

Fortification of Chocolate with Jackfruit (*Artocarpus heterophyllus* Lam.) Seed Powder: Qualitative and Storage Studies

Neelamanidurga D.^{1*}, Swami D.V.², Ashok P.³ and Salomisuneetha D.R.⁴

¹M.Sc. Horticulture Scholar, Department of Postharvest Technology, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari (Andhra Pradesh), India.

²Controller of Examination, Department of Horticulture, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari (Andhra Pradesh), India.

³Senior Scientist, Department of Horticulture, Horticulture Research Station, Venkataramannagudem, West Godavari, (Andhra Pradesh), India.

⁴Dean of Student Affairs, Dr. Y.S.R. HU, Professor, Department of Biochemistry, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, West Godavari (Andhra Pradesh), India.

(Corresponding author: Neelamanidurga D.*)

(Received: 18 December 2022; Revised: 23 January, 2023; Accepted: 30 January, 2023; Published: 07 February, 2023)
(Published by Research Trend)

ABSTRACT: Jackfruit (*Artocarpus heterophyllus* Lam.) is one of the most underutilized fruit and producing maximum yield than any other tree specie. Jackfruit seed contains lignins, isoflavones, saponins, all phytonutrients and it had numerous health benefits such as anti cancer to anti hypertensive, anti aging, anti oxidant, anti ulcer and many others. Due to high perishable nature and lack of postharvest techniques we didn't enjoy the taste of jackfruit seeds throughout the year. Nutrients and flavour of jackfruit seeds which are more helpful to human health are available by value addition through fortification of chocolate with jackfruit seed powder. The experiment was conducted in Completely Randomized Design with eight treatments and three replications. In this experiment chocolate has been prepared by incorporation of jackfruit seed powder with different levels (5g, 10g, 15g, 20g, 25g, 30g and 35g) by using double boiling method. Then the moulded chocolates were wrapped with aluminum foil and studied the storage life (up to 2 months) of chocolate. During storage period, qualitative parameters like moisture content (%), Total soluble solids (Brix), titratable acidity (%), total sugars (%), reducing sugars (%), non reducing sugars (%), Protein content (%) and sensory parameters like appearance, texture, colour, taste, flavour and overall acceptability based on hedonic scale were recorded at every 15 days interval. The findings revealed that, lowest moisture content (2.17%), titratable acidity (1.08%) and highest total soluble solids (68.26°Brix), reducing sugars (2.79%), total sugars (44.92%) were recorded in T₂ (10g incorporation of jackfruit seed powder) and highest protein content (13.37%) was recorded in T₇ (with 35g jackfruit seed powder) jackfruit seed powder chocolate which was stored under refrigerated condition. Finally incorporation 10g of jackfruit seed powder chocolate was found to be the best among all treatments.

Keywords: Jackfruit, jackfruit seed powder, cocoa butter, cocoa powder, different levels, fortification.

INTRODUCTION

Jackfruit is the largest edible fruit in the plant kingdom and occupies a top position in quantity of food produced per unit area. India is the leading producer of jackfruit in the world with a production of 1876.66 thousand MT from an area of 185 thousand hectares (NHB, 2019). Tripura is the leading jackfruit producer in India and its total cultivation has been recorded to be 291.6 thousand tons and contributed about 16.8% of its share to India, followed by Orissa (232.8 thousand tons), Assam (197.2 thousand tons), West Bengal (196.8 thousand tons). Jackfruit seeds make-up around 10 to 15% of the total fruit weight and are rich in carbohydrate and protein (Tulyathan *et al.*, 2002).

The nutritional content of jackfruit seed is moisture content 61.80%, protein 11.85%, fibre 3.19% and carbohydrate 26.20%. The calorific value is 382.79 kcal/100 g. The ash and fat content (dry matter basis) is

0.15% and 1.0% respectively (Gupta *et al.*, 2011). Jacalin, the major protein from the jack seeds has proved useful tool for the evaluation of immune status of patients infected with HIV (Morton, 1987). Jackfruit seed contains lignins, isoflavones, saponins, all phytonutrients and it had numerous health benefits such as anti cancer to anti hypertensive, anti aging, anti oxidant, anti ulcer and many others (Swami *et al.*, 2012). Jackfruit seeds contains 15.88%, 2.49%, 5.78% of moisture, crude fibre and protein respectively but low in fat content 1.77% (Shariful and Rokeya 2015). Arpit and David (2015) studied the effects of different levels of jackfruit seed flour on the quality characteristics of chocolate cake and concluded that 10% jackfruit seed flour chocolate cake was better than 5% and 15% incorporation of jackfruit seed flour. Mishra *et al.* (2016) carried out an experiment on optimization of guava milk chocolate using response surface methodology and reported that the chocolate

produced with 14.3% guava powder had good sensory attributes.

Divya *et al.* (2017) carried out an experiment on standardization of optimal level of coconut based ingredients in chocolate preparation based on consumer acceptance. They concluded that cocoa butter substituted at the levels of 10% coconut oil, 20% coconut cream and 30% coconut milk were yielded best consumer acceptance. Rohan (2017) studied the standardization of recipe for nutraceutical dark chocolate bar with added moringa and quinoa. They stated that dark chocolate bar with added moringa and quinoa was highly nutritious product containing some traces of bio active compounds (quercetin, lutein, kaempferol and saponins) which can potentially provide several health benefits.

Rudrawar and Singar (2017) studied on incorporation of gulkhand in desiccated coconut chocolate during process standardization and their sensory attributes. They observed that gulkhand added desiccated coconut chocolate was found most acceptable compared to mint and basil added samples. Akter and Haque (2018) carried out an experiment on utilization of jackfruit seed flour in food processing. They concluded that addition of jackfruit flour cookies resulted in nutritionally superior products, particularly enriched with mineral and fibre content. Singh *et al.* (2018) carried out an experiment on optimization and functional analysis of guava enriched chocolate formulation. They observed that chocolate made from 16% guava powder, 84% other ingredients was acceptable and can be stored upto 2 months at lower temperature (10°C) without any spoilage.

Deshpande *et al.* (2019) studied the standardization process and sensory evaluation of probiotic chocolate. The probiotic milk chocolate had similar sensory properties as like probiotic free chocolate.

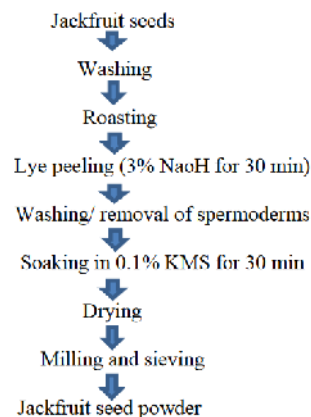
An experiment on quality evaluation of muskmelon seed flour and jackfruit seed flour for confectionary products development. The jack fruit seed flour cake was overall acceptable in quality and sensory attributes than muskmelon seed flour cake. Ejiofor and Sailu (2020) studied the effect of jackfruit pulp inclusion on physic - chemical and sensory properties of cake. The cake produced with 10% jackfruit pulp flour had good sensory attributes. Fitriani *et al.* (2020) studied the physico-chemical, antioxidant and sensory properties of chocolate spread fortified with jackfruit seed flour. The chocolate spread prepared with 10% of jackfruit seed flour was highly acceptable. Ramya *et al.* (2020) studied the nutritional and sensory evaluation of cookies incorporated with jackfruit rind powder. They observed that cookies prepared with 5% jackfruit rind powder had the highest overall acceptance in sensory evaluation. To reduce the postharvest losses and make available the nutrients of jackfruit seed throughout the year which are more beneficial to human health in the form of chocolates by fortification.

MATERIALS AND METHODS

The experiment carried out during 2021-22 at Postharvest Technology Research station, Venkataramannagudem. The experiment was laid out in

completely Randomized design with 8 treatments and 3 replications. Jackfruit seeds were extracted from freshly harvested jackfruit from the jackfruit orchard, HRS Venkataramannagudem and jackfruit seed powder was prepared from jackfruit seeds.

Flow Chart for Preparation of Jackfruit Seed Powder



Preparation of Jackfruit Seed Powder Chocolate.

First take the 50g of cocoa butter and melted then all ingredients are poured into melted cocoa butter.

Moulded in required shapes after complete homogenization and refrigerate for 3 hours at 4. finally prepared chocolates were wrapped with aluminium foil and for 2 months. Studied the qualitative parameters like total soluble solids (°Brix), moisture content, reducing sugars, non reducing sugars, total sugars, protein content, ascorbic acid and titratable acidity and sensory parameters are flavour, colour, taste, appearance, texture and overall acceptability at 15 days interval upto 2 months.

Statistical Analysis. The data obtained were analysed statistically by following standard methods developed by Panse and Sukhatme (1967) for Complete Randomized Design (CRD). Statistical significance was tested, using 'F' value at 5% level of significance. The results were depicted graphically wherever necessary.

RESULTS AND DISCUSSION

The effect of jackfruit seed powder on different qualitative parameters like moisture content (%), total soluble solids (°brix), total sugars (%), titratable acidity (%), ascorbic acid (mg), Protein content (%), overall acceptability of chocolate during storage period were studied, statistically analyzed, findings tabulated.

Moisture content (%). There was increase in moisture content of chocolate prepared with jackfruit seed powder from initial day to 60th day of storage. During the entire storage period, the moisture content was gradually increased from initial day to 60th day of the storage. It might be due to water retaining capacity of dry solids which have more water retaining capacity. Same results were observed by Deshpande *et al.* (2019) in prebiotic chocolate and Fitriani *et al.* (2020) in chocolate spread fortified with jackfruit seed flour.

Total soluble solids (°Brix). The data referring to total soluble solids of chocolate prepared with jackfruit seed powder were presented in Table 1. Highest total soluble

solids (65.70 °Brix) recorded on initial day and increased to 69.93 °Brix on 60th day in 15g jackfruit seed flour incorporated chocolate. Maximum mean total soluble solids (68.26 °Brix) in 15g jackfruit seed powder incorporated chocolate followed by 10g jackfruit seed powder incorporated chocolate.

Conversion of starch and insoluble carbohydrates into sugars which are present in the chocolate leads to increasing the total soluble solids up to 60 days. Similar trend of increase observed in enriched jackfruit seed powder chocolate spread by Fitirani *et al.* (2020) and in guava milk chocolate by Mishra *et al.* (2016).

Table 1: Effect of jackfruit seed powder on total soluble solids (°brix) of chocolate at different days of storage.

Treatments	TSS (°Brix)					Mean
	Initial day	15 th day	30 th day	45 th day	60 th day	
T ₁	64.60	68.60	68.90	69.16	69.53	68.16
T ₂	65.70	66.90	69.13	69.63	69.93	68.26
T ₃	65.46	66.47	67.06	67.93	69.47	67.28
T ₄	62.70	63.56	66.93	67.43	69.86	67.10
T ₅	63.77	63.53	68.10	69.60	69.33	66.87
T ₆	63.53	64.76	66.90	68.46	69.8	66.69
T ₇	64.60	65.20	66.13	66.43	68.03	66.08
T ₈	60.47	61.56	62.30	63.30	64.30	62.39
SE(m)±	0.133	0.41	0.651	0.461	0.289	
CD @ 5%	0.401	1.241	1.968	1.394	0.875	

Total sugars (%). The peak total sugars (44.92%) noticed in 15g jackfruit seed powder incorporated chocolate. 15g jackfruit seed powder incorporated chocolate has gained maximum mean total sugars (44.92%) followed by 20g jackfruit seed powder

incorporated chocolate (44.37%). Degradation of organic acids reason for recording peak total sugars. Analogous observations reported in nutraceutical dark chocolate by Molu *et al.* (2021); Rudrawar and Singar (2017).

Table 2: Effect of jackfruit seed powder on total sugars (%) of chocolate at different days of storage.

Treatments	total sugars (%)					Mean
	Initial day	15 th day	30 th day	45 th day	60 th day	
T ₁	41.10	41.40	43.50	44.60	45.03	43.13
T ₂	43.90	44.17	44.72	45.08	46.73	44.92
T ₃	42.33	42.47	43.83	44.83	46.63	44.02
T ₄	43.40	43.63	44.10	44.20	46.53	44.37
T ₅	41.37	42.13	43.70	44.37	46.37	43.59
T ₆	41.77	42.17	44.67	44.87	46.87	44.07
T ₇	42.40	43.43	43.96	44.43	46.21	44.08
T ₈	39.40	40.40	41.30	43.40	44.40	41.78
SE(m)±	0.195	0.138	0.212	0.142	0.449	
CD @ 5%	0.59	0.418	0.645	0.43	1.357	

Protein content (%). The results found that, there was a significant difference among all the treatments. The maximum protein content was recorded in 35g jackfruit seed powder incorporated chocolate with 13.37% because it have maximum content of jackfruit seed powder. Protein content was gradually declined from

initial to 60th day of storage period it might be due to degradation of proteins into amino acids. Sarkate (2012) observed in cashew bar same as this experiment results and by Rohan (2017) in nutraceutical dark chocolate.

Table 3: Effect of jackfruit seed powder on protein content (%) of chocolate at different days of storage.

Treatments	Protein content (%)					Mean
	Initial day	15 th day	30 th day	45 th day	60 th day	
T ₁	6.54	6.49	5.43	5.10	4.03	5.52
T ₂	7.83	7.58	6.47	6.23	5.10	6.64
T ₃	9.13	9.07	8.95	8.70	7.63	8.70
T ₄	10.40	10.34	9.31	9.20	8.10	9.47
T ₅	11.70	11.61	10.59	10.50	9.37	10.75
T ₆	13.00	12.49	11.47	11.37	10.23	11.71
T ₇	14.27	14.22	13.21	13.13	12.00	13.37
T ₈	5.30	5.24	4.13	4.03	3.00	4.34
SE(m)±	0.19	0.071	0.11	0.134	0.085	
CD @ 5%	0.57	0.214	0.33	0.406	0.257	

Over all acceptability. The results revealed that, there was a significant difference among all treatments and showed in Table 4. The highest score was recorded in 15g jackfruit seed powder incorporated chocolate (8.48) followed by 20g jackfruit seed powder chocolate (8.45)

among all treatments. 15g jackfruit seed powder incorporated chocolate has gained overall acceptance with respect to taste, flavour, colour, appearance and texture. Analogous findings observed in guava milk chocolate observed by Mishra *et al.* (2016).

Table 4: Effect of jackfruit seed powder on overall acceptability of chocolate at different days of storage.

Treatments	Overall acceptability					Mean
	Initial day	15 th day	30 th day	45 th day	60 th day	
T ₁	8.62	8.61	8.46	8.23	8.14	8.41
T ₂	8.72	8.68	8.48	8.35	8.15	8.48
T ₃	8.70	8.65	8.45	8.33	8.13	8.45
T ₄	8.62	8.58	8.38	8.25	8.13	8.39
T ₅	8.60	8.56	8.41	8.29	8.13	8.40
T ₆	8.63	8.54	8.44	8.24	8.04	8.38
T ₇	8.58	8.52	8.41	8.21	8.09	8.36
T ₈	8.25	8.23	8.14	8.08	8.02	8.14
SE(m)±	0.007	0.007	0.008	0.007	0.009	
CD @ 5%	0.021	0.02	0.023	0.022	0.028	

CONCLUSION

The experiment was carried out with 8 treatments and 3 replications. In the experiment, different levels of jackfruit seed powder was incorporated in chocolate and prepared chocolates were stored at 4°C up to 2 months. During storage period, qualitative and sensory parameters were recorded at 15 days interval from initial day to 60th day. Among all the treatments, incorporation of 15g of seed powder chocolate was the best in both qualitative and sensory parameters and gaining highest benefit cost ratio (1.43).

FUTURE SCOPE

In Present investigation, jackfruit seed powder was incorporated in chocolate which is more beneficial to human health, to extend the research work there is the possibility of adding moringa, curry leaf, dry fruits along with jackfruit seed powder to enrich the chocolate.

Acknowledgement. I extend my sincere thanks to my advisory committee for giving me proper guidance throughout my research work and to university for providing facilities for research.

Conflict of Interest. None.

REFERENCES

Arpit, S. and David, J. (2015). Effect of different levels of jackfruit seed flour on the quality characteristics of chocolate cake. *Research Journal of Agriculture and Forestry Sciences*, 3(11), 6-9.

Deshpande, W. H., Kharat, T. V., Katke, D. S. and Jadhav, B. V. (2019). Studies on process standardization and sensory evaluation of probiotic chocolate. *International Journal of current Microbiology and Applied Sciences*, 8(8), 1527-1534.

Divya, V., Baskaran, D., Gnanalakshmi, S. K., Reinclude, A. M. and Reiyas, A. M. (2017). Standardization of optimal level of coconut variants in chocolates based on consumer acceptance. *Journal of Current Research in Nutrition and Food science*, 5(1), 36-42.

Ejiofor, E. J. and Sailu, C. (2020). Effect of jackfruit pulp inclusion on the physico-chemical and sensory

properties of cake. *Journal of Food science and Nutrition Technology*, 5(2), 152-161.

Fitriani, N. U.A., Yusuf, M., Pirman, Syahriati and Rahmiah, S. (2020). Physicochemical, antioxidant and sensory properties of chocolate spread fortified with jackfruit seed flour. *Indian Journal of Food research*, 4(6), 2147-2155.

Gupta, D., Mann, S., Sood, A. and Gupta, R. K. (2011). Phytochemical, nutritional and anti oxidant activity evaluation of seed of jackfruit. *International Journal of Pharma and Biosciences*, 2(4), 336-345.

Morton, J. (1987). Jackfruit. *Fruits of Warm Climate*, 58-64.

Mishra, D., Chauhan, A., Bhardwaj, R., Kumar, P. and Yadav, D. (2016). Optimization of guava milk chocolate using response surface methodology. *Journal of Biosciences Biotechnology Research Asia*, 13(3), 1715-1723.

Molu, R. K., Sharon, L. C., Panjikaran, T. S., Aneena, R. E., Lakshmy, S. P., Nivya, M. E. and Rajeesha, R. C. (2021). Standardization of jackfruit seed incorporated chocolates and its quality evaluation. *Asian Journal of Dairy and Food research*, 40(4), 471- 475.

NHB (2019). Crop wise area production of Horticultural crops for three years. *Horticultural statistics at a glance*, 2018. National Horticulture Board, Ministry of Agriculture and Farmers welfare, Government of India, New Delhi. P.9. <www.nhb.gov.in>

NHB (2015). Crop wise area production of Horticultural crops for three years. *Horticultural statistics at a glance*, 2015. National Horticulture Board, Ministry of Agriculture and Farmers welfare, Government of India, New Delhi. P.10. <www.nhb.gov.in>

Panase, V. G. and Sukhatme, P. V. (1967). Statistical methods for agriculture workers. Completely Randomized Design (CRD). *Agricultural Research in the Dry Areas*, 342, 326-328.

Ramya, N. H., Anitha, S. and Ashwini, A. (2020). Nutritional and sensory evaluation of jackfruit rind powder incorporated with cookies. *International Journal of Current Microbiology and Applied Sciences*, 9, 189-197.

Rohan, S. R. (2017). Standardization of recipe for nutraceutical dark chocolate bar with added moringa and quinoa. Thesis submitted in MIT Art Design and Technology University, Pune, Maharashtra.

Rudrawar, D. B. and Singar, N. S. (2017). Utilization of gulkand in desiccated coconut chocolate process

- standardization and their sensory attributes. *International Journal of Life Sciences Leaflets*, 84, 46-56.
- Sarkate, S. M. (2012). Studies on preparation of cashew (*Anacardium occidentale* L.) bar. A M.Sc. (Post harvest management) thesis submitted to the Post Graduate Institute of Post Harvest Management, Killa-Roha, Dist Raigad, Maharashtra state.
- Shariful, I. and Rokeya, B. (2015). A Study on Nutritional and Functional Properties Analysis of Jackfruit Seed Flour and Value Addition to Biscuits. *International Journal of Engineering Research and Technology*, 4(12), 139-147.
- Singh, S., Mishra, D. and Chauhan, A. K. (2018). Optimization and functional analysis of guava enriched chocolate formulation. *Indian Journal of Dairy Sciences*, 71(6), 571-578.
- Swami, S. B., Thakor, N. J., Haldankar, P. M. and Kalse, S. B. (2012). Jackfruit and its many functional components as related to human health: a review. *Comprehensive Reviews in Food Science and Food Safety*, 11(6), 565-576.
- Tulyathan, V., Tananuwonga, K., Songjinda, P. and Jaiboon, N. (2002). Some Physicochemical Properties of Jackfruit (*Artocarpus heterophyllus* Lam.) Seed Flour and Starch. *Science Asia*, 28(2), 37-41.

How to cite this article: Neelamanidurga D., Swami D.V., Ashok P. and Salomisuneetha D.R. (2023). Fortification of Chocolate with Jackfruit (*Artocarpus heterophyllus* Lam.) Seed Powder: Qualitative and Storage Studies. *Biological Forum – An International Journal*, 15(2): 107-111.