Octa Journal of Biosciences
Octa J. Biosci. Vol. 9(2):119-122

International peer-reviewed journal
July-Dec 2021

Octa Journal of Biosciences
ISSN 2321 – 3663
journal homepage: www.sciencebeingjournal.com

Original Research Article

Received: 02/08/2021 / Revised: 30/11/2021 / Accepted: 21/12/2021 / Published on-line: 30/12/2021

Physical characteristics and flow behavior of custard apple powder

Narotam Soni[1]*, Maya sharma[1], V D Mudgal[1], P S Champawat[1] and Deepika Kohli[1]
[1] **College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur Rajasthan, India, 313001**
*corresponding author e-mail address: narotamsoni@gmail.com

ABSTRACT
Fresh custard apple pulp was dehydrated using convective tray drying technique, physical characteristics and flow behaviour were studied. Moisture content, solubility index, bulk and tapped density, hygroscopicity, total soluble solids, water absorption capacity, degree of caking and colour lightness were found as 7.44 per cent (db), 8.00 ml, 359.97 kgperm3 and 423.84 kgperm3, 0.83 g water per kg solids per min, 53.86% Brix 0.66 %, 50.97 % and 77.69, respectively. The values of compressibility and hausner ratio for samples of dried powder were recorded as 15.06 per cent and 1.18 indicats good flow behavior. The results revealed that the powder obtained has shown good physical status, appreance quality with good flow.
Keywords: Convective Drying; Custard apple powder; Hygroscopicity; Flow charaterstics

1. INTRODUCTION

Custard apple (*Annona squamosa* L.) commonly known as sitaphal, is one of the most important multipurpose plant species of Indian sub-continent and known by several vernacular names such as sugar apple, sweet sop, sitaphal and sharifa in different part of the country (Khodifad and Kumar, 2019, Soni et. al., 2021). The fruit is rich in free sugars, minerals and vitamins and contains about fifty three compounds including limonene, alpha-pinene, beta-pinene, germacrene D and bornyl acetate (Pino, 2010). Custard apple has medicinal and industrial applications due to properties like anti-oxidant, anti-diabetic, hepato-protective, cyto-toxic, geno-toxic, anti-tumor and anti-lice agent (Sharma and Panesar, 2018). Custard apple pulp is being used for production of soft drinks, ice-creams and certain food products. Fruits have short shelf-life and spoiled because of non-availability of proper post-harvest technology. Dehydrated custard apple powder will inhibit the quality deterioration, browning of pulp and fruit, microbial contamination and increase in shelf life. Spray drying of custard apple pulp was studied by Shashirekha et al., (2008) and reported that spray dried powder was free of bitterness, discoloration and off-flavour. Patil, (2011) reported that 20 % level of maltodextrin and 1 % tricalcium phosphate is optimum for maximum yield of custard apple powder by spray drying. Vaccum storage of freeze dried custard apple powder in polyethelene bags was reported optimum by Sondarva et al., (2016). Natural circulation solar drying of custard apple pulp was performed by Ojha et al., (2018) and reported that whole drying took placed in falling rate only in 29 hours. Dehydration of custard apple pulp in thin layer foam mats was done by Khodifad and Kumar, (2019) and found that 2 mm pulp thickness took drying time 100 to 140 min at 60–75^{o} C temperatures. Custard apple pulp was dried in thin layer of 4 mm even thickness at temperature of 50, 55, 60 and 65 °C with air velocity of 2 m/s in a tray dryer by Soni, (2021). The average drying time was decreased 16.67, 10.00 and 22.22 per cent for per 5 °C temperature increase. The average drying rates were found 0.00052, 0.0006, 0.00066 and 0.0008 g water/g dry matter/sec at selected temperatures. Only limited research work has been reported related to custard apple dehydration and storage of powder, no literature related to effect of drying methods on structural, physical and flow characteristics of custard apple powder was available.

The physical and flow characteristics of food powder is essential to predict shelf life and are desired in quality control, equipment design, storage and handling. Therefore present study was aimed to investigate the physical characteristics and flow behaviour of tray dried custard apple powder.

2. MATERIALS AND METHODS

Tray drying method was selected for dehydration of custard apple pulp. Drying of custard apple pulp was performed with laboratory scale tray dryer TD 5220 (Khera Scientific, India) at 60 ºC temperature and 2 m/s air velocity. The prepared custard apple powder was analyzed for its physical characteristics and flow behaviour using standard methodologies.

Moisture content of food material is a deciding factor in prediction for perishability of any product. The moisture content of the custard apple powder was determined by an oven method, as mentioned by Ranganna (2002). Solubility index is an important feature which provides idea about reconstitution ability of powdered food. Solubility index was measured according to a standard procedure (IDF, 1979). Bulk dentisy of custard apple powder was measured by dividing the mass of powder with volume occupied and for tapped density measurement the volume measuring cylinder was tapped until a constant volume attained (Jinapong, 2008). Hygroscopicity can be expressed as per gram increase in weight of powder when subjected to an 80 % relative humidity atmosphere for 900 minutes. Hygroscopicity of the developed powder was determined using the method suggested by Goula and Adamopoulos (2004) and expressed as kg moisture/kg dry solids/min. Wet sample left after hygroscopicity test was dried at 102º C in an oven and cooled. After cooling, the dried sample was weighed and sieved for 5 min with 500 µm size sieve. The degree of caking was calculated using formula suggested by Jaya and Das, 2004. The index of colour such as L*, a* and b* scale were used for colour determination in hunter lab colorimeter. The color L*, a* and b* values indicate the lighter (+L), darker (□ L), red (+a), green (□a), yellow (+b) and blue (□b) respectively. One gram of powder sample was dissolved in 1 ml of water and made into a viscous liquid. One drop of the viscous liquid was placed on refractometer and soluble solid content was measured (Vongsawasdi, 2002). Water absorption capacity of custard apple powder was measured by slightly modifying the method proposed by (Medcalf and Gilles, 1965). Sample powder (1.5 g) was placed into a centrifuge at 3,250 rpm for 25 minutes the supernatant was discarded and residue was air dried and weighed.

Flow behaviour of prepared custard apple powder was evaluated in terms of Carr Index (CI) and Hausner ratio (Carr, 1965). Carr index or per cent compressibility and Hausner ratio was calculated by comparing bulk and tapped densities of the prepared custard apple powder (Kyu et al., 1998).

3. RESULTS

The physical characteristics and flow behaviour of custard apple powder obtained from convective tray drying method is presented in Table 1.

3.1 Moisture content, solubility index and density

As drying efficiency of powder is directly related to moisture content. In case of tray drying lower value of moisture content reduces chances of deterioration due to microorganisms. Moisture content (db) of tray dried custard apple powder ranges from 7.60 to 7.30 per cent.

The values of solubility index for tray dried powder was in the range of 7 to 9 ml. It means that the custard apple powder obtained could be dissolved in water at room temperature without any difficulty and make it convenient to use.

The bulk density and tapped density of custard apple powder prepared by using tray drying technology was in the range of 370.37 to 344.83 kg/m3 and 434.78 to 416.67 kg/m3. Higher bulk density values are recommended for smaller package size and longer shelf-life. While at lower values of bulk density higher the posibility to entrapped air with in powder particles cause oxidation of powder, which reduces storage stability of the powder.

3.2 Hygrscopicity and degree of caking

Hygroscopicity of developed custard apple powder was in the range of 0.76 to 0.86 g of water/kg dry solids/min. It is clear that custard apple powder obtained from tray drying method is highly hygroscopic in nature may be due to high sugar content. The value of hygroscopicity of samples decreases with increase in drying air temperature. As the moleculer weight of the powder is low it contains more hydrophilic groups and it adsorps more water. The degree of caking for custard apple powder was found to be in the range of 54.26 to 49.43. Normally higher value of degree of caking necessitates the incorporation of an anti-caking agent.

3.3 Colour, total soluble solids and water absorption capacity

Acccording to the result, The L* value for tray dried custard apple powder was ranged 75.15 to 80.25. Total soluble solid content and water absorption capacity of obtained custard apple powder was recorded to be between 52.68 to 54.67 % Brix and 0.63 to 0.68, respectively. Water absorption capacity for prepared powder indicated moderate dispersion and favorable reconstitution effect of custard apple powder.

3.4 Carr's index and Hausnar ratio

Carr's Index of custard apple powder prepared using convective tray drying technology was ranged from 7.01 to 12.06. As value of Carr's Index lies in range of 8-17 which indicates good flow behaviour of powder (Carr, 1965). Caking and stickiness are moderate due to good flowability of produced powders (Yousefi et al., 2011).

Hausner ratio of custard apple powder prepared using tray drying was in the range of 1.13 to 1.21. As Hausner ratio is <1.25 for the powder, which indicates that the powder has good flow (Carr, 1965).

Table. 1: Characteristics of custard apple powder

S. No.	Characteristic	Value
1.	Moisture content (% db)	6.77 ± 0.22
2.	Solubility index (mL)	6.60 ± .89
3.	Bulk density (ρ_b) (kg/m^3)	309.79 ± 8.63
4.	Tapped density (ρ_t), (kg/m^3)	355.23 ± 16.25
5.	Hygroscopicity (g water/ kg solids per min)	0.81 ± 0.01
6.	Degree of caking (%)	55.77 ± 2.00
	Colour scale L* value	91.94 ± 0.88
7.	Colour scale a* value	0.88 ± 0.06
	Colour scale b* value	0.62 ± 0.09
8.	Total soluble solids (% Brix)	41.71 ± 1.22
9.	Water absorption capacity (%)	0.62 ± 0.05
10.	Carr Index (%) or Compressibility	12.72 ± 2.38
11.	Hausner ratio	1.15 ± 0.03

All data are the mean value ± SD, n=5

4. CONCLUSION

The values of compressibility and hausner ratio for samples of dried powder were recorded as 15.06 per cent and 1.18 indicats good flow behavior. The results revealed that the powder obtained has shown good physical status, appreance quality with good flow. Water absorption capacity for prepared powder indicated moderate dispersion and favorable reconstitution effect of custard apple powder.

ACKNOWLEDGEMENTS

Author's extend their sincere gratitude to CSIR, New Delhi for their financial assistance during the course of investigation.

REFERENCES

Carr, R.L. 1965. Evaluating flow properties of solids. Chemical Engineering. 72: 163–168.

Charul, J. Champawat, P. S. Mudgal, V. D. Madhu, B. and Jain, S. K. (2019). Post-harvest processing of custard apple (Annona squamosa L.): A review. International Journal of Chemical Studies, 7(3): 1632-1637. DOI: 10.1080/10942919809524564

Goula, A.M. and Adamopoulos, K. 2004. Spray drying of tomato pulp: effect of feed concentration, Dry Technology. 22: 2309–2330.

IDF. 1979. In: Determination of the dispersibility and wettability of instant dried milk (Reference method). IDF standard. International Dairy Federation, Brussels: 87.

Jaya, S. and Das, H. 2004. Effect of maltodextrin, glycerol monostearate and tricalcium phosphate on vacuum dried mango powder properties. Journal of Food Engineering. 63: 125–134.

Jinapong, N. Suphantharika, M. and Jamnong, P. 2008. Production of instant soymilk powders by ultrafiltration, spray drying and fluidized bed agglomeration. Journal of Food Engineering. 84: 194–205.

Khodifad, B.C. and Kumar, N. 2019. Foaming properties of custard apple pulp and mathematical modelling of foam mat drying. Journal of Food Science and Technology. https://doi.org/10.1007/s13197-019-04082-0

Kyu, S.C. Dong, W.K. Suk S.K. and Mun Y.J. 1998. Bulk flow properties of model food powder at different water activity. International Journal of Food Properties, 1: 45-55.

Medcalf, D.G. and Gilles, K.A. 1965. Wheat starches: Comparison of physical properties. Cereal Chemistry, 42: 558–568.

Ojha, C. Jain, S. Kothari, S. Kaushik, R.A. and Panwar, N.L. 2018. Drying kinetics of custard apple pulp in natural circulation solar dryer. International Journal of Chemical Studies, 6: 939-942.

Patil, T. 2011. Standardization of a pretreatments for liquefaction of custard apple pulp for spray drying. M. Sc. Thesis, Post Graduate Institute Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722, Maharashtra, India.

Pino, J.A. 2010. Annona fruits. In: Hui, Y.H. (Eds.), Handbook of Fruit and Vegetable Flavors. Wiley, New Jersey: 229-246.

1Ranganna, S. 2002. In: Handbook of analysis and quality control for fruits and vegetable products. Tata McGraw Hill. New Delhi.

Sharma H.K. and Panesar, P.S. 2018. Processing and value addition of Custard Apple. In: Technologies in Food Processing, Apple Academic Press Inc, Waretown, USA.

Shashirekha, M.N. Revathy, B. Rao, L.J. Vijayalakshmi, M.R. and Rajarathnam, S. 2008. Influence of processing conditions on flavour compounds of custard apple (Annona squamosa L.). Swiss Society of Food Science and Technology, LWT. 41: 236–243.

Sondarva, K.N. Cholera, S.P. Jayswal, P.S. and Bharadiya, N.N. 2016. Preparation of custard apple powder and its packaging for storage. Agricultural Research– An International e-journal. 5: 88-97.

Soni, N. Mudgal, V.D. Champawat, P.S. 2021. Post-harvest processing of custard apple (Annona Squamosa L.) - a review. Journal of Postharvest Technology, 09: 96-102.

Soni, N. 2021. Studies on de-pulping mechanism and dehydration characteristics of custard apple pulp. Ph. D. Thesis, Maharana Pratap University of Agriculture and technology, Udaipur – 313 001, Rajasthan, India.

Vongsawasdi, P. Nopharatan, M. Tangbumrungpong, D. and Apinunjarupong, S. 2002. Production of instant fruit and vegetable juice by spray dryer and micro- wave-vacuum dryer. KMUTT Research and Development Journal. 25: 257-277.

Yousefi, S. Emam-Djomeh, Z. Mousavi, S.M. 2011. Effect of carrier type and spray drying on the physicochemical properties of powdered and reconstituted pomegranate juice (Punica ranatum L.). Journal of Food Science and Technology. 48: 677–684.