fruit that belongs to the Annonaceae family. It is native to America and is widely cultivated in many tropical and subtropical regions around the world. The fruit gets its name from its creamy, custard-like texture and sweet flavour.

The advancement of processing technology plays a pivotal role in maximizing the utilization of custard apple fruits by creating value-added products. This approach can help to prevent a glut of fresh fruit in the market and ensure the availability of custard apples for an extended period. By transforming them into processed products, their benefits can reach consumers for a more extended period, enhancing their economic and nutritional value for rural communities. In addition to pulp preservation, custard apple can be preserved using various other methods. One such method involves converting the juice of custard apple pulp into powder through techniques like freeze drying, foam mat drying, spray drying and tunnel drying. Among these, spray drying is a widely employed technique for producing fruit juice powders. Consequently, there is a significant potential for preparing custard apple powder using spray drying with maltodextrin acting as a carrier agent (Quek *et al*., 2007).

MATERIAL AND METHODS

Materials: Custard apple (*Annona squamosa* L.) fruits of the Saswad local variety were sourced from Horticultural Research and Extension Centre (HREC) Badakundri (Hidkal Dam) in Karnataka and the fruits were brought to the laboratory to facilitate subsequent experimental procedures.

Methodology for the production of custard apple powder. The experiment was conducted using a laboratory spray dryer (LSD-48) manufactured by Techno search and Systems Pvt. Ltd., located in Thane, Mumbai.

Spray drying process: Feed solution is prepared by diluting 100 grams of extracted custard apple pulp with water in 1:5 ratio for which 20 per cent maltodextrin was added and continuously homogenized for 8-10 minutes in the mixer and filtered with the double sieve, inlet air temperature (175, 180 and 185°C) and outlet air temperature (70, 80 and 90ºC), feed flow rate 2 ml/min was maintained. The obtained powder was collected and packed in 50 micron aluminium pouches and stored at an ambient room temperature. The assessments were conducted on samples taken to analyze alterations in both physical and chemical characteristics.

Analysis of physicochemical properties

Powder recovery (%)

$$\text{Powder recovery} = \frac{\text{Weight of the powder}}{\text{Weight of the pulp}} \times 100$$

Moisture content (%). Moisture content of custard apple powder was determined by using moisture analyser (Model: P1019319, A and D Company Limited, Made in Japan).

Water activity (a_w). Water activity of the spray dried custard apple powder was measured by using water activity meter (Model: Novasia AG, Switzerland).

Chemical parameters

Ascorbic acid (mg/100 g). Ascorbic acid was determined titrimetrically using 2, 6- dichlorophenol indophenol dye as per the modified procedure of AOAC (Anon., 1984).

Non-enzymatic browning (OD value)

The non enzymatic browning of spray dried custard apple powder was estimated by using the spectrophotometric method as suggested by Srivastava and Sanjeevkumar (1998).

RESULT AND DISCUSSION

Effect of spray drying condition on powder recovery: Recovery percentage of microencapsulated custard apple powder varied from 17.23 to 20.42 per cent (Table 1). The maximum recovery (20.42%) was recorded in the combination I_3O_3 with 185ºC inlet temperature and 90ºC outlet temperature which was followed by I_3O_2 (19.91%) with 185ºC inlet temperature and 80ºC outlet temperature. This high recovery of the powder with the increase in the inlet and outlet temperature might be due to the high rate of heat and mass transfer inside the chamber which prevented the stickiness of the powder and the addition of maltodextrin (MD) resulted in non-sticky powder. The low recovery of 17.23, 17.35 and 17.91 per cent was observed in I_1O_1, I_1O_2 and I_1O_3, respectively. This was due to lower inlet and outlet temperature, lower rate of heat and mass transfer occurred that resulted in a lower recovery of the powder. Hence, it is evident that, at higher inlet and outlet temperature better recovery of the powder was obtained. This was in accordance with Swetha (2016) in custard apple juice powder and Aswathy (2016) in cherry tomato powder.

Moisture content and water activity: Moisture content and water activity are important powder properties as they are related to the drying efficiency. Moisture content and water activity of micro encapsulated powder plays an important role in determining the flowability, stickiness and storage stability (Shrestha *et al.*, 2007). Moisture content and water activity of spray dried custard apple powder were in the range of 7.10 to 4.92 per cent and 0.39 to 0.27, respectively which was sufficient to make powder biologically safe. Similar result was reported by Tze *et al.* (2012) in pitaya fruit powder where moisture content of the powder was less than 10 per cent.

Generally, increasing the inlet and outlet temperature decreased the moisture content and water activity of the powder. The lowest moisture content (4.92%) and water activity (0.27) was noticed in the treatment combination I_3O_3 with 185ºC inlet temperature and 90ºC outlet temperature during initial period and upon storage a meagre increase was recorded (Table 1).

This might be due to the greater loss of water from powder because of the higher rate of heat transfer into sprayed small particles (more surface area), which caused faster water removal. The results in the present investigation were following similar trend and are in similar line with Swetha (2016) in custard apple powder, Ersus and Yurdagel (2007) in black carrot powder, Chegini and Ghobadian (2005) in orange juice powder.

Table 1: Influence of inlet and outlet temperature levels on recovery, moisture content, water activity and particle size of spray dried custard apple powder.

Treatments	Recovery (%)				Moisture content (%)				Water activity (a_w)			
	O_1	O_2	O_3	Mean of I	O_1	O_2	O_3	Mean of I	O_1	O_2	O_3	Mean of I
I_1	17.23	17.35	17.91	**17.50**	7.10	6.73	6.12	**6.65**	0.39	0.37	0.38	**0.38**
I_2	18.12	18.64	18.78	**18.51**	6.28	5.83	5.21	**5.77**	0.37	0.34	0.33	**0.35**
I_3	19.56	19.91	20.42	**19.96**	5.28	5.11	4.92	**5.10**	0.32	0.29	0.27	**0.29**
Mean of O	**18.30**	**18.63**	**19.04**	**18.66**	**6.22**	**5.89**	**5.42**	**5.84**	**0.36**	**0.33**	**0.33**	**0.34**
	S.Em±		**CD @ 1%**		**S.Em±**		**CD @ 1%**		**S.Em±**		**CD @ 1%**	
I	0.006		0.024		0.014		0.063		0.014		0.060	
O	0.006		0.024		0.014		0.062		0.014		0.060	
I × O	**0.010**		**0.042**		**0.024**		**0.10**		**0.025**		**NS**	

I_1- Inlet temperature 175°C O_1 – Outlet temperature 70°C MAS – Months after storage
I_2-Inlet temperature 180°C O_2– Outlet temperature 80°C
I_3-Inlet temperature 185°C O_3– Outlet temperature 90°C

Chemical parameters

Ascorbic acid: Ascorbic acid is the one of the important parameters from the nutritional point of view. It is an important antioxidant which contributes to the antioxidant activity of the powder (Table 2). Ascorbic acid content was highest (17.16 mg/100 g) in treatment combination of I_1O_1 with 175ºC inlet temperature and 70ºC outlet temperature and the lowest (12.03 mg/100g) was recorded in I_3O_3 with 185ºC inlet temperature and 90ºC outlet temperature during initial period. It was found that with the increase in the inlet and outlet temperature the ascorbic acid content was found to decrease in microencapsulated custard apple powder. This might be due to oxidation of ascorbic acid at high temperature. These results were in accordance with Chiang (2011) in orange juice and Lee *et al.* (2013) in dragon fruit powder.

Non enzymatic browning: No significant difference was noticed among the treatment combinations (Table 2). Maximum non enzymatic browning (0.006) was found for the treatment combination I_3O_3 and the minimum (0.001) was recorded for the treatment I_1O_1. A very meagre increase was noticed with the increase in the inlet and outlet temperature this might be due to the action of enzymes and the oxygen trapped inside the package and due to the millard reaction. These results were in accordance with Singh *et al.* (2013) in ber juice powder.

Table 2: Influence of inlet and outlet temperature levels on ascorbic acid and non enzymatic browning of spray dried custard apple powder.

Treatments	Ascorbic acid (mg/100g)				Non-enzymatic browning (OD value)			
	O_1	O_2	O_3	Mean of I	O_1	O_2	O_3	Mean of I
I_1	17.16	16.48	16.12	**16.59**	0.001	0.003	0.003	**0.0023**
I_2	15.65	15.08	14.86	**15.20**	0.003	0.004	0.004	**0.0036**
I_3	14.72	13.64	12.03	**13.46**	0.005	0.005	0.006	**0.0053**
Mean of O	**15.84**	**15.07**	**14.34**	**15.08**	**0.003**	**0.0040**	**0.0043**	**0.0037**
	S.Em±		**CD @ 1%**		**S.Em±**		**CD @ 1%**	
I	0.004		0.012		0.007		NS	
O	0.003		0.010		0.009		NS	
I × O	**0.006**		**0.020**		0.01		**NS**	

I_1- Inlet temperature 175°C O_1 – Outlet temperature 70°C MAS – Months after storage
I_2-Inlet temperature 180°C O_2– Outlet temperature 80°C
I_3-Inlet temperature 185°C O_3– Outlet temperature 90°C

CONCLUSIONS

Custard apple powder obtained at inlet temperature of 185ºC and outlet temperature of 90ºC (I_3O_3) was found to be good with respect to recovery (20.42%), moisture content (4.92%), water activity (0.27), while the maximum ascorbic acid was noticed at inlet temperature of 175ºC and outlet temperature of 70ºC.

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