Reprint **ISSN 1991-3036 (Web Version)**

International Journal of Sustainable Crop Production (IJSCP)

(*Int. J. Sustain. Crop Prod.*)

Volume: 11 **Issue: 1** **February 2016**

Int. J. Sustain. Crop Prod. 11(1): 23-29 (February 2016)

STUDIES ON THE STORAGE LIFE AND QUALITY OF RIPE JACKFRUIT POWDER

M. IBRAHIM, M.O.H. HELALI, A.K.M.S. ALAM, R. AMIN AND S. AKHTER

An International Scientific Research Publisher

Green Global Foundation©

Web address: http://ggfjournals.com/e-journals archive
E-mails: editor@ggfjournals.com and editor.int.correspondence@ggfjournals.com

ISSN-1991-3036 (Online)
Int. J. Sustain. Crop Prod. 11(1):23-29(February 2016)

STUDIES ON THE STORAGE LIFE AND QUALITY OF RIPE JACKFRUIT POWDER

M. IBRAHIM[1*], M.O.H. HELALI[1], A.K.M.S. ALAM[2], R. AMIN[1] AND S. AKHTER[3]

[1]Fruits and Food Processing and Preservation Research Division, Bangladesh Council of Scientific and Industrial Research Laboratories, Rajshahi-6206, Bangladesh; [2]Applied Botany Research Division, Bangladesh Council of Scientific and Industrial Research Laboratories, Rajshahi-6206, Bangladesh; [3]Institute of Biological Sciences, University of Rajshahi, Rajshahi-6205, Bangladesh.

*Corresponding author & address: Dr. Md. Ibrahim, E-mail: dr.ibrahim62@yahoo.com
Accepted for publication on 25 January 2016

ABSTRACT

Ibrahim M, Helali MOH, Alam AKMS, Amin R, Akhter S (2016) Studies on the storage life and quality of ripe jackfruit powder. *Int. J. Sustain. Crop Prod.* 11(1), 23-29.

The research was carried out as a part of sustainable development goal which mitigate the malnutrition of our people. The perishability and climacteric pattern of ripe jackfruit guide to need some preservation technology that's way we have prepared ripe jackfruit powder and studied the storage life and quality characteristics of that product. The physical (colour, flavor, and taste), biochemical (moisture, dry matter, total soluble solids, total sugar, non-reducing sugar, reducing sugar, ash, minerals i.e. phosphorous, iron, calcium, protein, pH, acidity, vitamin C, vitamin A, soluble protein, starch and total carbohydrate) analysis and microbial (total colony count, total fungal count and fecal coliform) evaluation were done during storage period. From the assessment of the above parameters of jackfruit powder were acceptable in terms of quality parameters.

Key words: *jackfruit powder, storage period, microbial loads, local cultivar, perishability, quality*

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lam.; Moraceae), is a tropical fruit, commonly known as "**National fruit of Bangladesh**". It's the most important fruit of Bangladesh because its one of the delicious and esteemed fruits of the world evidently (Akhter 2014). It is a nutritious fruit and an excellent source of essential minerals, beta carotene (Provitamin A), vitamin C, carbohydrate and energy in human nutrition, therefore, it is useful to prevent many deficiency diseases (Salunkhe and Kadam, 1995). The annual production of jackfruit in Bangladesh is 9,57,000 MT. (BSS 2014)

Most tropical countries like Bangladesh, India, Myanmar, Brazil, the Philippines, Pakistan, Thailand, Malaysia, Sri Lanka, Africa and some other parts of Australia and America actually cultivating plenty of this fruit (Akhter 2014). With increasing recognition of it's nutritional value in human diet, this fruit is gaining commercial importance. The jackfruit is hardly regarded as commercial fruit crop although extensively cultivated (Bose and Mitra, 1990). It is still in the group of underutilized fruit crop.

It is cross pollinated and largely propagated by seeds. Jackfruits are oval or oblong, pale green to yellow-brown in color, rind formed by a number of conical homy protuberances. Raw (tender) jackfruit can be separated into edible (47%) and non edible portions (53%) whereas ripe fruit can be separated in five parts, *viz*. (i) pulp (bulbs), (ii) seeds, (iii) rind (iv) central core and (v) sheath around the pericarp. Of these parts of jackfruit, pulp is the most utilized part for human consumption. The pulp whether ripe or immature can be used for making jams, jellies, beverages, candies and dehydrated products (Sonwalkar 1951; Bhatia *et al.* 1995; Chadha and Pareek, 1993.) Seemingly all parts of the fruits are usable for human welfare.

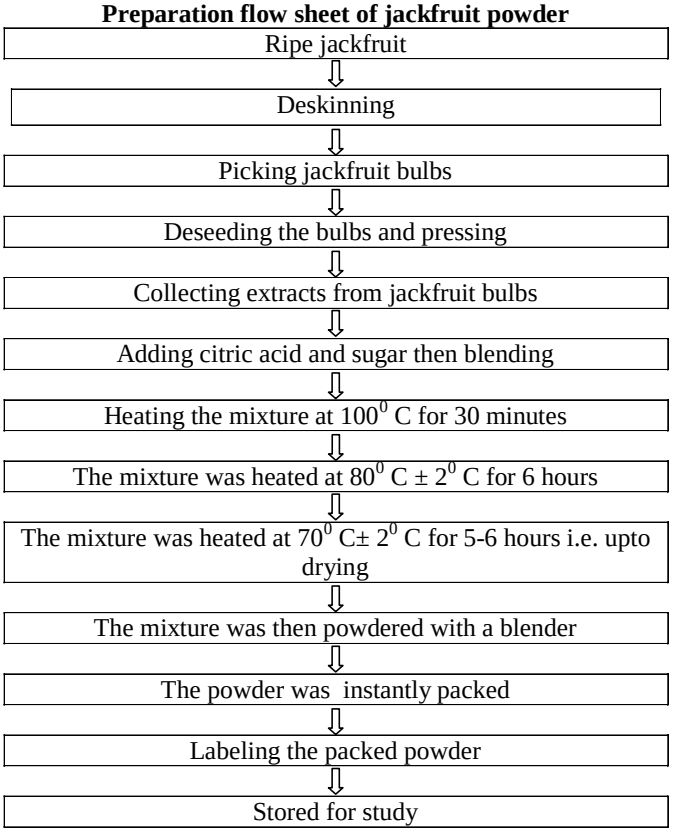
Every year over 40% of the produced jackfruit undergoes postharvest losses (Akhter 2014). Awareness in respect of reducing post harvest losses of such potential fruit is required urgently. In addition, biochemical and nutritional investigation of this underutilized fruit is still very scanty. In view of the above aspect, the present study has been undertaken to through light on some of the constituents of jackfruit for making processed products as well as to apprehending the fruit as a supplementary food having a good nutritional value with a hope to be recognized jackfruit as major fruit crop of our Bangladesh as well as whole world.

MATERIALS AND METHODS

Freshly harvested and uniformly ripe jackfruit cultivar of khaja type were collected from the experimental jackfruit research garden of BCSIR Laboratories Rajshahi, Bangladesh during June–July, 2014 and 2015. Only sound and firm ripe jackfruits were undertaken in this experiment. The jackfruits were washed in fresh water. After that the fruit was deskinned and bulbs were collected from deskinned jackfruit. Next all the jackfruit seeds were removed from the bulbs. Then the bulbs were pressed and the extract was collected. Sugar and a small quantity of citric acid were added and mixing well by a blender. The mixture was then heated again and again for perfect dehydration. Then mixture was powdered and packed immediately because they are very hygroscopic in nature. After labeling the packed powders were stored for study. Preserved jackfruit 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 in the following intervals. 7 days up to 21st day, 15 days up to 66th day, 30 days up to 156th day and 60 days up to 336 day. The biochemical changes were also determined using the standard methods. The moisture content was determined by oven drying method (Karmas 1990). The sugar content was determined by spectrophotometric method (Miller 1959), the reducing sugar was estimated by the same method (Jayaraman 1981), measurement of starch and total carbohydrate (Dubois *et al*. 1956), soluble protein (Lowry *et al*. 1951),

vitamin A (Eqbal *et al*. 2011), vitamin C (Jagota and Dani, 1982), calcium (Stern and Lewis, 1957), phosphprus (Fisk and Row, 1925), iron (Wong 1928). TSS (total soluble solids) was determined by refractometric (add scale 0-30 or 30-60 like) method (Gofur *et al.* 1997) and pH was determined by a standard pH meter (Ibrahim 2002). Acidity was estimated by acid–base titrimetric method (Ranganna 1986) using standard sodium hydroxide solution. The preserved jackfruit powder was analyzed periodically and the results were recorded in tables (Table 1, 2 & 3). Microbiological test was done by pour plate and spread plate method (Buchanan and Gibbons, 1974). The presence of faecal coliforms was determined by using EZ^{TM} Coliform cult (X-GAL/MUG) test kit (Table 4). Organoleptic test and acceptability (Gofur *et al*. 1997) of the preserved product was performed by a panel of ten judges on the basis of their scoring, excellent- 80% or above, good 70-80% and below 70% fair depending on general appearance (colour), flavor and taste (Table 5).

Preparation flow sheet of jackfruit powder



RESULTS AND DISCUSSION

Table 1 represents the biochemical changes considering moisture, dry matter, TSS, total sugar, reducing sugar and non reducing sugar of jackfruit powder from the day of preparation to 336 days during storage.

Moisture content of a food is the total water component of the food sample. It is used to measure the quality of food sample. The increase of moisture in jackfruit powder during storage period was very low and only 0.44 percent. Rahman *et al.* (2012) also observed that the increase of moisture during storage period of osmotic dehydrated jackfruits. Ramachandran *et al.* (2014) has also reported that the increasing behavior of moisture content in papaya powder. The increase of moisture was recorded due to very hygroscopic in nature during the storage period of the products.

According to Niemirowicz–Szczytt *et al.* (1996), the high content of dry matter assures long storage period of fruits. 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/fruits cultivars. Because, relatively much less moisture has to be removed per unit of products when high dry matter containing fruits were used. A problem called dry matter loss can result from heat generation, as caused by microbial respiration.

Total soluble solids (TSS) are one of the most important quality factors for most of the processed fruit products. In this study the TSS has increased gradually from 82.5% at 0 day to 90.0% at 336 days. The increased rate was low but showed higher increase rate than jackfruit drinks. Similar result has been observed by Ayub *et al.* (2010) in his experimental sample. Sharaf and EI-Saadany (1987) has indicated that the increase in soluble solids content could be attributed to the conversion of starch.

The total sugar content of jackfruit powder slowly decreased during the storage period followed by starch & total carbohydrate and the decrease rate was only 0.27%, 0.510% and 0.048% respectively (Table 1 and 2)

which is very low. Rahman *et al.* (2012) also found in his experiment that total sugar content was decreased of stored dehydrated jackfruit for a storage period of eight months. Reducing sugar increased and non reducing sugar decreased gradually in our experiment of jackfruit powder. Rahman *et al.* (2012) also found the increase of reducing sugar in osmotic dehydrated jackfruits. Decrease in total sugars might be due to the increase in reducing sugars (Mir and Nath, 1993) by acid hydrolysis of total and non reducing sugars and thereby inversion of total (Rahman *et al.* 2012) and non- reducing sugars to reducing sugars (Roy and Singh, 1979).

Table 1. Biochemical composition of jackfruit powder during storage

Storage period (Days)	Moisture (%)	Dry matter (%)	Total soluble solids (%)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)
0	3.44±0.06	96.56±0.25	82.5±0.05	53.27±0.11	17.20±0.10	36.07±0.13
7	3.46±0.03	96.54±0.07	82.5±0.03	53.27±0.07	12.23±0.05	35.99±0.05
14	3.47±0.08	96.53±0.21	82.5±0.10	53.24±0.08	17.25±0.03	35.99±0.05
21	3.53±0.10	96.47±0.08	82.5±0.17	53.20±0.04	17.26±0.06	35.94±0.13
36	3.55±0.15	96.45±0.05	85.0±0.10	53.20±0.03	17.30±0.12	35.90±0.10
51	3.58±0.06	96.42±0.15	85.0±0.06	53.17±0.06	17.33±0.15	35.84±0.12
66	3.62±0.03	96.38±0.06	85.0±0.11	53.12±0.10	17.35±0.12	35.77±0.05
96	3.65±0.07	96.35±0.04	87.5±0.05	53.09±0.15	17.36±0.06	35.73±0.11
126	3.69±0.13	96.31±0.05	87.5±0.09	53.07±0.09	17.40±0.03	35.67±0.02
156	3.73±0.15	96.27±0.15	87.5±0.20	53.04±0.06	17.42±0.13	35.62±0.04
216	3.75±0.15	96.25±0.10	90.0±0.13	53.03±0.04	17.42±0.05	35.56±0.03
276	3.78±0.06	96.22±0.03	90.0±0.17	53.03±0.05	17.52±0.10	35.51±0.21
336	3.88±0.04	96.18±0.12	90.0±0.20	53.00±0.09	17.65±0.12	35.35±0.15

Table 2 represents the biochemical parameters changes in the context of ash, minerals (i.e. calcium, phosphorus and iron) pH, acidity of jackfruit powder over 336 days of storage period.

The ash of a biological material is an analytical term for the inorganic residue that remains after organic matter has been burnt off. It gives an idea about the inorganic content of the samples form where the mineral content could be obtained. In our study the ash percentage of jackfruit powder decreased gradually from the day of storage 336 days. The decreasing rate was very low; it was from 0.8207% to 0.8185%. Ashaye *et al.* (2006) has also found decreasing trend in ash content during storage period in his study with roselle jam. Lower ash content is due to increase of microorganism utilizing the minerals for growth (Ashaye *et al.* 2006; Alam *et al.* (2010) has found decrease in ash content in papaya pulp with increase of storage period.

Living organism require a continuous supply of large number of substances (food) from outside of the body to complete their life cycle. This supply is called as nutrition. The mineral as nutrition is an important aspect and its pivotal role in human life for healthy growth. Such type of minerals (*viz.* calcium, phosphorus and iron) is available in jackfruit powder. Among the minerals we have studied the calcium, phosphorus and iron content has decreased gradually with the increase of storage period. The gradual reduction 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 upto 90 days and it was 8.80% during 90^{th} day. The reduction was phosphorus 0.21 mg/100g, iron 0.017 mg/100g and calcium 0.17 mg/100g during 336 days in our experiment.

Considering the pHof jackfruit powder, we observed that it has increased gradually with the increase of storage period. The enhancement of pH was 0.05 and stable upto 156 days which was measured at 7, 15, 30 days intervals. Then again enhancement 0.03 was observed and found stable upto 336 days was measured at 60 days intervals. Akhtar *et al.* (2010); Emmanuel *et al.* (2006) has also found gradual increase in pH with gradual decrease in acidity during their concerning fruit products.

In our study we observed that a gradual decrease of acidity with the increase of storage period. The decrease rate was very low 0.0015%. According to Rahman *et al.* (2012); Pareek and Kaushik (2012) the decrease of acidity might be due to hydrolysis of sugar into glucose and fructose with subsequent fermentation of alcohol and formation of organic acids etc (Gofur *et al.* 1994). Micro-organisms might be responsible for causing these changes (Frazier and Westhoff, 1978).

Table 2. Biochemical composition of jackfruit powder during storage period

Storage period (Days)	Ash (%)	Minerals mg/100 gm			pH	Acidity % as citric acid
		Phosphorus	Iron	Calcium		
0	0.8207±0.0010	22.76±0.13	0.754±0.007	17.65±0.10	4.85±0.08	0.0230±0.0013
7	0.8207±0.005	22.73±0.05	0.753±0.011	17.63±0.06	4.85±0.13	0.0230±0.0015
14	0.8203±0.0022	22.73±0.08	0.750±0.006	17.63±0.03	4.87±0.11	0.0228±0.0003
21	0.8203±0.0003	22.70±0.06	0.750±0.003	17.62±0.05	4.87±0.20	0.0226±0.0004
36	0.8201±0.0003	22.70±0.03	0.748±0.010	17.62±0.03	4.87±0.15	0.0223±0.0005
51	0.8200±0.0008	22.67±0.04	0.748±0.013	17.60±0.10	4.88±0.06	0.0221±0.0007
66	0.8197±0.0016	22.66±0.12	0.746±0.006	17.57±0.15	4.89±0.12	0.0220±0.0002
96	0.8196±0.0012	22.63±0.08	0.742±0.002	17.57±0.05	4.89±0.05	0.0220±0.0006
126	0.8196±0.0015	22.62±0.15	0.742±0.003	17.54±0.03	4.90±0.03	0.0218±0.0017
156	0.8194±0.0005	22.60±0.06	0.740±0.007	17.53±0.12	4.90±0.07	0.0217±0.0002
216	0.8193±0.0007	22.60±0.07	0.740±0.009	17.53±0.14	4.93±0.02	0.0217±0.0007
276	0.8190±0.0010	22.55±0.03	0.737±0.015	17.50±0.10	4.93±0.05	0.0215±0.0005
336	0.8185±0.0023	22.55±0.12	0.737±0.010	17.48±0.05	4.93±0.12	0.0215±0.0013

Table 3 represents the biochemical parameters changes in the context of vitamin A, vitamin C, protein, carbohydrate, starch, soluble protein of jackfruit powder over the 336 days of storage during the period.

The ripe jackfruit contains 11.82 mg/100gm vitamin C. After making powder the vitamin C content has increased. This may be due to high moisture loss and addition of small amount of citric acid. In order to keep the vitamin C losses in minimum level and followed by vitamin A also during heating citric acid was added to the pre mixed of jackfruit before drying. Because, according to author, the loss of vitamin C is minimum (0.5-5.5.0%) in acidic condition (Gofur *et al.* 1994). Rahman *et al.* (2012) found a remarkable reduction in ascorbic acid (vitamin C) content of the osmotic dehydrated jackfruit samples during storage. The reduction could be due to both oxidative and non-oxidative changes as described by Land (1962).The protein content of jackfruit powder was 2.765% at the initial day and it became 2.719% after a gradual decrease of last edible stage followed by soluble protein. Famurewa *et al.* (2013) observed decrease in protein content in his samples of tomato paste over the storage period of six weeks. The paste was prepared by concentrating the tomato pulps at 104^0C.

Table 3. Biochemical composition of jackfruit powder during storage period

Storage period (Days)	Vitamin A µg/100 g	Vitamin C mg/100 g	Protein (%)	Total carbohydrate (%)	Starch (%)	Soluble protein (%)
0	1821.61±23	35.82±11	2.765±05	77.64±16	21.696±10	2.387±00
7	1821.45±20	35.74±17	2.763±03	77.62±14	21.692±13	2.387±03
14	1821.38±15	35.68±09	2.763±11	77.60±18	21.690±16	2.383±07
21	1821.05±13	34.25±15	2.761±02	77.57±20	21.684±12	2.380±06
36	1820.00±20	33.81±13	2.760±03	77.52±16	21.684±15	2.375±02
51	1813.02±24	33.47±17	2.757±09	77.45±12	21.680±08	2.371±01
66	1809.02±16	33.26±19	2.753±07	77.39±14	21.673±13	2.363±05
96	1805.31±07	32.59±07	2.750±06	77.33±13	21.670±11	2.360±03
126	1800.27±14	31.85±16	2.743±04	77.30±09	21.665±08	2.352±04
156	1789.05±17	31.39±15	2.738±05	77.26±11	21.660±05	2.348±06
216	1782.33±09	30.76±08	2.732±03	77.21±08	21.657±09	2.342±07
276	1775.26±24	30.58±20	2.725±06	77.18±06	21.653±17	2.335±02
336	1762.83±18	30.27±13	2.719±04	77.13±03	21.648±14	2.327±09

The table 4 regarding of microbial loads in jackfruit powder reveals that, microbial counts was nil initially and increases slightly during storage (Hashmi *et al.* 2007 and Andres *et al.* 2004). This result was in conformity with the findings of Rahman *et al.* (2012). No micro organisms was traceable initially may be due to adding citric acid and high amount of added sugar. After a certain period the total colony count increased because of keeping the product in ambient temperature and the effect of citric acid may decrease during long storage period. However, the sample contained microbial loads in the range of Gulf standard (Gulf Standards 2000) for foods.

Table 4. Microbial loads in jackfruit powder

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	4-6	-	0
156	15-18	-	0
216	34-39	-	0
276	79-83	-	0
336	167-174	-	0

Consumer's acceptability of any food products depends mainly on appearance (color), flavor and taste. Hence, organoleptic tests were carried out on the color, flavor and tastes of jackfruit powder by a panel of ten judges. The mean results of the preferential comments from the panel members were summarized and converted into acceptability scores and also order of rating.

Table 5. The rating of jackfruit powder as judged by the panel of judges based of general qualities

General qualities	Scoring by individuals judges (at the last edible stage)										Total score	Mean score	Order of rating
	01	02	03	04	05	06	07	08	09	10			
Color	85	79	80	81	78	85	84	80	80	83	815	8.15	Excellent
Flavor	85	79	82	86	75	78	85	75	75	81	801	80.1	Excellent
Taste	86	81	85	84	85	86	80	82	75	83	827	82.7	Excellent

CONCLUSION

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

ACKNOWLEDGEMENT

The authors are grateful to the Director, BCSIR Laboratories. Rajshahi for providing laboratory facilities to carry out the research work. The authors are thankful to Mr. Md. Ziaullah Shafique, Chief Scientific Officer (Ex.), BCSIR Laboratories, Rajshahi for his heartiest inspiration to analyses the data and valuable suggestions. Thanks are also due to Mr. Md. Idris Ali, Tech. for his co-operation and help throughout the research work.

REFERENCES

Akhtar S, Riaz M, Ahmad A, Nisar A (2010) Physico-chemical, microbiological and sensory stability of chemical preserved mango pulp. *Pak. J. Bot.* 42(2), 853-862.

Akhter S (2014) Studies on post harvest technology jackfruit (*Artocurpus heterophyllus* Lam.) and evaluation of its processed products in Rajshahi region of Bangladesh. M Sc. Thesis, Rajshahi University, pp. 92.

Alam MA, Islam MA, Uddin MS, Hassain MZ, Bashir M (2010) Fruit characteristics of ten jackfruit genotypes grown in ChapaiNawabgonj condition. *J. Bangladesh Soc. Agric. Sci. Technol.* 8(1 and 2), 189-192.

Andres SC, Giannuzzi L, Zritzky NG (2004) Temperature effect on microbial growth in film packed apple cubes with preservative added orange juice. *International Journal of Food Science and Technol*. 39, 927-933.

Anonymous (2014) Statistical yearbook of Bangladesh (BBS), 33nd edition, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of People's Republic of Bangladesh. p. 226.

Ashaye OA, Taiwo OO, Adegoke GO (2006) Quality attributes of stored Roselle jam. *International Food Research Journal.* 16, 363-371.

Ayub M, Ullah J, Ali M, Zeb A (2010) Evaluation of strawbarry juice preserved with chemical preservatives at refrigeration temperature. *International Journal of Nutrition and Metabolism*. 2(2), 027-032.

Bhatia BS, Siddapa GS, Lal G (1995) Composition and nutritive value of jackfruit. *Indian J. Agric Sci.* 25, 303-306.

Bose TK, Mitra SK (1990) Tropical and Subtropical, NayaProkash, 206 BidhanSarani, Callcatta 700006, India, pp. 638-649.

Buchanan RE, Gibbons NE (1974) Bergey's Manual of Determinative Bacteriology, Baltimore. Williams and Wiokins Co. 8thedtn. pp. 34-89.

Chadha KL, Pareek OP (1993) Advance in Horticulture. Malhotra Publishing house, A-383 Mayapuri Industrial Area, Phase- 1, New Delhi, India, 4, p. 1715.

Dubois M, Gilles KA, Hail JK, Rebers PA, Smith F (1956) Colorimetric method for determination of sugars and related substance. Anal. chem. 28, 350-356.

Emmanuel SA, Taiwo OO, Odeyemi G (2006) Studies on the storage stability of soursop (*Annona muricata* L.) juice. *African Journal of Biotechnology*. 5(19), 1808-1812.

Eqbal D, Halimah AS, Aminah A, Halimah M, Ab Gapor MT (2011) Vitamin E and β-Carotene composition in four different vegetable oils. *American J App. Sci*. 8(85), 407-412.

Famurewa JAV, Ibidapo PO, Olaifa Y (2013) Storage stability of tomato paste packaged in plastic bottle and polythene stored in ambient temperature. *International Journal of Applied Science and Technology*. 3(6), 34-42.

Fisk CH, Row YS (1925) The colorimetric determination of phosphorus. *J. Biol. Chem*. 66, 375-400.

Frazier WC, Westhoff DC (1978) Food microbiology. Tata-Macgrow Hill Publishing Co. Ltd. New Delhi. p.11.

Gofur A, Shafique MZ, Helali MOH, Ibrahim M, Rahman MM, Alam MS (1997) Studies on extension of post harvest storage life of mango (*Mangifera indica* L.). *Bangladesh J. Sci. Ind. Res*. 32(1), 148-152.

Gofur MA, Shafique MZ, Helali OH, Ibrahim M, Rahman MM, Hakim A (1994) Studies on the formulation and preservation of ripe mango nectar. *Bangladesh J. Sci. India. Res* 24(3), 151-162.

Gulf Standards (2000) Microbiological Criteria for Foodstuffs Part-1, GCC (Gulf Cooperation Council), Riyadh, Saudi Arabia.

Hashmi MS, Alam S, Riaz A, Shah AS (2007) Studies on microbial and sensory quality of mango pulp storage with chemical preservatives. *Pakistan Journal of Nutrition*. 6(1), 85-88.

Ibrahim M (2002) Application on Plant Hormone of the Control of Anthracnose Disease, Yield and Quality Characteristics of Mango. Ph D thesis. Institute of Biological Sciences, University of Rajshahi, Rajshahi, Bangladesh. Ace. No. 0034, pp. 181.

Jagota SK, Dani HM (1982) A new colorimetric technique for the estimation of vitamin C using folin phenol reagent. Anal. Biochem. 127, 178-182

Jayaraman J (1981) Laboratory Manual in Biochemistry. New age International Lit, New Delhi. pp. 180.

Karmas E (1990) Techniques for measurement of moisture content of foods. Food Technol. 34, 52.

Land DG (1962) Stability of plant pigments. Advanced Food Research. 2, 50-56.

Lowry OH, Rosebrough NJ, Farr AL, Randall RJ (1951) Protein measurement with the folin phenol reagent, *J. Biol. Chem.* 193, 265-275.

Miller GL (1959) Use of dinitrosalicylic acid reagent for determination of reducing sugar. Anal. Chem. 31(3), 426-428.

Mir Ma, Nath N (1993) Storage changes on fortified mango bars. *J Food Sci. Technol*. 30, 279-282.

Niemirowicz-Szczytt K, Korzeniewska A, Galecka T (1996) New varieties of winter squash (*Cucurbita maxima* Duch.) with a high content of dry matter, starch, protein, and carotenoids. In: Materials 6th National Congress of Horticultural Society"Plant Breeding, for Improved Quality" Krakow, 15-16 February (1996) pp. 148-151 (in polish).

Pareek S, Kaushik RA (2012) Effect of drying methods on quality of Indian gooseberry (*Emblica officinalis* Gaertn.) powder during storage. *Journal of Scientific and Industrial Research*. 71, 727-732.

Rahman MM, Miaruddin M, Chowhdury MGF, Khan MHH, Rahman MME (2012) Preservation of jackfruit by osmotic dehydration. *Bangladesh J. Agril. Res*. 37(1), 67-75.

Ramachandran P, PoojithaMN, Srividya N (2014) Influence of maltodextein and nutritive anti–caking agents on quality characteristics and storage stability of papaya powder. Research Journal of Pharmaceutical, Biological and Chemical Science. 5(2), 1108-1123.

Ranganna S (1986) Handbook of Analysis and Quality Control for Fruit & Vegetable Products. Tata McGraw-Hill Publishing Company Lit. New Delhi. pp. 1101.

Roy SK, Singh RN (1979) Studies on utilization of bael fruit (*Aegle marmelos*) for processing: III. Preparation and preservation of bael fruit products. Indian food packer. 33, 9-14.

Salunkhe DK, Kadam SS (1995) Handbook of Fruit Science and Technology. Production Composition. Storage and Processing. Published by Library of Congress.270, Madison Avenue, New York, USA. pp. 123-169.

Sharaf A, EL-Saadany SS (1987) Biochemical studies on guava fruits during different maturity stages. Chem. Microbial. Technol. Lebensm. 10, 145-149.

Sonwalkar MS (1951) A study of jackfruit (*Artocarpus heterophyllus* Lam.) seeds. *Indian J. Hort*. 8, 27-30.

Stern J, Lewis WHP (1957) The colorimetric estimation of calciam in serum with o-cresolphthaleincomplexone. Clinica Chemica Acta. 2(6), 376-580.

Vidhya R, Narain A (2011) Formulation and evaluation of preserved products utilizing under exploited fruit, wood apple (*Limonia acidissima*). *American-Eurasian J Agric. Environ. Sc*i. 10(1), 112-118.

Wong SY (1928) Colorimetric determination of iron and hemoglobin in blood. *J. Biol. Chem*. 77, 409-412.