Effect of Incorporation of Jackfruit (*Artocarpus Heterophyllus*) Seed Flour on the Quality of Cookies

Bunty Maskey[1], Sarmila Subedi[2], & Nabindra Kumar Shrestha[3]

[1]Principal Author
Lecturer
Central Department of Food Technology, Dharan, Tribhuvan University, Nepal

[2]Corresponding author
Sunsari Technical College, Dharan, Tribhuvan University, Nepal

[3]Co-author
Central Department of Food Technology, Dharan, Tribhuvan University, Nepal

[1]Email: bunty.maskey@cdft.tu.edu.np

DOI: https://doi.org/10.3126/dristikon.v10i1.34541

Abstract

The paper aims to determine the effect of jackfruit seed flour incorporation on the quality of cookies. D-optimal mixture design has been employed for formulating the recipe of cookies. Five different formulations of cookies containing 0, 12.5, 25, 37.5, and 50 parts jackfruit seed flour were prepared. The prepared cookies are subjected to sensory evaluation by ten semi-trained panelists for consumer acceptability. The obtained data have been statistically analyzed using two-way ANOVA (no blocking) at 5% level of significance. From the mean sensory scores, 12.5 parts jackfruit seed flour incorporation was selected as the best formulation and subjected to proximate analysis. The protein, fat, fiber and ash contents are significantly ($p<0.05$) higher in jackfruit seed flour incorporated cookies than wheat flour cookies (control). The phytate and oxalate contents were also found to be significantly ($p<0.05$) higher in jackfruit seed flour incorporated cookies than control but were below tolerance level and safe for consumption.

*Keywords :*jackfruit seed flour, cookies, sensory evaluation, proximate analysis

Introduction

A cookie is a small, flat, sweet, baked good, usually containing flour, eggs, sugar, and either butter, cooking oil or another oil or fat. It may include other ingredients such as raisins, oats, chocolate chips or nuts. Compared to biscuit, cookie tends to be larger with a softer chewer texture. Cookie is consumed extensively all over the world as a snack food and on a large scale in developing countries where protein and caloric malnutrition are prevalent (Chinma & Gernah, 2007). The food industries are facing with the challenge of producing food products containing functional ingredients in order to meet the nutritional requirements of individuals with health challenges (Day et al., 2009). Cookies can therefore serve as a vehicle

for delivering important nutrients. The nutritive values of cookie are being improved by modifying their nutritive composition (Apotiola & Fashakin, 2013).

Jackfruit (*Artocarpus heterophyllus*) is one of the important underutilized fruits belonging to the family Moraceae and to the genus Artocarpus which includes evergreen or deciduous trees producing more yield than any other fruit tree species and bears the largest edible fruit (Ranasinghe et al., 2019). Jack fruit seed contains high amount of dietary fiber, vitamins, minerals, protein, and low amount of fat. This low-fat food is thus a low-calorie food, which can be adopted by the person on a crash diet for losing weight. It has high content of dietary fiber (7 times more than that of whole wheat flour) (Felli et al., 2018), which have functional properties such as weight reduction, prevention of constipation, bowel cancer and reduction of cholesterol level. Jackfruit seed is rich in manganese (1.12 mg/kg) (Ocloo et al., 2010), and it also contains iron which helps in proper blood circulation (Abedin et al., 2012). Potassium (14.78 g/kg) in the jackfruit seed is found to help in lowering blood pressure and reversing the effects of sodium that causes a rise in blood pressure, which affects the heart and blood vessels (Ocloo et al., 2010). This helps in preventing heart disease. Jackfruit seed powder contains manganese and magnesium elements (Barua & Boruah, 2004). Phytate (48.56 mg/100g) and oxalate (6.37mg/100g) are anti-nutritional factors found in jackfruit seed Okpala et al. (2013). The reduction in anti-nutritional factor of jackfruit can be achieved by boiling, roasting and fermentation (Abiola et al., 2018).

Research Problem

Cookies prepared from refined wheat flour is nutritionally poor, which is deficient in several nutrients including vitamins, minerals as well dietary fiber (Asifulalam et al., 2014). Flour blends with high dietary fiber flour have been widely applied in the bakery industry to minimize the use of large amounts of flour as well as to increase the consumer dietary fiber intake (Ho et al., 2017).

Research Objective

The general objective of this research work is to determine the effect of the incorporation of jackfruit seed flour on the quality of cookies. The specific objectives are to prepare jack fruit seed flour incorporated cookies; and to perform sensory quality as well as physicochemical analysis of the cookies.

Research Limitation

The mineral contents of the cookies could not be determined and the texture analysis could not be carried out.

Significance of the Paper

The incorporation of jackfruit seed flour for making cookies not only increases the nutritional quality of cookies, but also gives a diversification in the bakery product.

Materials and Methods

Raw Materials

Wheat flour named 'Fortune Maida' produced by Nutri Food Pvt. Ltd., Sonapur, Sunsari, Nepal was used for cookies making. Granulated sugar and eggs were bought from local market of Dharan. Butter named 'Amul butter' was purchased from Dharan which contained 80% milk fat, 16% moisture, 3% salt and 1% curd. Baking powder named as 'Weikfield baking powder double action' containing sodium bicarbonate, sodium aluminium phosphate and corn flour manufactured and packed by Weikfield food Pvt. Ltd., Pune, India was used. It was purchased from local market of Dharan. Jackfruit (*Artocarpus heterophyllus*) was purchased from local market of Itahari. High density polyethylene (HDPE) of 50 microns was used for the packaging of the product.

Methods

Formulation of Recipe

Design Expert (Version 12) software was used to create the recipe. D-optimal mixture design was used to formulate the recipe. The independent variable for the experiment was proportions of jackfruit seed flour used to make cookies. The cookies were made as per the recipe formulation done and code name A, B, C, D and E were given to each recipe. The recipe formulation for the jackfruit seed flour incorporated cookies is shown in Table 1.

Table 1

Recipe Formulation for Cookies

Ingredient	A	B	C	D	E
Jackfruit seed	12.5	25	37.5	50	0
Wheat flour	87.5	75	62.5	50	100
Sugar	47	47	47	47	47
Fat	55	55	55	55	55
Baking powder	2.67	2.67	2.67	2.67	2.67
Egg yolk	15	15	15	15	15

Note. Five runs obtained from D-optimal mixture design.

Preparation of Jackfruit Seed Flour

The jackfruit seed were cleaned and manually peeled off. Then they were soaked in 1.5-2 volumes of water for 3-5 minutes to remove the thin brown spermoderm cover the

cotyledons. The spermoderm layer was removed by rubbing the seeds between the hands and washing thoroughly under running water. The peeled seeds were sliced into thin chips and dried at 50-60°C for 16 h or until constant final weight. The dried chips were powdered in a grinder and passed through 200μ mesh sieve and packed in high density polyethylene (HDPE) of 50 micron and stored at room temperature (21°C) for further processes (Hasan et al., 2010).

Preparation of Jackfruit Seed Flour Incorporated Cookies

Ground sugar and fat were creamed till smooth paste was obtained. The mixture of egg, water and baking powder was added in the paste and whipped continuously. Then, sieved wheat flour and jackfruit seed flour were added in the mix with predetermined quantity and soft dough was prepared. The dough was sheeted to thickness of about 3-4 mm and cut to form circular shape of diameter of about 5cm. Cut parts were kept in a greased pan and baked in oven for 20 min at 180-200°C. After baking, the cookies were cooled to room temperature (21°C) and packed in polyethylene bag (Loza et al., 2017) .

Analysis of Raw Materials and Cookies

The physicochemical analysis of raw materials and cookies, as well as the analysis of physical parameters of cookies were performed.

Physicochemical Analysis

a. Moisture Content. Moisture content of the sample was determined by heating in an oven at 100 ± 5°C to get constant weight (Ranganna, 1986).

b. Crude Fat. Crude fat content of the samples was determined by solvent extraction method using Soxhlet apparatus and solvent petroleum ether (Ranganna, 1986).

c. Crude Protein. Crude protein content of the samples was determined indirectly by measuring total nitrogen content by micro Kjeldahl method. Factor 6.25 was used to convert the nitrogen content to crude protein (Ranganna, 1986).

d. Ash Content. Ash content of the samples was determined by following the method given by (Ranganna, 1986) using muffle furnace.

e. Crude Fiber. Crude fiber content of the samples was determined by the method given by (Ranganna, 1986).

f. Gluten Content: Gluten content was determined by method described by Pearson (1981).

g. Water Absorption Capacity. Twenty grams of flour was taken and required amount of water was added to get a dough of moderately stiff consistency. The amount of water required was noted and expressed in ml/ 100g (Devkota et al., 2015).

Physical Parameters Analysis

a) Diameter of Cookie. Diameter of cookie was measured by using Vernier caliper (Suriya et al., 2017).

b) Thickness of Cookie. Thickness was measured by stacking three cookies on top of each other and taking average thickness as prescribed by Suriya et al. (2017).

c) Spread Ratio. The spread ratio of the biscuit was determined by using the formula as per (AOAC, 2005).

$$\text{Spread ratio} = \frac{\text{Diameter (mm)}}{\text{Thickness (mm)}}$$

Where, diameter was measured in mm by Vernier caliper and thickness was measured in mm by screw gauge.

Antinutritional Factor Analysis

a) Oxalic Acid. Oxalic acid was determined using the method as described by Amadi et al. (2018).

b) Phytic Acid. Phytic acid was determined as described by Amadi et al. (2018). The spectrophotometric analysis was done at 655 nm and the iron content (µg) was determined from standard curve.

Sensory Analysis

The sensory analysis for overall quality attributes was carried out with ten semi-trained panelists. The parameters for sensory evaluation were texture, crispiness, color, taste, flavour and overall acceptability. Sensory evaluation was performed according to the 9-point hedonic scale (Ranganna, 1986).

Statistical Analysis

The obtained data were analyzed by using IBM SPSS Statistics (Version 26) predictive analytics software, for Analysis of Variance (ANOVA) at 5% level of significance. The data obtained from sensory evaluation were subjected to two-way ANOVA. The significance of the means was tested by using Tukey's honestly significant difference (HSD) method.

Results and Discussion

Wheat flour was mixed with 12.5, 25, 37.5, 50 and 0 parts jackfruit seed flour to make 5 formulations of cookies and coded as A, B, C, D and E respectively. Both wheat flour (control) and jackfruit seed flour cookies were subjected to proximate analysis. Cookies were analyzed for determination of effect on physical parameters of cookies with increase in jackfruit seed flour content.

Proximate Composition of Flour

The proximate composition of wheat flour and jackfruit seed flour was analyzed and is presented in Table 2.

Table 2

Proximate Composition of Wheat Flour and Jackfruit Seed Flour

Parameter	Wheat flour (%)	Jackfruit seed flour (%)
Moisture	12.06^{b}±1.10	10.53^{a}±0.31
Crude protein (db)	12.80^{a}±0.14	13.10^{b}±0.98
Crude fat (db)	1.07^{a}±0.36	2.41^{b}±0.13
Crude fiber (db)	0.62^{a}±0.03	2.50^{b}±0.16
Crude ash (db)	0.43^{a}±0.83	1.27^{b}±0.96

Note. All data are the mean ± standard deviation of its triplicates.

The crude protein, crude fat, crude fiber and crude ash content in wheat flour were significantly ($p<0.05$) lower than that of Jackfruit seed flour. The higher amount of crude fiber indicates that jackfruit seed flour is good source of crude fiber and can be incorporated to enhance nutritive value of various food products. The significant ($p<0.05$) increase in ash content is due to the presence of higher amount of minerals found in jackfruit seed than in wheat flour. Similar results were obtained by Ocloo et al. (2010).

Physical Properties of Flour

The physical properties of wheat flour and jackfruit seed flour was analyzed and is presented in Table 3:

Table 3

Physical Analysis of Wheat Flour and Jackfruit Seed Flour

Parameter	Wheat flour	Jackfruit seed flour
Gluten content (% wb)	10.6	0
Water absorption capacity (ml/100g)	140±3.21	155±1.29

The gluten content of the whole wheat flour was found to be 10.6% wb, while in case of Jackfruit seed flour, gluten was not observed which resembles the gluten less explanation of

Jackfruit seed flour. The water absorption capacity of jackfruit seed flour (155±1.29 ml/100g) are higher than wheat flour (140±3.21 ml/100g). Since, the jackfruit seed flour has good absorption capacity due to high fiber content, it absorbed more water than wheat flour. Similar result was obtained by Maurya (2017).

Physical Properties of Cookies

The physical parameters such as diameter, thickness and spread ratio were affected by the increasing level of jackfruit seed flour in cookies. Table 4 shows effect of jackfruit seed flour incorporation on physical parameters such as diameter, thickness and spread ratio of cookies.

Table 4

Physical Properties of Cookies Proportion

Sample	Thickness (cm)	Diameter (cm)	Spread ratio
A	0.92±0.03	6.07±0.05	6.67±0.02
B	0.91±0.01	6.01±0.04	6.65±0.05
C	0.90±0.01	5.92±0.02	6.57±0.01
D	0.89±0.01	5.90±0.01	6.46±0.07
E	0.95±0.01	6.10±0.04	6.72±0.02

Note. Values are means of triplicates ± standard deviation.

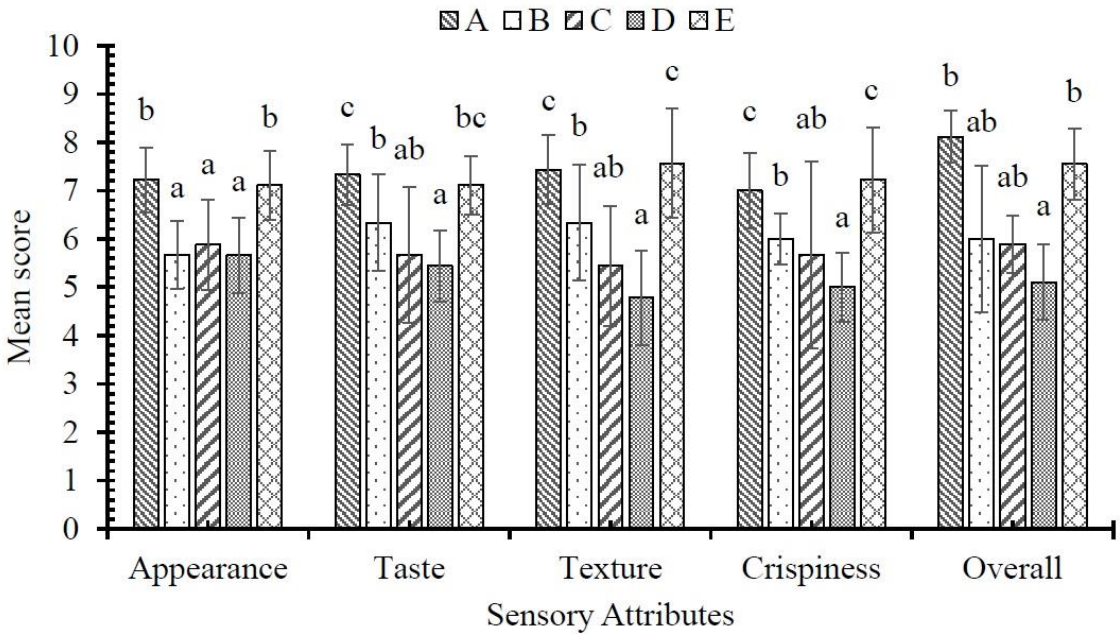
It was seen that the percent expansion decreases with the increased level of jackfruit seed flour. These results are in accordance with the findings of Maurya (2017). The decrease in spread factor may be due to the fact that gluten is decreased with increased level of replacement of wheat flour (Chowdhury et al., 2012). Increase in water absorbing fiber content retarded the spreading of cookies thus reducing the diameter (Hasan et al., 2010). It has been noted that the spread factor of cookies is affected by the competition of ingredients for the available water; flour or any other ingredient that absorbs water during dough mixing decreases it (Suriya et al., 2017). Therefore, the reduced spread-ratios of jackfruit seed flour incorporated cookies can be attributed to the presence of more water absorbing constituents like protein and fiber.

3.4 Effect of incorporation of jackfruit seed flour in sensory quality of cookies

The sensory scores (9-point hedonic scale) of the sample cookies are graphically represented in Figure 1:

Figure 1

Graphical View of Mean Sensory Scores of Cookies



Statistical analysis showed that the partial substitution of wheat flour with jackfruit seed flour had significant effect ($p<0.05$) on all the sensory attributes. Sample A got the highest mean sensory scores for appearance and taste which were not significantly different ($p>0.05$) from sample E and significantly different ($p<0.05$) with samples B, C and D. The decrease in appearance score with increase in jackfruit seed flour may be due to the increase in darkness of cookies due to darker color of jackfruit seed flour while the decrease in taste score may be due to increase in bitterness and increase in jackfruit seed flour. Similar results were obtained by Hasan et al. (2010) who found highest score for control biscuits and gradually decrease in score with increase in jackfruit seed flour content.

The highest mean sensory scores for texture and crispiness was obtained by sample E with gradual decrease in score with increase in jackfruit seed flour content. Sample E was not significantly ($p>0.05$) different with sample A, but was significantly different ($p<0.05$) with B, C and D. The comparatively higher texture score for control than jackfruit seed flour incorporated sample may be due to presence of gluten in wheat flour, leading to the formation of an elastic, smooth dough that will result to cookies with better texture (Maurya, 2017). The result obtained is in accordance with findings of (Hasan et al., 2010) who found the highest score for control with decreasing scores with increase in jackfruit seed flour content. The

decrease in crispiness score may be due high amount of fiber in jackfruit seed flour than the wheat flour (Rojo-Poveda et al., 2020).

Sample A scored the highest in overall acceptability of the sensory conducted among the panelists. There was no significant difference ($p>0.05$) among samples A and E but significant difference ($p<0.05$) was found in comparison with samples B, C and D. The decrease in score with increase in jackfruit seed flour content may be due to darker color, increased bitterness, increased grittiness and increased residual branny mouth feel. Similar result was obtained by Bhetwal (2016) in which 20 part of jackfruit seed flour incorporated cookies scored high with gradual decrease in score with increase in jackfruit seed flour.

Chemical Composition of Control and Optimized Cookies

The chemical composition of the control (product E) and optimized product (product A) was found out by chemical analysis. Table 5 shows the proximate analysis of control and optimized cookies.

Table 5

Proximate Analysis of Optimized Product and Control

Parameters	Optimized product (%)	Control sample (%)
Moisture	$3.14^{b}\pm0.05$	$2.82^{a}\pm0.25$
Protein (db)	$12.80^{b}\pm0.2$	$10.55^{a}\pm0.10$
Crude fat (db)	$26.39^{b}\pm0.43$	$25.33^{a}\pm0.63$
Fiber (db)	$2.78^{b}\pm0.06$	$0.85^{a}\pm0.05$
Total ash (db)	$1.43^{b}\pm0.09$	$1.20^{a}\pm0.40$

Note. All data are the mean ± standard deviation of its triplicates.

The moisture content increased from 2.82% in control to 3.14% in 12.5% level of substitution. This increase in moisture may be due to more water retaining capacity of the fibers as well as more amount of water required to prepare the cookies dough having more amount of fiber (Chowdhury et al., 2012). There is increase in protein content from 10.55% to 12.8%. This is because of higher protein content of jackfruit seed flour than wheat flour. The fat content has slightly increased from 25.33% to 26.39% because jackfruit seed flour contains slightly higher fat content than wheat flour. So, jackfruit seed flour incorporated cookies can be considered as good source of energy. Similarly, there is decrease in crude fiber from 2.78% to 0.85% in control because of jackfruit seed flour contain high amount of fiber. The increase in total ash content from 1.20% to 1.43% is due to the higher amount of minerals in jackfruit seed flour than in wheat flour. Bhetwal (2016) presented similar results in case of moisture, protein, ash and crude fiber on analysis of jackfruit seed flour incorporated cookies. However, Hasan et al. (2010) found slight decrease in fat content and ash content.

Antinutritional factors

Phytate and oxalate were measured in jackfruit seed flour and jackfruit seed incorporated cookies which gives bitterness in the product. Table 6 shows the antinutritional factor of jackfruit seed flour, control sample and optimized cookies.

Table 6

Antinutritional Factors of Jackfruit Seed Flour, Control Sample and Optimized Cookies

Sample	Phytate (mg/100g)	Oxalate (mg/100g)
Jackfruit seed flour	50.02±1.56	7.67±0.32
Control	1.63±0.02	0.31±0.17
Optimized product	24.12±0.12	4.56±0.90

Note. All data are the mean ± standard deviation of its triplicates.

The phytate and oxalate content in control sample was found to be 1.63mg/100g and 0.31mg/100g respectively. The phytate content of jackfruit seed flour was found to be 50.02mg/100g which is near to 48.56 mg/100g as described by Okpala et al. (2013) and the optimized product was found to be 24.12mg/100g. Similarly, the oxalate content of Jackfruit seed flour was found to be 7.67mg/100g which was near to the range 6.37mg/100g as explained by Okpala et al. (2013) and the optimized product was found to be 4.56mg/100g. This reduction in both phytate and oxalate content may be due to only partial substitution of wheat flour with jackfruit seed flour as well as the heat treatment during baking (Singh et al., 2015). It has been reported that the maximum tolerated dose of phytate in the body is from 250- 500 mg/100g (Bushway et al., 1984) and toxic dose of oxalic acid as 2-5g (Munro & Bassir, 1969). Hence, we can conclude that phytate and oxalate content of optimized product was below the tolerance level and were safe for consumption.

Conclusion

Based on the study, it can be concluded that the cookies prepared by incorporation of 12.5% jackfruit seed flour with 87.5% wheat flour showed better sensory scores (appearance, crispiness, texture, taste and overall acceptability). Protein, ash and fiber content in jackfruit seed flour incorporated cookies were higher than the wheat flour cookies. The antinutritional factor in cookies like phytate and oxalate seemed to increase with the increase of jackfruit seed flour but were under the tolerance level in optimized product.

Implication

These findings suggest that jackfruit seed flour can be successfully incorporated in wheat flour up to the concentration of 12.5 parts without any adverse effect on sensory attributes giving a nutritionally enriched product having low anti-nutritional factors.

Acknowledgement

We would like to sincerely thank Sunsari Technical College and Central Department of Food Technology, Dharan for all their help and coordination. We are indebted to every personnel who are directly or indirectly involved in completion of this research.

References

Abedin, M. S., Nuruddin, M. M., Ahmed, K. U., & Hossain, A. (2012). Nutritive compositions of locally available jackfruit seeds (Artocarpus heterophyllus) in Bangladesh. *International Journal of Biosciences, 2(8),* 1–7.

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

Amadi, J. A. C., Ihemeje, A., & Afam-Anene, O. C. (2018). Nutrient and phytochemical composition of jackfruit (*Artocarpus heterophyllus*) pulp , seeds and leaves. *International Journal of Innovative Food, Nutrition &Sustainable Agriculture*, *6*(3), 27–32.

AOAC. (2005). *Official Methods of Analysis of the Association of Official Analytical Chemists* (18th ed.).

Apotiola, Z. O., & Fashakin, J. F. (2013). Evaluation of cookies from wheat flour, soybean flour and cocoyam flour blends. *Food Science and Quality Management*, *14*, 17–22.

Asifulalam, S. M., Islam, M. Z., Hoque, M. M. & Monalisa, K. (2014). Effects of drying on the physico-chemical and functional properties of green banana (*Musa sapientum*) flour and development of baked product. *American J. Food Sci. & Technolo. 2*(4), 128-133.

Barua, A. G., & Boruah, B. R. (2004). Minerals and functional groups present in the jackfruit seed: A spectroscopic investigation. *International Journal of Food Sciences and Nutrition*, *55*(6), 479–483. https://doi.org/10.1080/09637480400015810

Bhetwal, B. (2016). Utilization of jackfruit seed flour for preparation of cookies and its quality evaluation. *B. Tech. Thesis*, Tribhuvan University

Bushway, R. J., Bureau, J. L., & Mcgann, D. F. (1984). Determinations of organic acids in potatoes by high performance liquid chromatography. *Journal of Food Science*, *49*(1), 76–77. https://doi.org/10.1111/j.1365-2621.1984.tb13673.x

Chinma, C. E., & Gernah, D. I. (2007). Physicochemical and sensory properties of cookies produced from cassava/soyabean/mango composite flours. *Journal of Food Technology, 5*(3), 256–260.

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

Day, L., Seymour, R. B., Pitts, K. F., Konczak, I., & Lundin, L. (2009). Incorporation of functional ingredients into foods. *Trends in Food Science and Technology*, *20*(9), 388–395. https://doi.org/10.1016/j.tifs.2008.05.002

Devkota, S. C., De, A., & Sathian, B. (2015). Nutritional deficiencies: Major public health problems in Nepal. *American Journal of Public Health Research, 3*(4A), 1–5. https://doi.org/10.12691/AJPHR-3-4A-1

Felli, R., Yang, T. A., Abdullah, W. N. W., & Zzaman, W. (2018). Effects of incorporation of jackfruit rind powder on chemical and functional properties of bread. *Tropical Life Sciences Research, 29*(1), 113–126. https://doi.org/10.21315/tlsr2018.29.1.8

Hasan, S. M. K., Hossain, M. A., Hossain, M. J., Roy, J., & Sarker, M. S. H. (2010). Preparation of biscuit from jackfruit (*Artocarpus hetephyllus*) seed flour blended with wheat flour. *The Agriculturists*, *8*(1), 10–18.

Ho, L., Tan, T.-C., Aziz, N. A. A., & Muhamad, N. (2017). Physical and functional properties of banana pseudostem flour and its effect on the quality (texture and microstructure) of formulated bread. *J. Agrobiotechnol.*, *8*(1), 1–12.

Loza, A., Quispe, M., Villanueva, J., & Peláez, P. P. (2017). Development of functional cookies with wheat flour, banana flour (*Musa paradisiaca*), sesame seeds (*Sesamum indicum*) and storage stability. *Scientia Agropecuaria*, *8*(4), 315–325. https://doi.org/10.17268/sci.agropecu.2017.04.03

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.

Munro, A., & Bassir, O. (1969). Oxalates in nigerian vegetables. *West African Journal of Biology and Applied Chemistry, 12*, 14–18.

Ocloo, F. C. K., Bansa, D., Boatin, R., Adom, T., & Agbemavor, W. S. (2010). Physico-chemical, functional and pasting characteristics of flour produced from jackfruits (*Artocarpus heterophyllus*) seeds. *Agric. Biol. J. N. Am.*, *1*(5), 903–908.

Okpala, L., Okoli, E., & Udensi, E. (2013). Physico-chemical and sensory properties of cookies made from blends of germinated pigeon pea, fermented sorghum and cocoyam flours. *Food Sci. and Nutr.*, *1*(1), 8–14.

Pearson, R. (1981). *Pearson's Chemical Analysis of Foods* (8th ed.).

Ranasinghe, R. A. S. N., Maduwanthi, S. D. T., & Marapana, R. A. U. J. (2019). Nutritional and health benefits of jackfruit (*Artocarpus heterophyllus Lam.*): A review. *Hindawi International Journal of Food Science*. https://doi.org/10.1155/2019/4327183

Ranganna, S. (1986). Manual analysis of fruits and vegetable products.

Rojo-Povedo, O., Barbosa-Pereira, L., Orden, D., Stevigny, C., Zeppa, G., & Bertolino, M. (2020). Physical properties and consumer evaluation of cocoa beal shell-functionalized biscuits adapted for diabetic consumers by the replacement of sucrose with tagatose. *Foods, 9*(814), 1-16.

Singh, A., Maurya, S., Singh, M., & Singh, U. P. (2015). Studies on the phenolic acid contents in different parts of raw and ripe jackfruit and their importance in human health. *Internat. J. Appl. Sci.-Research & Review*, *2*(3), 69–73.

Suriya, M., Rajput, R., Reddy, C. K., Haripriya, S., & Bashir, M. (2017). Functional and physicochemical characteristics of cookies prepared from Amorphophallus paeoniifolius flour. *Journal of Food Science and Technology*, *54*(7), 2156–2165. https://doi.org/10.1007/s13197-017-2656-y