Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 25, No. (3) : 2023 : 408-413

ISSN-0972-3005

DOI No.: http://doi.org/10.53550/AJMBES.2023.v25i03.003

UTILIZATION OF AROMATIC JACKFRUIT SEED FLOUR FOR THE DEVELOPMENT OF FUNCTIONAL COOKIES

K. HIBA AND P.R. GEETHA LEKSHMI*

Kerala Agricultural University, Department of Postharvest Management,
College of Agriculture, Vellayani, Thiruvananthapuram 695 522, India

(Received 2 January, 2023; Accepted 6 March, 2023)

Key words: *Aromatic jackfruit seed flour, Crumb colour, Functional cookies, Sensory analysis, Spread ratio*

Abstract– Jackfruit (*Artocarpus heterophyllus* Lam) is an important tropical fruit which bears profusely leading to seasonal glut and postharvest losses. The fruits remain underutilized and the jackfruit seeds, rich in nutrients and phytochemicals are often discarded. Cookies are widely consumed as a snack food and the demand for healthy bakery products is increasing. The food processing industry has recognized jackfruit seed as a novel food ingredient with desirable functional properties due to its high content of phytonutrients. Refined wheat flour which is generally used for cookie preparation can be replaced with jackfruit seed flour to make it more healthy. The present study was conducted with the objective to develop functional cookies with aromatic jackfruit seed flour, processed after pre-treatment, with good sensory acceptability. The cookies were prepared in different combinations of refined wheat flour, aromatic jackfruit seed flour, and jackfruit seed flour without any pre-treatments. Nutritional, physical and sensory qualities of the cookies were analysed. Aromatic jackfruit seed flour cookies had more carbohydrates, crude protein, crude fibre and total ash content than other cookies. Cookies with aromatic jackfruit seed flour (10%) and refined wheat flour (90%) combination had the highest carbohydrate (30.60%), crude protein (10.53%), crude fibre (2.47%) and total ash (2.00%) content. The yield of jackfruit seed flour cookies varied from 141.57% to 158.40% between the treatments combinations even though the difference was statistically non-significant. The thickness of jackfruit seed flour cookies was not influenced by the formulation and type of jackfruit seed flour. The treatment combination of refined wheat flour (100%) without cocoa powder had the highest diameter of 6.47 cm, and aromatic jackfruit seed flour (10%) and refined wheat flour combination (90%) recorded a diameter of 4.39 cm. The spread ratio of jackfruit seed flour varied from 6.76 to 4.01 and the treatment combination of aromatic jackfruit seed flour (10%) and refined wheat flour (90%) had a spread ratio of 4.17. The sensory qualities of the jackfruit cookies revealed that the treatment combination of 10% aromatic jackfruit seed flour and refined wheat flour (90%) recorded the highest mean score for appearance, crumb colour, texture, mouthfeel, flavour and overall acceptability with lower cracking. Based on the results of nutritional, physical and sensory analyses, the cookies developed by the substitution of 10% aromatic jackfruit seed flour instead of refined wheat flour yielded nutritionally rich cookies with consumer acceptability.

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam) is the largest edible fruit with the highest yield which remains underutilised. As a fruit, jackfruit bulbs are used and seeds are often wasted which contribute to about10 to 15 per cent of the total weight of the fruit. Jackfruit seeds are abundant in starch, protein, dietary fibre, minerals, and phytonutrients and jackfruit seed flour could be a novel functional ingredient with promising nutraceutical potential. Food products containing functional ingredients are the major thrust of food industry to meet the nutritional requirement of people for a healthy diet. Cookies are widely consumed as a snack food, especially in developing nations. Therefore, by modifying their nutritional composition, cookies can act as a vehicle for delivering important nutrients. Blending jackfruit seed flour and wheat flour without adversely affecting the sensory profile of the final product could improve the nutritional quality of the processed product (Akter and Haque, 2018). Suitable pre-treatment and processing techniques of jackfruit seeds could develop chocolate aroma in jackfruit seed flour which is an inventive substitute for cocoa powder in food

preparations (Spada *et al*., 2018). The baking industry in India is growing at a very faster rate and the demand for healthy bakery products is increasing. Biscuits and cookies generally prepared from refined wheat flour are deficient in proteins, vitamins, minerals and fibre. Jackfruit seed flour can be utilised for the preparation of nutrient-dense cookies (Varghese *et al*., 2020) as jackfruit seed flour had higher levels of protein, ash, fibre and other nutrients. The jackfruit seed flour with chocolate aroma developed through various pre-treatments and processing methods could be utilised for the preparation of cookies with chocolate flavour and it is a novel process to improve the acceptability of jackfruit seed flour cookies with better nutritional and sensory qualities.

MATERIALS AND METHODS

Jackfruit seeds after fermentation were washed and dried after removing the spermoderm, in a hot air oven at 60°C for 2 hours. The seeds were then roasted (170 °C, 30 minutes) and milled to obtain aromatic jackfruit seed flour (AJSF). The jackfruit seeds without fermentation were dried in a hot air oven at 60 °C for 2 hours after removing the spermoderm and then roasted at 170 °C for 30 minutes and milled to get dried jackfruit seed flour (DJSF). The refined wheat flour (WF) was replaced with aromatic jackfruit seed flour (AJSF) as well as jackfruit seed flour (DJSF) at different proportions along with ground sugar, butter, curd, milk, baking powder, salt for the preparation of cookies. Cookies from refined wheat flour with cocoa powder and without cocoa powder were also taken as control. The cookies were baked in a convection oven at 170 ^{0}C. The treatment combinations were, T_1- Aromatic jackfruit seed flour (AJSF 5%) + Refined wheat flour (WF 95%), T_2- Aromatic jackfruit seed flour (AJSF 10%) + Refined wheat flour (WF 90%), T_3- Aromatic jackfruit seed flour (AJSF 15%) + Refined wheat flour (WF 85%), T_4- Aromatic jackfruit seed flour (AJSF 20%) + Refined wheat flour (WF 80%), T_5- Aromatic jackfruit seed flour (AJSF 25%) + Refined wheat flour (WF 75%), T_6- Dried jackfruit seed flour (DJSF 5%) + Refined wheat flour (WF 95%), T_7- Dried jackfruit seed flour (DJSF 10%) + Refined wheat flour (WF 90%), T_8- Dried jackfruit seed flour (DJSF 15%) + Refined wheat flour (WF 85%), T_9- Dried jackfruit seed flour (DJSF 20%) + Refined wheat flour (WF 80%), T_{10}- Dried jackfruit seed flour (DJSF 25%) + Refined wheat flour (WF 75%), T_{11}- Refined wheat flour (100%) with cocoa powder and T_{12}- Refined wheat flour (100%) without cocoa powder. The cookies developed were analysed for biochemical (nutritional), physical, antinutritional and sensory quality using standard procedures and protocols.

Biochemical analysis: The cookies were analysed for carbohydrate (Dubois *et al*., 1956) crude protein (Bradford, 1976), crude fibre (Sadasivam and Manickam, 1992) crude fat (Soxhlet extraction with petroleum ether as solvent), total ash (Ranganna, 1986), and antinutritional factors *viz*., oxalate (Chinma and Igyor, 2007) and phytate content (Wheeler and Ferrel, 1971).

Physical parameters : The yield (%) was calculated as the ratio of weight of the baked cookies to the weight of raw cookies, thickness (cm) and diameter (cm) of cookies were measured using a vernier caliper. The spread ratio was calculated as the diameter to thickness ratio as described by Nandeesh *et al*. (2011).

Sensory analysis

Sensory attributes of developed cookies were analysed by a 30-member semi-trained panel using a 9-point hedonic scale for appearance, cracking, crumb colour, texture, mouth feel, flavour and overall acceptability (Ranganna, 1986) in the order of preference *viz*., 1-Dislike extremely,2-Dislike very much,3-Dislike moderately,4-Dislike slightly,5-Neither like or dislike, 6-Like slightly,7-Like moderately, 8-like very much and 9-Like extremely for all parameters except for cracking. For the cracking attributes, the scores were 1- No cracking, 2- very less cracking, 3- Less cracking, 4- Moderate cracking, 5- Slight cracking, 6- High cracking, 7- Very high cracking, 8- Extreme cracking and 9- Full cracking.

Statistical analysis

The data generated were analysed statistically using a Completely Randomized Design (CRD) and significance was tested using analysis of variance at 5% significance level. The Kruskall-Wallis test (chi-square value) was used to analyse the sensory attribute score to check the statistical difference between the treatments (Shamrez *et al*., 2013).

RESULTS AND DISCUSSION

Biochemical analysis of cookies

Biochemical analysis of jackfruit seed flour cookies of different formulations are depicted in Table 1. The

carbohydrate content of cookies varied from 16.12%. to 34.73%. The cookies developed with aromatic jackfruit seed flour (25%) and refined wheat flour (75%) recorded the highest carbohydrate content of 34.73% which was on par with cookies formulation of 5% AJSF with 95% RF, 10% AJSF with 90% RF, 15% with 85% RF, 20% AJSF with 80% RF. The lowest carbohydrate content (16.121%) was observed for the formulation of jackfruit seed flour from drying process (5%) and refined wheat (95%) which showed no significant difference with dried jackfruit seed flour cookies with 10% and 15% formulations. Ramya *et al*. (2020) reported that total carbohydrates in cookies were found to increase with the replacement of jackfruit rind flour and cookies with 15% jackfruit rind flour resulted in higher carbohydrate content of 64.56%.

The crude protein content of jackfruit seed flour cookies varied from 7.90% to 11.54% and the cookies with aromatic jackfruit seed flour (25%) recorded the highest values of 11.54% for protein and which showed no significant difference with treatment formulation of 5% AJSF, 10% AJSF,15%AJSF and 20% AJSF with refined wheat flour. The roasting / thermal processing might have increased the protein content of jackfruit seed flour which improved the protein content of cookies prepared with the addition of aromatic jackfruit seed flour as reported by Zuwariah *et al*. (2018).

The treatment formulation with 25% AJSF and 75%WF had the highest crude fibre content of 3.51% which showed no significant difference with cookies prepared from 10%, 15% and 20% aromatic jackfruit flour with refined wheat flour while the treatment with 100% WF with cocoa powder and without cocoa powder recorded the lowest crude fibre content of 1.01 % and 1.19% respectively. The crude fat content of the cookies was not influenced by the treatment formulations and the total ash content of jackfruit cookies varied from 0.89% to 3.20%. The highest total ash content of 3.20% was observed for treatment formulation of 25% AJSF and 75%WF which showed no significant difference with formulation of 20% AJSF and 80% WF. The control treatments (refined wheat flour with cocoa powder and without cocoa powder) recorded the lowest ash content (0.91 % and 0.89% respectively). These results are in line with the findings of Maskey *et al*. (2020) who reported that 2.78% of crude fibre, 12.80% crude protein, 26.39% crude fat, and 1.43% total ash content in jackfruit cookies with 12.5% jackfruit seed flour.

Anti-nutritional factors viz., oxalate and phytate were not detected in jackfruit seed flour cookies. According to Abiola *et al.* (2018), the roasted samples had the highest percentage reduction in all the anti-nutrients when compared to the fermented sample (tannin, phytate, oxalate, and saponin). Attaugwu *et al.* (2016) reported that fermentation, roasting, and boiling treatments reduced anti-nutritional factors like oxalate, phytate, tannin, trypsin inhibitor, and haemagglutinin.

Physical parameters of cookies

The yield, thickness, diameter and spread ratio of cookies are given in Table 2. The yield of jackfruit seed flour cookies varied from 141.57% to 158.40% and there was no significant difference between the treatments. Quast *et al*. (2016) presented similar results for the yield of cookies which varied from

Table 1. Biochemical parameters of jackfruit seed flour cookies

Treatment formulations	Carbohydrate (%)	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Total ash (%)
T_1 [AJSF(5%) + WF(95%)]	29.76^{abc}	10.25^{bc}	1.96^{bcde}	12.09	1.58^{de}
T_2 [AJSF(10%) + WF(90%)]	30.60^{abc}	10.53^{ab}	2.47^{abcd}	12.07	2.00^{cd}
T_3 [AJSF(15%) + WF(85%)]	32.92^{ab}	11.22^{ab}	2.72^{abc}	14.03	2.41^{bc}
T_4 [AJSF(20%) + WF(80%)]	33.33^{ab}	11.35^{a}	3.05^{ab}	14.08	2.79^{ab}
T_5 [AJSF(25%) + WF(75%)]	34.73^{a}	11.54^{a}	3.51^{a}	12.30	3.20^{a}
T_6 [DJSF (5%) + WF(95%)]	16.12^{f}	8.80^{def}	1.45^{de}	12.25	0.97^{ef}
T_7 [DJSF(10%) + WF(90%)]	16.92^{f}	8.61^{def}	1.53^{de}	11.97	1.18^{ef}
T_8 [DJSF(15%) + WF(85%)]	18.35^{f}	9.02^{de}	1.83^{cde}	12.13	1.23^{ef}
T_9 [DJSF(20%) + WF(80%)]	19.72^{ef}	9.15^{de}	2.04^{bcde}	13.58	1.42^{def}
T_{10} [DJSF(25%) + WF(75%)]	21.24^{def}	9.35^{ed}	2.35^{bcd}	12.31	1.55^{de}
T_{11} [WF(100%) with cocoa powder]	25.28^{cde}	8.29^{ef}	1.01^{e}	14.23	0.91^{f}
T_{12} [WF (100%) without cocoa powder]	27.22^{bcd}	7.90^{f}	1.19^{e}	14.99	0.89^{f}
SE(±m)	2.284	0.349	0.387	1.771	0.21
CD (0.05)	6.666	1.018	1.128	NS	0.613

84.4% to 87.5% for taro flour cookies and the yield did not differ significantly between the different combinations of taro flour addition. The thickness of the jackfruit seed flour cookies was not significantly different between the treatments and varied from 0.95 cm to 1.12 cm. The diameter of jackfruit seed flour was reduced with the addition of jackfruit seed flour however aromatic jackfruit seed flour (25%) cookies had lowest value (4.00 cm) for diameter which was on par with formulation of 20% aromatic jackfruit seed flour and 80% refined wheat flour. The highest value of 6.47 cm for diameter was recorded for cookies with 100% refined wheat flour without cocoa powder which showed no significant difference with treatment 100% refined wheat flour with cocoa powder. Maurya (2017) observed that the diameter decreased as the quantity of jackfruit seed flour increased and the diameter of jackfruit seed flour cookies varied from 0.89% to 0.95% (Maskey *et al*., 2020).

The spread ratio of jackfruit seed flour cookies varied from 4.01 to 6.76 and decreased with an increasing amount of jackfruit seed flour and aromatic jackfruit seed flour cookies had a lower spread ratio than dried jackfruit seed flour cookies. The treatment formulation 100% refined wheat flour without cocoa powder had highest spread ratio (6.76) and the treatment formulation of 25% AJSF with 75% WF recorded the lowest spread ratio of 4.01 which was on par with the treatment formulation of AJSF (5%) with WF (95%), AJSF (10%) with WF (90%), AJSF (15%) with WF (85%) and AJSF (20%) with WF (80%). The spread factor might have decreased as a result of gluten being

Table 2. Physical parameters of jackfruit seed flour cookies

Treatment formulations	Yield (%)	Thickness(cm)	Diameter(cm)	Spread ratio
T_1 [AJSF(5%) + WF(95%)]	142.30	1.12	4.71^{cdef}	4.19^{e}
T_2 [AJSF(10%) + WF(90%)]	145.13	1.05	4.39^{def}	4.17^{e}
T_3 [AJSF(15%) + WF(85%)]	150.37	1.01	4.21^{ef}	4.14^{e}
T_4 [AJSF(20%) + WF(80%)]	155.40	1.00	4.12^{f}	4.07^{e}
T_5 [AJSF(25%) + WF(75%)]	158.40	0.99	4.00^{f}	4.01^{e}
T_6 [DJSF (5%) + WF(95%)]	141.57	1.03	5.70^{abc}	5.68^{c}
T_7 [DJSF(10%) + WF(90%)]	144.76	1.01	5.45^{abcd}	5.42^{cd}
T_8 [DJSF(15%) + WF(85%)]	146.04	1.00	5.39^{abcde}	5.39^{cd}
T_9 [DJSF(20%) + WF(80%)]	149.88	0.98	5.10^{bcdef}	5.22^{d}
T_{10}[DJSF(25%) + WF(75%)]	151.00	0.95	4.89^{bcdef}	5.13^{d}
T_{11} [WF(100%) with cocoa powder]	146.88	0.99	6.10^{ab}	6.24^{b}
T_{12} [WF (100%) without cocoa powder]	150.23	0.96	6.47^{a}	6.76^{a}
SE(±m)	4.56	0.07	0.43	0.15
CD (0.05)	NS	NS	1.26	0.45

Table 3. Evaluation of sensory qualities of jackfruit seed flour cookies

	Mean scores						
Treatment formulations	Appearance	Cracking	Crumb colour	Texture	Mouth feel	Flavour	Overall acceptability
T_1 [AJSF (5%) + WF (95%)]	8.80	6.20	6.00	8.60	8.00	7.40	7.40
T_2 [AJSF (10%) + WF (90%)]	8.40	6.40	6.20	8.20	8.60	7.60	8.60
T_3 [AJSF (15%) + WF (85%)]	7.20	6.80	6.60	7.80	7.20	8.00	7.20
T_4 [AJSF (20%) + WF (80%)]	6.20	7.00	7.80	7.40	7.40	8.20	6.60
T_5 [AJSF (25%) + WF (75%)]	5.20	7.20	8.40	7.20	7.00	8.20	6.60
T_6 [DJSF (5%) + WF (95%)]	7.00	7.60	6.00	7.80	7.00	6.00	6.40
T_7 [DJSF (10%) + WF (90%)]	6.60	7.80	6.40	7.60	6.80	6.20	6.40
T_8 [DJSF (15%) + WF (85%)]	6.40	8.20	7.00	7.40	7.00	6.60	5.80
T_9 [DJSF (20%) + WF (80%)]	5.80	8.40	7.60	7.00	6.80	7.00	5.80
T_{10} [DJSF (25%) + WF (75%)]	5.60	8.60	8.20	7.00	7.00	7.00	5.40
T_{11} [WF (100%) with cocoa powder]	6.80	6.20	6.80	8.40	7.60	7.20	6.40
T_{12}[WF (100%) without cocoa powder]	6.80	6.00	5.60	8.60	7.20	5.00	6.00
K	128.08	130.10	124.46	80.69	59.74	120.47	93.86
x^2(0.05)	19.68						

reduced with increased levels of replacement of wheat flour (Chowdhury *et al*., 2012). The biscuit prepared with jackfruit seed flour and coconut milk residue recorded a spread ratio in the range of 8 to 10 (Barge and Divekar, 2018).

Sensory qualities of cookies

The jackfruit seed flour cookies formulation with 5 % aromatic jackfruit seed flour and cookies formulation with 95% refined wheat flour recorded the highest mean score of 8.80 for appearance and the lowest score (5.20) was recorded for cookies with 25% aromatic jackfruit seed flour (Table 3). The appearance score might have decreased as the amount of jackfruit seed flour increased because the darker colour of jackfruit seed flour made the cookies darker than other types of flour. In the present study, the cracking of jackfruit seed flour cookies varied from 6.00 to 8.60. The increase in cracking might be due to the replacement of refined wheat flour with jackfruit seed flour, and dried jackfruit seed flour cookies had higher cracking than aromatic jackfruit seed flour cookies and dried jackfruit seed flour (20%) with refined wheat flour (80%) cookie recorded highest cracking mean score of 8.40 while cookies prepared from refined wheat flour without cocoa powder recorded a lowest cracking score of 6.00. The highest texture mean score (8.60) was obtained for refined wheat flour without cocoa powder and 5% aromatic jackfruit seed flour formulation with 95% refined flour.There was a slight decrease in texture when the amount of jackfruit seed flour was increased; however, aromatic jackfruit seed flour cookies had a higher score for texture compared to dried jackfruit seed flour. The aromatic jackfruit cookies formulation with 10% aromatic jackfruit seed flour and 90% refined wheat flour had the highest value for mouthfeel (8.60) and with a good flavour (7.60). It was observed that when the amount of aromatic jackfruit seed flour increased, the flavour of the cookies also increased. The overall acceptability score (8.60) of 10% aromatic jackfruit seed flour cookies was higher as compared to all other formulations.

Similar results were obtained by Maskey *et al*. (2020) for appearance, crumb colour, and texture. Appearance score might have decreased as the amount of jackfruit seed flour increased because the darker colour of jackfruit seed flour made cookies darker than other formulations. The crumb colour of jackfruit seed cookies improved as the amount of jackfruit seed flour increased. Ramya *et al*. (2020) reported decreased mean sensory scores for texture with increased amount of jackfruit rind flour in preparation of cookies. The jackfruit seed flour could be used as a substitute for cocoa powder and 10 % substitution did not alter the characteristics of chocolate (Ravindran*et al*., 2020). Cookies made with jackfruit seed flour had good printability and quality for 3D printed nutrient dense cookies (Varghese *et al*., 2020).

CONCLUSION

The biochemical, physical, and sensory analyses of jackfruit cookies developed with different combinations of jackfruit seed flour revealed that the formulation with 10 % aromatic jackfruit seed flour and 90 % refined wheat flour as the best formulation for the development of aromatic jackfruit seed flour cookies. Jackfruit seed flour could be used as a potential substitute for refined wheat flour for the development of functional cookies as jackfruit seed flour had higher levels of protein, ash, fibre and other nutrients. The processed aromatic jackfruit seed flour improved the acceptability of cookies with better nutritional and sensory qualities. Thus health and wealth could be generated from the wasted jackfruit seeds for better farm income and nutritional security.

ACKNOWLEDGEMENT

Authors acknowledge the Kerala Agricultural University for the financial support provided for the research work

REFERENCES

Abiola, T., Akinyode, O.A. and Sholademi, K.D. 2018. The effect of processing on the nutritional and anti-nutritional factors in the raw, roasted and fermented jackfruit. *EC Nutr*. 13(9): 632–638.

Akter, B. and Haque, M. A. 2018. Utilization of jackfruit (*Artocarpus heterophyllus*) seed's flour in food processing: a review. *The Agric.* 16(2): 131-142.

Attaugwu, R.N., Anyadioha, J.I., Ukpong, E.S. and Achugonye, M. 2018. Effects of fermentation, boiling and roasting on some micronutrients and antinutrient composition of jackfruit seed flour. *Niger. Food J.* 34(2): 86-93.

Barge, K.R. and Divekar, S.P. 2018. Development of coconut milk residue and jackfruit seed enriched biscuit. *Int. J. Agric. Eng*.11(2): 373-378.

Bradford, M.M. 1976. A rapid and sensitive method for

the quantitation of microgram quantities of protein utilizing the principles of protein-dye binding. *Anal. Biochem*. 72(1-2): 248-254.

Chinma, C.E. and Igyor, M.A. 2007. Micronutrients and anti-nutritional contents of selected tropical vegetables grown in South East. *Nigerian. Food. J. 25*(1): 11-116.

Chowdhury, A.R., Bhattacharyya, A.K. and Chattopadhyay, P. 2012. Study on functional properties of raw and blended jackfruit seed flour (a non-conventional source) for food application. *Indian J. Nat. Prod. Resour.* 3(3): 347-353.

Dubois, K.M., Gilles, K.A., Hamilton, G.J.K., Rebers, P.A. and Smith, F. 1956. Calorimetric method for determination of sugars and related substances. *Analyt. Chem.* 28: 350-356.

Maskey, B., Subedi, S. and Shrestha, N. 2020. Effect of incorporation of jackfruit (*Artocarpus heterophyllus)* seed flour on the quality of cookies. *Dristikon: A Multidisciplinary J*. 10(1): 60-72.

Maurya, P. 2017. *Utilization of jackfruit* (*Artocarpus heterophyllus* lam.) *seed for the development of value added products and their quality evaluation.* Ph. D. thesis, Maharana Pratap Univ. of Agriculture and Technology, Udaipur, Rajasthan. 195.

Nandeesh, K., Jyotsna, R. and Venkateswara, R.G. 2011. Effect of differently treated wheat bran on rheology, microstructure and quality characteristics of soft dough biscuits. *J. Food Process. Preserv*. 35(2): 179-200.

Quast, E., Alflen, T.A., Bertan, L.C. and Bainy, E.M. 2016. Partial substitution of wheat flour with taro (*Colocasia esculenta*) flour on cookie quality. *Revista Ciencias Exatase Naturais*. 18(2): 202-212.

Ramya, H. N., Anitha, S. and Ashwini, A. 2020. Nutritional and sensory evaluation of jackfruit rind powder incorporated with cookies. *Int. J. Curr. Microbiol. App. Sci*. 9(11): 3305-3312.

Ranganna, S. 1986. *Hand of Analysis and Quality Control for Fruits and Vegetable Products.* Tata Mc Graw-Hill Education, p.140.

Ravindran, A., Raman, M., Babu, N., Dinakaran, A., Sankar, T.V. and Gopal, T. S. 2020. Diet chocolates and replacement of cocoa powder with jackfruit seed powder. *Food Nutr. Sci.* 11(03): 220-233

Sadasivam, S. and Manikam, A. 1992. Biochemical methods of Agricultural Science. Wiley eastern Ltd, New Delhi, p. 8-10.

Shamrez, A., Shukla, R.N. and Mishra, A. 2013. Study on drying and quality characteristics of tray and microwave dried guava slices. *Int. J. Sci. Eng. Technol.* 3(4): 2348-4098.

Spada, F.P., Silva, P.P.M., Mandro, G.F., Margiotta, G.B., Spoto, M.H.F. and Canniatti-Brazaca, S.G. 2018. Physico-chemical characteristics and high sensory acceptability in cappuccinos made with jackfruit seeds replacing cocoa powder. *PLoS One*. 13(8): 1–12.

Varghese, C., Wolodko, J., Lingyum, C., Doschak, M., Srivastav, P.P. and Roopesh, S. 2020. Influence of selected product and process parameters on microstructure, rheological, and textural properties of 3D printed cookies. *Foods.* 9(7): 907.

Wheeler, E.L. and Ferrel, R.E. 1971. A method for phytic acid determination in wheat and wheat fractions. *Cereal Chem*. 48(3): 312-320.

Zuwariah, I., Noor, F., Hadijah, M.B., and Rodhiah, R. 2018. Comparison of amino acid and chemical composition of jackfruit seed flour treatment. *Food Res*. 2(6): 539-545.