Welcome

WORKSHOP: VALORISATION OF TRADITIONAL PROCESSING OF INDIGENOUS AND UNDERUTILISED FRUITS

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Value Addition to Jackfruit *(Artocarpus heterophyllus* Lam.) through Integrated Processing and Preservation

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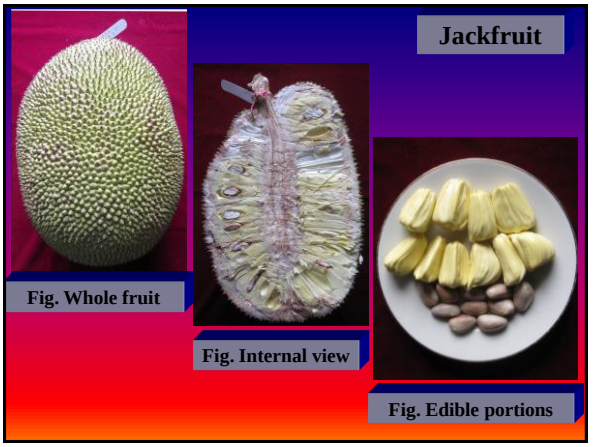
BANGLADESH PROFILE

- North-eastern part of South Asia
- Stretching between 20.34^0 & 26.38^0 N latitude and between 88.01^0 and 92.41^0 E longitudes
- Diverse ecosystems like, hills, plains, coastal and wet lands
- The climate is tropical and sub-tropical
- High and medium high land are mostly suitable for fruit production
- Winter (cool and dry months): October-March)
- Summer (hot and humid months): April-September
- Most of the fruits are produced in summer season

Importance of Postharvest Technologies in Bangladesh

- **Minimization of postharvest losses;**
- **Value addition and nutritional improvement;**
- **Food and financial security of the people especially in the rural areas of Bangladesh;**
- **Employment generation;**
- **Increase export potential of fresh and processed fruits and vegetables.**



INTRODUCTION

- Jackfruit *(Artocarpus heterophyllus* Lam.) belongs to the family Moraceae.
- It is the largest fruit in the world.
- Originally, it is native to Indian sub-continent including Bangladesh (Haque, 2010).
- It is an important and widely distributed fruit crop in Bangladesh and very popular to the people.

- Jackfruit has gained the national fruit of Bangladesh due to its popularity and special features.
- The ripe jackfruit is mainly used as a dessert for its sweet and aromatic arils (bulb).
- The fruit is rich in carotene, potassium and carbohydrates, moderately rich in ascorbic acid (Rahimand Quddus, 2000; Samaddar, 1985; Hossain et al., 1979).

- ✓ It also contains some minerals like calcium and potassium and Vitamin B like thiamin, riboflavin, and Niacin (Acedo, 1992).
- ✓ The young and pre-mature fruit is also used as vegetable, which also contain high amount of vitamins and minerals.
- ✓ Seed is mainly used in curry, and reported to be more nutritious than the bulb, being richer in protein, fat, potassium and carbohydrate with considerable amount of phosphorus and calcium (Acedo, 1992; Rahim and Quddus, 2000).

- ✓ On the other hand, malnutrition problem is still prevailing in the country to a lesser extent particularly at rural and remote areas.
- ✓ The average food intake is deficient in calories, calcium, vitamin A, riboflavin and vitamin C. (INFS, 1989).
- ✓Thus, the intake of fresh and processed jackfruit products significantly contribute to the nutrition and health benefits of the rural people of Bangladesh.

- Every year, a huge amount of jackfruit is produced in Bangladesh, out of which a significant portion goes to waste due its perishable nature and seasonal glut (Haque, 2010).
- Value addition through processing and preservation has to be considered an important alternative for reducing the postharvest losses of this nutritive fruit and for serving in off-season to the people.

Introduction continued….

- Bangladesh Agricultural Research Institute (BARI) has been so far developed technologies for preparing jackfruit chips, candy, pickles, leathers, sugar syrup preserves and jackfruit seed powder (Molla et al., 2011).
- Protocols for preparing jackfruit biscuit, flake, butter, toffee and powder were developed by Bangladesh Council of Scientific and Industrial Research (BCSIR) (Hossain et al., 2011).
- Green jackfruit pickle and jackfruit sweet pickle were also prepared (Kabir et al., 2007).

Introduction continued….

❑ However, research on microbial contamination and the changes in nutritional value of the processed products during storage has yet not been done.

❑ Thus, the products developed from jackfruit are needed to be further standardized.

❑ If the fruit can be processed on a commercial scale, it could have great impact on the improvement of nutritional status, employment and income generation of the poverty stricken people of the society.

OBJECTIVES

- ✓ To upscale and validate of the existing developed technologies;
- ✓ To preserve nutrients and safety of the processed jackfruit products;
- ✓ To disseminate the developed technologies to the small and medium entrepreneurs (SME) including rural women.

MATERIALS AND METHODS

- ❑ The major part of this paper has been prepared from the results of the different experiments that were conducted at BARI, BCSIR, Bangladesh Agricultural University, Mymensingh and Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh.
- ❑ Some secondary data are also included in the paper.

RESULTS AND DISCUSSION

Area and Production of Jackfruit

❑ In the year of 2010-11, the total production of jackfruit was estimated approximately 0.96 million ton from 10652 ha of land (BBS, 2012).

❑ It ranks top in production among the fruits grown in the country accounting 23.08% of total fruit production in 2009-2010 (BBS, 2010).

❑ The average yield per plants is also high in jackfruit compared to other tropical fruits.

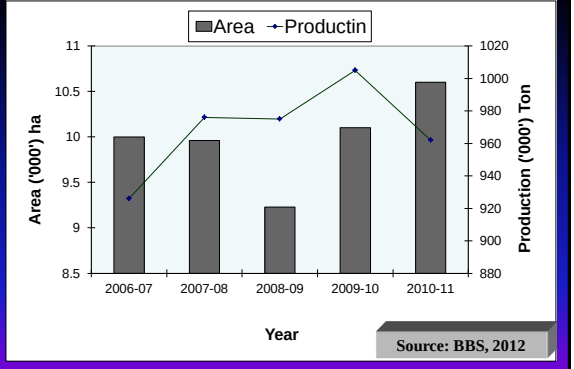


Fig. Area and production of Jackfruit over the past years

Nutritive value of jackfruit

✓Jackfruit is rich in vitamin A, C and sugar. It contains more protein, calcium, thiamin, riboflavin and carotene than banana, but less nutritious than mango (Hossain et al., 1979).

✓As the yield of jackfruit is manifold higher than mango, therefore, vitamin and minerals production per unit area is higher than mango.

Table 1. Nutritional composition of the edible parts of jackfruit

Fruit	Edible Parts (100g)		
	Tender fruit	Ripe fruit	Seed
Moisture (g)	85.0	76.51	54.8
Protein (g)	2.40	1.98	6.6
TSS (%)	14.50	22.00	-
Reducing sugar (%)	4.28	7.65	-
Non-reducing sugar (%)	3.30	9.21	-
Total sugar (%)	7.58	16.86	-
Calcium (mg)	31.22	20.15	1.37
Phosphorous (mg)	38.13	41.51	0.17
Iron (mg)	1.46	0.58	-
Carotene (µg $100g^{-1}$)	86.31	198.0	-
Ascorbic acid ($mg100g^{-1}$)	12.48	7.21	-
Energy (Kcal)	51.0	88.0	-

Table 2. Comparative nutritional status of some fruits in Bangladesh

Name of fruit	Ascorbic acid (mg $100g^{-1}$)	Carotene (µg $100g^{-1}$)	Sugar (%)	Brix (%)	Acidity (%)
Mango	79.45	8.35	11.92	23.00	0.10
Jackfruit	7.04	175.0	16.46	21.50	0.25
Golden apple	87.12	1.60	6.33	9.00	1.40
Carambola	64.98	0.33	4.98	5.00	2.10
Custard apple	40.26	0.01	14.66	20.00	0.21
Indian olive	47.52	0.45	2.36	9.00	2.21
Aonla	425.0	2.39	6.87	13.00	2.35
Bael	10.24	55.33	16.83	24.50	0.32
Tamarind	43.48	0.03	8.03	10.50	10.32

Postharvest Handling and Losses of Jackfruit

✓ The peak harvesting time of jackfruit is June to August in Bangladesh, when both the temperature and RH are very high (30-35 °C and 85-90%, respectively).

✓ Thus, the marketing of fruit becomes very difficult as the harvested fruits are rotten quickly once it ripens.

✓ As a result, a substantial amount of jackfruit remain unsold and ultimately goes to waste.

✓ The total postharvest losses of jackfruit at different levels in the supply chain was estimated 25.4%, which occurred mainly due to careless harvesting and handling, lack of proper transport and storage facilities.

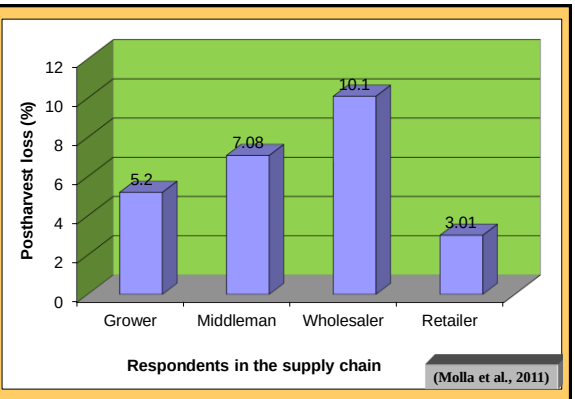


Fig. Postharvest losses of jackfruit in the supply chain

Postharvest losses of major fruits in Bangladesh

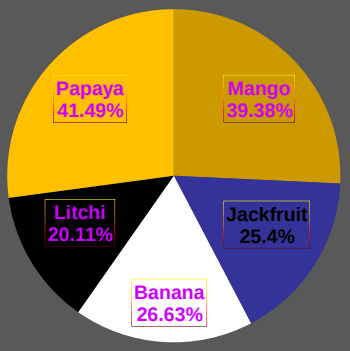


Fig. Postharvest loss of jackfruit during transportation

Valorisation of Jackfruit through Processing and Preservation

Preparation of Jackfruit Candy

Select half-ripe jackfruit (medium hard flesh)
↓
Wash with clean water
↓
Cut into 1x 0.5x 0.5 cm pieces
↓
Blanch the pieces in hot water at 95 °C for 4 minutes
↓
Immerse in 2% calcium lactate and 0.1% KMS for 2 hours and drain
↓
Dip into sugar solution of 25, 35,45, 50, 60 and 70 °Brix at 12 hours interval
↓
Drain the slices and wash with clean water to remove adhering syrup
↓
Dry at 70 °C in a cabinet dryer until the moisture content reach to 10%
↓
Pour the product into polypropylene pouch
↓
Store the product at room temperature (28-32 ˚C)

Fig. Jackfruit candy

Preparation of jackfruit chips

Select green mature jackfruit with medium hard flesh
↓
Wash with clean water
↓
Cut into 4x 2 cm pieces
↓
Blanch the pieces into hot water at 95 °C for 5 minutes
↓
Dried the slices at 60 ˚C for 1 hour and 70 ˚C for next 6 hours
↓
Finally the slices are fried at 160 ˚C in palm oil and stirred with narrow stick
↓
Put out the slices from the pan when turn to light yellow colour and mixed with tasting salt
↓
Pour the product into aluminum foil pouch
↓
Store the product at room temperature (28-32 °C)

Storage periods: 4 months

Fig. Jackfruit chips

Preparation of Jackfruit Leather

Selection of fully ripe jackfruit

↓

Wash with clean water

↓

Cut into half lengthwise

↓

Take bulb and remove seeds

↓

Blend the bulb with 10-15% sugar and boil for 5-7 minutes for extracting juice

↓

Add KMS @ 0.1g/kg and then boil for 3-5 minutes

↓

Concentrate the mixture with steam jacketed pan

↓

Spread the mixture in a stainless steel tray

↓

Put the tray in a cabinet dryer and dried for 20 hours at 60 ^{o}C until the moisture content reach to 20%

↓

Cool and pour the products into polypropylene pouch

Storage periods: 9 months at room temperature

Fig. Jackfruit leather

Preparation of Jackfruit Jam

Select the fully ripe jackfruit

↓

Wash with clean water

↓

Lengthwise cut the fruit into half

↓

Take bulb and remove seeds

↓

Blend the bulb and boil for 5-7 minutes and extract juice

↓

Add 700g sugar and 10g pectin with 1kg juice

↓

Cook until the TSS reach to 64 °Brix and add citric acid (0.25%)

↓

Determine end point through flake test

↓

Sterilize bottle and then poured into bottle and then waxing

↓

Label and store in room temperature (28-32 ^{o}C)

Storage periods: One year

Fig. Jackfruit Jam

Preparation of Jackfruit Rind Jelly

Select fully matured ripe jackfruit

↓

Wash with clean water

↓

Separate rind and cut into small pieces

↓

Add 1.5 L water and 2g citric acid for each Kg rind

↓

Boil 35 minutes and extracting juice

↓

Add 700g sugar and 200 mg citric acid with juice and start cooking

↓

Cook until the TSS reach to 65 °Brix and add rest citric acid

↓

Determine the end point of cooking

↓

Pour into sterilized bottle and waxing

↓

Label and store the product at room temperature

Fig. Jackfruit rind jelly

Preparation of Jackfruit Hot Pickle

Select pre-mature Jackfruit
↓
Wash up to cleaning
↓
Peeling and slicing
↓
Dip in 5% brine solution for 24 hours for fermentation
↓
Remove slices from the brine solution and washed with clean water
↓
Fry the slices in mustard oil for 10 minutes
↓
Add the pasted ginger and garlic with 4 ml glacial acetic acid
↓
Add all measured spices one by one
↓
Add 10 ml glacial acetic acid and cook for 3-5 minutes
↓
Sterilizing bottlle
↓
Pour the product into bottle
↓
Store at room temperature

Table. Formulations for jackfruit hot pickle

SI. No.	Name of ingredients	Amount
1	Jackfruit pulp	1000 g
2	Mustard oil	350 ml
3	Sugar	65 g
4	Zinger	25 g
5	Mustard powder	15 g
6	Pepper	15 g
7	Turmeric	5 g
8	Cumin	4 g
9	Aniseed	5 g
10	Fenugreek	4 g
11	Black cumin	2 g
12	Cinnamon	5 g
13	Cardamom	0.5 g
14	Salt	50 g
15	Vinegar	350 ml

Fig. Jackfruit Hot Pickles

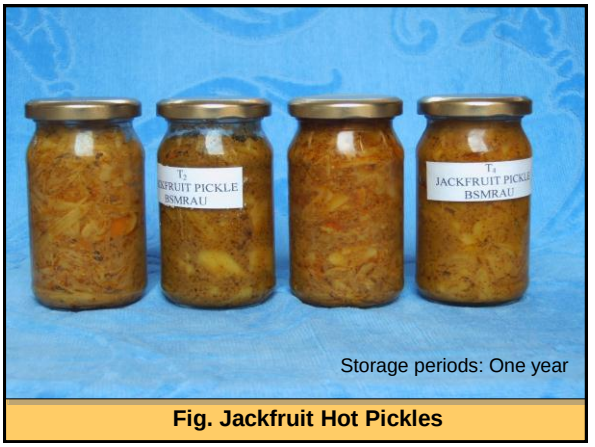


Fig. Jackfruit Hot Pickles

Preparation of jackfruit sweet pickle

Collection of fully matured but not yet soft fresh jackfruit
↓
Wash reasonably with tap water
↓
Separate bulb from seeds
↓
Slicing of bulbs
↓
Mix the slices with ginger and pepper
↓
Pour 250g mixture in each bottle
↓
Add sugar solution of 45 °Brix and capping
↓
Pasteurize at 85 °C
↓
Clean bottles and labeling
↓
Store in a cool and dry place

Table. Formulations for jackfruit sweet pickle

SI. No.	Ingredients	Amount
1.	Jackfruit bulb slice	1000 g
2.	Ginger	50 g
3.	Dried pepper	10 g
4.	Sugar solution	45 °Brix
5.	P^H	2.6

Fig. Sweet Jackfruit pickle

Preparation of Jackfruit nectar

Select ripe jackfruit
↓
Wash with clean water
↓
Extract the bulb and remove the seeds
↓
Blend the bulb and pass through a pulping mill
↓
Mix with 10% hot water and pass through a fine sieve
↓
Pour the prepared nectar into bottle
↓
Store in a cool and dry place

Preservation of Jackfruit in Salt Solution

- Mature green jackfruits are washed with clean water, peeled and cut into small pieces.
- Then kept them in 8% salt, 1.25% acetic acid, 0.1% KMS and 91.65% water solution.
- Then the materials poured into air tight plastic container and keep in cool and dry place.

Preservation of jackfruit in brine solution

Preservation of Jackfruit Bulb in Sugar Syrup

Select fully ripen jackfruit
↓
Wash with clean water
↓
Extract the bulbs and remove seeds from the bulb
↓
Make sugar solution with 25% sugar and 0.5% citric acid
↓
Add the bulbs into sugar solution
↓
Sterilize the bottles
↓
Pour the bulb into sugar solution containing bottle
↓
Store at room temperature (28-32 ^oC)

Storage periods: One year

Preservation of jackfruit bulb in sugar syrup

Table. Major components of different processed jackfruit products

Processed products	Moisture (%)	Ash (%)	pH	Protein (%)	Sugar (%)			TSS (%)	Mineral nutrients (mg/100g)		
					Reducing	Non-reducing	Total		Ca	Fe	P
Jackfruit hot pickle	66.55	1.15	4.3	2.43	5.35	4.31	9.66	18.5	42.88	1.53	46.27
Jackfruit sweet pickle	68.90	1.18	4.6	1.81	7.48	9.78	17.26	29.0	20.88	0.61	48.53
Jackfruit bulb in syrup	75.40	0.88	5.1	1.60	7.91	9.92	17.83	31.0	20.64	0.62	47.19
Jackfruit rind jelly	33.52	0.75	3.3	1.02	15.26	43.25	58.51	67.2	8.60	0.45	35.15
Mean	61.09	0.99	4.33	1.48	9.00	16.82	25.82	36.4	23.25	0.80	44.29
SD (±)	18.76	0.21	0.76	0.41	4.32	17.22	22.11	21.2	14.29	0.49	6.16

Marketing channel of processed products in Bangladesh

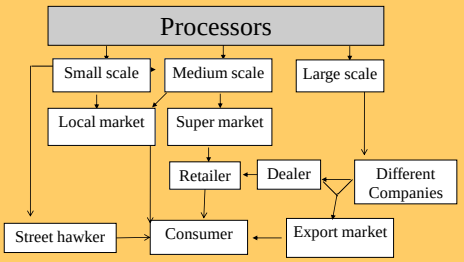


Fig. Flow diagram for marketing of processed fruits (Source: World Bank 2007)

Constraints of Indigenous Fruit Processing

- No private organization or company has been developed yet for the production and marketing of jackfruit processed products in Bangladesh;
- Lack of research strategy to develop postharvest package technology for individual fruit crop;
- Lack of adequate training programme on postharvest management and processing of indigenous fruits;
- Most of the processing equipments are not locally devised. Thus, it is difficult to collect them from overseas country with high cost;
- Lack of entrepreneur's interest to invest money on processing industry of indigenous fruit due to risk and unavailability of year round supply of raw materials;

Opportunities

- Increase area and production of indigenous fruit and their processed products;
- Development of modern low-cost processing technologies of indigenous fruits with their diversified products for small and cottage industries including rural women;
- Retention of maximum nutrients through modern processing protocol;
- Development of large, medium and small scale fruit processing industries in Bangladesh;

Conclusion

1. Some of the postharvest technologies of jackfruit have already been developed, which are very popular among the end users.
2. Up scaling and validation are needed for the developed technologies before recommendation and transfer to the entrepreneurs for commercial production and marketing;
3. Increase consumption of jackfruit processed products will prevent the incidence of malnutrition disorders and generate more income to the farmers and traders;

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