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STORAGE LIFE AND QUALITY CHARACTERISTICS OF NUTRITIOUS FLOUR FROM RIPE JACKFRUIT SEED

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ABSTRACT

This research work has been executed to demonstrate the food value, quality characteristics as well as shelf life of newly prepared jackfruit seed flour. The physical characteristics such as appearance, flavor and taste of the prepared jackfruit seed powder were excellent. The biochemical parameters e.g. dry matter, moisture, ash, total soluble solids, minerals i.e. phosphorous, iron and calcium were found in food grade level. The sugar, protein, vitamin A, soluble protein and total carbohydrate of the powder product were in excellent grade. The observed pH, acidity and vitamin C of the product were in acceptable limit. The microbial assay of the product strengthened the quality characteristics during storage period.

Keywords: *Nutritious flour; Storage life; Microbial loads; Quality characteristics; Perishability*

1. INTRODUCTION

Jackfruit is highly nutritious and an excellent source of important minerals such as phosphorous, iron and calcium. It is a strong root of beta carotene (Provitamin A), vitamin C, carbohydrate and energy for human nutrition. So, it is highly useful to prevent many deficiency diseases. Hence, this is absolutely one of the delicious and cherishes fruits of the world and it is our national fruit. The ripe fruit accommodates well flavor and seeds having yellow sweet bulbs. The edible bulbs of ripe jackfruit are consumed fresh or processed into canned products. Seeds makeup around 10-15% of the total fruit weight and have high carbohydrate and protein contents (Ibrahim *et al*., 2016; Kumar *et al.,* 1988). This seed cannot be stored for a long time. The seed flour may be a substitute product which can be used in some food items. The seeds are generally discarded as waste, except sometimes they are fractious and germinate immediately after maturity. So, it is very much tough to store fresh seeds for long time. On account of shortage of processing and preservation techniques, a lot of jackfruit seeds are damaged in each year in Bangladesh. In general, wheat flour in the confectionary and bakery industries is using as major food ingredient. The market value of wheat flour is rising day by day. So, jackfruit seed powder may be the second components to be utilized in bakery and bread making in different ratio for different purpose (Hasidah and Noor Aziah, 2003). However, the flour from jackfruit seed can be used with wheat flour to develop nutritious bakery products and this type of uses will reduce the postharvest loss of jackfruit seeds in Bangladesh. Singh *et al.* (1991) reported that Jackfruits are highly rich in starch with protein. Jackfruit seeds are highly perishable and generally dropped or stored for degeneration. The jackfruit seeds which privilege to all fragrance may be razzed and accepted as a light meal or boiled and consumed as an instant food item. The flour is generally prepared by drying and roasting jackfruit seed. Hence, this powder may be substitute food, which can be easily sustained and used for food value extension and to mix with other cereal alike wheat powder without altering the functional and nutritional profiles of the final production (Banerjee and Datta, 2015). Omale and Friday (2010) gave an idea on the rich amount of lignans, isoflavones, saponins and all phytonutrients in jackfruit seed. These nutrients are highly important for human health and working as anticancer agent, antihypertensive substitute, antiaging material, antioxidant compound, antiulcer agent and so on. The powder of jackfruit seed has the capability to mitigate discomfort for indigestion. Bhat and Pattabiraman (1986) has reported that extract of jackfruit seed having high potent to prohibit the proteolytic activities of different animal pancreatic preparations effectively. This seed is highly rich in jacalin and artocarpinlectins proteins. The major protein jacalin extracted from *Artocarpusheterophyllus* seeds has been found to have strong activities against human immunodeficiency virus1 (Haq, 2006). However, the jackfruit is highly decomposable and cannot be preserved for long duration due to its internal composition and structural aspect. Anyway, the jackfruit processing technique is very scanty in Bangladesh. So, considering the above circumstances, the present study has been considered to develop the jackfruit seed powder quality. The shelf life and nutritional values of the potential flour from ripe jackfruit seed have been also investigated.

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2. MATERIALS AND METHODS

The experimental ripe jackfruit had been collected from the jackfruit research garden of BCSIR Laboratories Rajshahi, Bangladesh. Only sound and firm ripe jackfruits were undertaken in this work. The harvested fruits were cleaned in fresh water. After that the fruit was de-skinned and bulbs were collected from de-skinned jackfruit and then all the seeds of jackfruit were compiled from the bulbs. Then seeds were cleaned and washed in fresh water and slightly dried up to remove the water from upper layer of the seed. The milky white seeds were separated from white and brown layers and then carefully crushed. The crushed product was heated for overnight at 65ºC. The mixture was heated again and again to perfect dehydration. The crushed product was cooled in room temperature for few minutes. The dried mixture was blended to fine powder. The fine powder was sieved, and the nutritious flour was obtained. The nutritious flour was packed immediately. Then labeling was done and the product was stored for study. Preserved jackfruit seed powder was stored for a period of 336 days or one year at ambient temperature (25-35^{0}C). The biochemical and microbial analysis were done at an interval of 7 days to 21st day, 15 days to 66th day, 30 days to 156th day and 60 days to 336th day. The biochemical changes were also determined using the standard methods. The oven drying technique (Karmas, 1990) was applied to estimate the amount of moisture. Spectrophotometric method and general analytical procedures were used to analyze the contents of sugar, starch, carbohydrate, protein, vitamin C, calcium, phosphorus and iron. The refractometric method was applied to measure TSS (total soluble solids). A standard pH meter was applied to determine pH of the powder. Acidity has been estimated by acid-base titrimetric method. A periodical study was done to analyze the preserved flour and the obtained results were recorded in tables (Table 1, 2 & 3). The pour plate and spread plate method (Buchanan and Gibbons, 1974; Frazier and Westhoff, 1978) was done for microbiological test. The EZ^{TM} coliform cult (X-GAL/MUG) test kit was used to detect the presence of faecal coliforms (Table 4). Organoleptic test and acceptability (Humayun *et al.,* 2014) of the preserved product was accomplished by a group of 10 justice considering the scoreonphysical appearance, flavor and taste (below 70% fair, good 70-80% and excellent 80% or more) which is presented in Table 5. Preparation Flow Sheet of Nutritious Flour from Ripe Jackfruit Seed

Ripe jackfruit
⇩
Washing in running tap water
⇩
Deskinning the jackfruit
⇩
Picking the bulbs from deskinned jackfruit
⇩
Collecting seeds from the bulbs and thoroughly washed
⇩
The white and brown layers were removed and crushed
⇩
The crushed product was heated for overnight at 65^0 C
⇩
The dried mixture was then blended to fine powder
⇩
The fine powder was sieved to get nutritious flour
⇩
The nutritious flour was instantly packed
⇩
Labelling the packed product
⇩
Storing and ready for study

3. RESULTS AND DISCUSSION

Table 1 represents the changes of biochemical parameters such as moisture, dry matter, TSS and sugar of jackfruit flour from the day of preparation to 336 days during storage. Moisture content of a food is the total water component of the food sample and used to measure the quality of food sample. The increase of moisture in jackfruit flour during storage period was very low which 0.27% is only. Ramachandran *et al.* (2014) has reported the increasing behavior of moisture content in papaya powder. The increase of moisture is due to hygroscopic in nature during the storage period of the products. Long shelf life of fruits mainly depends on higher dry matter content (Niemirowicz-Szczytt *et al.,* 1996). Dry matter content is vital and should be greater yield of dehydrated products such as powder & other products. Yield of powder is higher from higher dry matter

containing fruits/fruit cultivars. Because, relatively much less moisture has to be removed per unit of product when high dry matter fruits are used. The dry matter loss problem can be resulted from heat generation, for microbial respiration. The quality factor TSS (Total soluble solids) is very much important for all the processed fruit products. In this study the TSS is increased gradually from 32.5% at 0 day to 41.2% at 336 days. The increasing rate was low but showed higher increase in the rate of jackfruit flour. Ayub *et al.* (2010) found the same type of result for strawberry juice. The total sugar of jackfruit powder slowly decreased during the storage period followed by starch & total carbohydrate and the decrease rate was only 0.30%, 0.35% and 0.53% respectively (Table 1 and 2) which is very low. Rahman *et al.* (2012) also found in their experiment that total sugar content was decreased in stored dehydrated jackfruit for a storage time of eight months. The gradual rising in reducing sugar and decrease in non reducing sugar was noted in our experiment of jackfruit flour. This result reinforces the study of Rahman *et al.* (2012) in osmotic dehydrated jackfruits. This type of decrease in total sugar generally occurred as a result of increase in reducing sugar by acid hydrolysis of total sugar(Mir and Nath, 1993) and non reducing sugar and so that conversion of total sugar (Rahman *et al.,* 2012) and non-reducing sugar to reducing sugar (Roy and Singh, 1979).

Table 1: Chemical characteristics of nutritious flour from ripe jackfruit seed during storage period

Storage period (Day)	Moisture (%)	Dry matter (%)	TSS (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)
0	5.43±0.05	94.57±0.17	32.5±0.0	5.50±0.06	1.72±0.04	3.78±0.07
7	5.43±0.03	94.57±0.08	37.5±0.5	5.48±0.05	1.73±0.06	3.75±0.03
14	5.45±0.14	94.55±0.06	32.7±0.2	5.46±0.02	1.75±013	3.71±0.12
21	5.46±0.16	94.54±0.03	32.9±1.0	5.43±0.10	1.75±0.10	3.68±0.05
36	5.48±0.06	94.52±0.02	34.0±1.7	5.42±0.11	1.78±0.05	3.64±0.08
51	5.48±0.08	94.52±0.13	35.6±1.0	5.37±0.07	1.79±0.03	3.63±0.02
66	5.52±0.05	94.48±0.15	35.8±1.5	5.35±0.14	1.80±0.06	3.55±0.14
96	5.52±0.07	94.48±0.03	37.2±1.5	5.32±0.03	1.80±0.12	3.52±0.06
126	5.59±0.09	94.41±0.12	37.5±0.5	5.27±0.05	1.82±0.03	3.45±0.10
156	5.63±0.15	94.37±0.05	40.0±0.5	5.25±0.07	1.84±0.07	3.41±0.13
216	5.65±0.13	94.35±0.06	40.6±1.0	5.22±0.05	1.84±0.07	3.38±0.14
276	5.68±0.08	94.32±0.02	40.8±1.0	5.22±0.13	1.86±0.16	3.36±0.03
336	5.70±0.12	94.30±0.03	41.2±1.5	5.20±0.15	1.90±0.10	3.30±0.05

Table 2 shows the biochemical parameters changes in the context of ash, minerals, pH, acidity, vitamin C, protein, of jackfruit flour from the initial day to 336th day after preparation. The residue that remains after burning of the organic matter in a biological material is an analytical term for inorganic materials. This inorganic component gives a clear concept on inorganic content of the biological material. In our study the ash percentage of jackfruit flour decreased gradually from the day of storage to 336th day. The decreasing rate was so slow; it was from 2.82% to 2.82%. This study supports the work of Alam *et al.* (2010). These minerals calcium, phosphorus and iron are available in jackfruit flour and these nutrients play a vital role in human life for healthy growth. Calcium, phosphorus and iron have been investigated and the content of these have been found to decrease gradually with the enlargement of preservation stage and the decreasing rate was very slow (Table 2). Vidhya and Narain (2011) have observed the same in their study with wood apple jam. The reduction of the minerals was observed up to 90 days and it was 8.80% during 90th day. The reduction of phosphorus, iron and calcium was 0.21 mg/ 100g, 0.017 mg/100g 0.15 mg/100g respectively during 336 days in our experiment. Among the nutrients phosphorus plays a very important role in human body, animal and plant animation. Phosphorus exists in muscles, bones, teeth and even in genes in human body. In this study phosphorus content of jackfruit flour decreased gradually with the extension of storage time and this gradual lowering was very slow (Table 2). Vidhya and Narain (2011) have observed the same in their study with wood-apple jam. The reduction in jam was observed up to 90 days and it was 8.80% during 90th day. The reduction was 0.17% during 336th day in our experiment. The trace element iron is a very much important mineral for human body which forms hemoglobin in blood. This provides the dark red color to blood and acts as a carrier of oxygen to human body. It has been found that the iron content has deceased slowly in our study with the increase of storage life (Table 2). Similar type of reduction in iron was observed for apple pulp at duration of 90 days (Durrani *et al.,* 2010). It was found that the calcium content reduced slowly up to 336th day of preservation period (Table 2). This type of reduction in calcium was observed in apple pulp (Durrani *et al.,* 2010). In addition, Vidhya and Narain, (2011) have observed the same in their study with wood- apple jam and fruit bar. Rising in pH of pulp of any fruit is proportional to reduction in acidity which has been proved by several scholars and this may be ascribed in the presence of sodium benzoate in pulp (Hussain *et al*., 2008). We have not added any chemical preservatives in our experiment with jackfruit flour but quickly packed and sealed to protect oxidation i.e. prohibits the growth of food decomposition and pathogenic microorganism. In this study gradual increase in pH was found with the expansion of storage life. The enhancement in pH was 0.05 and stable up to 156 days which was measured at 7,

15, 30 days intervals then again enhancement 0.03 was observed and found stable up to 336 days which was measured at 60 days intervals. A gradual extension in pH with decrease in acidity was found by Akhtar *et al.* (2010) during their concerning fruit products. A successive reduction in acidity with the expansion of storage time was observed in this study and this rate was 0.0015%. According to Rahman *et al. (*2012) the lowering of acidity might be due to hydrolysis of sugar into glucose and fructose with subsequent fermentation of alcohol and formation of organic acids etc. Micro-organisms might be responsible for causing these changes (Frazier and Westhoff, 1978).

Table 2: Chemical characteristics of nutritious flour from ripe jackfruit seed during storage period

Storage period (Day)	Ash (%)	Minerals (mg/100gm)			pH	Acidity (%) as citric acid
		Phosphorus	Iron	Calcium		
0	2.8207±0.13	168.39±0.08	0.782±0.010	137.38±0.03	5.55±0.04	0.0830±0.016
7	2.8207±0.06	168.37±0.05	0.782±0.008	137.35±0.06	5.57±0.10	0.0829±0.015
14	2.8204±0.02	168.35±0.13	0.780±0.012	137.35±0.08	5.58±0.12	0.0827±0.013
21	2.8203±0.05	168.32±0.10	0.778±0.005	137.32±0.02	5.62±0.08	0.0827±0.017
36	2.8203±0.07	168.30±0.15	0.778±0.002	137.31±0.14	5.64±0.07	0.0826±0.015
51	2.8201±0.03	168.29±0.06	0.776±0.015	137.31±0.06	5.65±0.13	0.0825±0.003
66	2.8200±0.08	168.27±0.08	0.776±0.008	137.29±0.04	5.67±0.14	0.0823±0.004
96	2.8197±0.15	168.26±0.12	0.775±0.013	137.29±0.05	5.68±0.05	0.0823±0.012
126	2.8196±0.12	168.23±0.09	0.773±0.006	137.27±0.02	5.68±0.06	0.0821±0.008
156	2.8194±0.06	168.22±0.15	0.772±0.007	137.06±0.13	5.75±0.60	0.0819±0.006
216	2.8193±0.03	168.20±0.14	0.769±0.005	137.25±0.01	5.76±0.12	0.0818±0.013
276	2.8185±0.07	168.18±0.16	0.765±0.012	137.25±0.08	5.82±0.03	0.0815±0.015
336	2.8169±0.14	168.18±0.07	0.765±0.004	137.23±0.12	5.84±0.05	0.0815±0.013

Table 3: Chemical characteristics of nutritious flour from ripe jackfruit seed during storage period

Storage period (Days)	Vitamin A µg/100 g	Vitamin C mg/100 g	Protein (%)	Total carbohydrate (%)	Starch (%)	Soluble protein (%)
0	821.61±0.23	55.82±0.12	12.567±0.05	67.65±0.16	41.63±0.10	8.387±0.00
7	821.45±0.20	55.74±0.17	12.565±0.03	67.63±0.14	41.62±0.13	8.387±0.03
14	821.38±0.15	55.68±0.09	22.565±0.11	67.61±0.18	41.60±0.16	8.383±0.07
21	821.05±0.13	54.55±0.15	12.565±0.02	67.57±0.20	41.57±0.12	8.380±0.06
36	820.00±0.20	53.51±0.13	12.563±0.03	67.54±0.16	41.54±0.15	8.375±0.02
51	813.02±0.24	53.47±0.17	12.559±0.09	67.48±0.12	41.50±0.08	8.371±0.01
66	809.02±0.16	53.36±0.19	12.759±0.07	67.43±0.14	41.46±0.13	8.363±0.05
96	805.31±0.07	52.29±0.07	12.557±0.06	67.39±0.13	41.42±0.11	8.360±0.03
126	800.27±0.14	51.25±0.16	12.548±0.04	67.30±0.09	41.37±0.08	8.352±0.04
156	789.05±0.17	51.19±0.15	12.542±0.05	67.25±0.11	41.360±0.5	8.348±0.06
216	782.33±0.09	50.13±0.08	12.533±0.03	67.22±0.08	41.33±0.09	8.342±0.07
276	775.26±0.24	50.08±0.10	12.525±0.06	67.16±0.06	41.30±0.17	8.335±0.02
336	762.83±0.18	50.03±0.06	12.519±0.04	67.12±0.03	41.28±0.14	8.327±0.09

Table 3 presents the biochemical parameters change in the context of vitamin A, vitamin C, protein, carbohydrate, starch, soluble protein of jackfruit flour over the 336 days of storage period. Vitamin C is a very much essential factor for assessing food value of any fruits as it easily converts to another compound during preservation life (Corina *et al.,* 2006; Del *et al*., 2004). Vitamin C in our jackfruit flour was 55.82 (+ 0.12) mg/100gm and 50.03 (+0.06) mg/100gm respectively at starting period and at the end of storage. A gradual decrease of vitamin C in fruit was observed by Esteve *et al*., (2005) with the extension of storage life in orange juice. Temperature, pH, salt, oxygen, light, metal catalysts, microbial loads, the ratio of ascorbic acid to dehydrate ascorbic acid and conservation capacity of the container strongly influence the amount of ascorbic acid in fruit (Zerdin *et al.,* 2003). Proteins are highly essential nutrient for animal and human endurance. The main activities of proteins in diet are to furnish enough quantity of requisite amino acids. Protein deficiency generates growth hindrance, muscle decay, edema, peculiar swelling of the belly and assembling of fluids in the body (Zarkada *et al.,* 1997). The amount of protein in our jackfruit flour was 12.57% and 12.52% respectively at the first time and at the 336th day. This slight reduction in protein may be due to the longer storage period. A successive reduction in protein composition of mango pulp during preservation period was reported by Akhtar *et al*. (2010).

Table 4 reveals the microbial loads in jackfruit flour. No microorganisms were traceable initially and that may be due to preparing the product in hygienic condition and sealed quickly. After a certain period, the total colony

count increased because of keeping the product in ambient temperature. However, the sample contained microbial loads in the range of Gulf standard (Gulf standards, 2000) for foods.

Table 4: Microbial loads in nutritious flour from ripe jackfruit seed

Storage period	Total colony count (cfu/ml)	Fecal coliform (+ or -)	Total fungal count (cfu/ml)
0	0	-	0
7	0	-	0
14	0	-	0
21	0	-	0
36	0	-	0
51	0	-	0
66	0	-	0
96	0	-	0
126	2-5	-	0
156	13-17	-	0
216	32-35	-	0
276	70-80	-	0
336	163-171	-	0

The appearance, flavor and taste of any food products determine the acceptance to consumers. So, a test called organoleptic experiment was carried out on the color, flavor and taste. The average results on comments of the judges were performed and transferred to acceptability grades and finally the rating order was calculated (Okwori *et al.*, 2017).

Table 5: Rating of nutritious flour from ripe jackfruit seeds judged by the panel members

General qualities	Scoring by individual judges (at the last edible stage)										Total score	Mean score	Order of rating
	01	02	03	04	05	06	07	08	09	10			
Colour	82	80	78	81	79	86	82	78	83	80	809	80.90	Excellent
Flavour	83	84	76	84	86	78	80	79	75	82	807	80.70	Excellent
Taste	85	83	76	86	85	87	78	84	76	89	829	82.90	Excellent

4. CONCLUSIONS

Jackfruit flour prepared and preserved in the present study could be used in the preparation of extruded products and as a health ingredient in confectionary and bakery products and to make vitamin C rich food items. The developed procedure for jackfruit flour could be easily adopted by small scales well interested entrepreneurs and cottage industries. In the conclusion, it can be recommended to the entrepreneurs and consumers that the prepared jackfruit flour is a natural product having good nutritional value; shelf life is nearly one year and microbiologically acceptable in quality.

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