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RESEARCH PAPER

Development and standardization of recipe for jackfruit candy

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SUMMARY : To standardize a recipe for the preparation of jackfruit candy, the bulb was steeped in 4 different combinations of sugar syrup concentrations (20/30/40°B, 25/35/45°B, 30/40/50°B and 40/50/60°B) for osmotic concentration. The osmosed jackfruit bulbs were then dried at 3 different temperatures 50, 60 and 70°C. It was observed that 3 candy products processed in sugar syrup combinations of (25/35/45°B, 30/40/50°B and 40/50/60°B) and all dried at 70°C were found to be best among the prepared 12 products by organoleptic evaluation. The B:C ratio of production of jackfruit candy was estimated to be 1: 1.95 for retail marketing and 1: 1.63 for wholesale marketing.

Key Words : Jackfruit, Processing, Recipe, B: C ratio

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Jackfruit (*Artocarpus heterophyllus* Lam.), an important minor fruit crop of tropics belonging to family Moraceae, is a native of India and grows wild in the rain forests of western ghats of India (Reddy *et al*., 2004). Jackfruit is a nutritious fruit, mostly consumed as a fresh table fruit. It has a short shelf-life of just one to two days after ripening and bulbs have one day shelf-life after separating from the fruit. In India, except the production of jackfruit chips from unripe fruit in some regions no commercial method of jackfruit processing is in practice. Therefore, there is a thrust in recent times, to improve the utilization of this fruit especially through product diversification.

Jackfruit consists of three important parts namely bulb, seed and rind. Bhatia *et al*. (1955) reported that the bulbs constitute 29 per cent, seeds constitute 12 per cent and rind constitutes 59 per cent of the ripe fruit. The bulk of the crop produced is generally utilized in unripe stage as a vegetable or made into pickles, while the ripe fruit is eaten fresh or preserved in syrup. Jack fruit, a poor man's fruit, is available in plenty during the season in the market as well as on road side with push cart vendors. They are sold often in most unhygienic conditions by the vendors. It is, therefore, envisaged to find out hygienic and scientific methods to preserve the bulbs for a short time. By preserving it in sugar syrup and packaging in convenient consumer packs, it can be sold in the market. This endeavor will help not only to utilize the excess produce of jackfruit during the season, but also ensures the development of a sustained jackfruit processing industry on a cottage scale in rural areas.

In spite of its popularity for centuries in Asia, very little work has been done scientifically to extend the nutritional and agricultural potential of this crop. However, the jackfruits are being valued by the processors to make use of enormous production and glut in the market during the harvesting season. Keeping in view the above requirements and also to explore the possibility of preparing and preserving the jackfruit products in a hygienic way, the present investigation was undertaken to study physical and bio-chemical properties of

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jackfruit bulbs and to develop a recipe for jackfruit candy from bulbs.

EXPERIMENTAL METHODS

Well matured, ripe and uniform sized jackfruits (with soft flesh type bulbs) were used in the study. The selected fruits were cut along their equatorial axis with the help of a sharp stainless steel knife smeared with edible oil. The bulbs were then carefully separated from the rind and placenta. After the bulbs were separated, they were deseeded along with testa (seed cover). Then the bulbs were sliced, the sliced bulbs were kept in sterile containers for further experimentation. The jackfruits collected from the tree were analyzed for physical parameters like weight of fruit, number of bulbs and seeds, weight of whole and deseeded bulbs, weight of peel, edible to non-edible ratio, bulb size, total soluble solids (TSS) and moisture content.

Based on the feeler trials, preliminary trials were conducted to osmotically dry deseeded jackfruit bulbs with different concentrations of sugar solutions (20/30/40^{0}B, 25/35/45^{0}B, 30/40/50^{0}B and 40/50/60^{0}B). Preparation of jackfruit candy from deseeded sliced bulbs was basically a two stage process. First, the sliced bulbs were osmotically dehydrated using sugar syrup of selected combination of concentrations for three days to partially remove moisture. The osmosed slices were then dehydrated in a convective tray dryer at selected temperatures (50, 60 and 70^{0}C) to the final storage moisture level. In each treatment, three concentrations of sugar solutions were employed during osmotic dehydration step-initially starting with lower concentration and increasing it to designed concentrations in next two days by way of adding additional sugar.

The process flow chart for the preparation of jackfruit candy is given in Fig. A. For clarity, the processing steps were explained using one combination *i.e.*, 40/50/60°B sugar syrup concentration. Well matured ripe, deseeded, sliced bulbs were immersed in 40^{0}B sugar syrup (450g sugar in 750 ml water) and the contents were heated to 80^{0}C and held for 10 minutes. The temperature was then reduced and held at 50^{0}C for 10 minutes. The preservative citric acid was added @ 0.5 per cent of bulb weight and the contents were cooled and held for 24 hours under room temperature. The solid to sugar syrup ratio was maintained at 1: 3 on weight basis. An Erma Hand Refractometer was used to acertain the strength of the syrup. The bulbs were then removed from the syrup and the syrup concentration was increased to 50^{0}B by adding more sugar to it. The syrup was filtered using a muslin cloth and it was heated to 80^{0}C for 10 minutes and cooled. The osmosed bulbs were transferred into the 50^{0}B syrup and kept for 24 hours under room temperature. Again the bulbs were separated from the syrup, concentration of the syrup was increased to 60^{0}B by adding additional sugar and the syrup was heated to 80^{0}C for 10 minutes and cooled. The osmosed bulbs were transferred into 60^{0}B syrup and kept for 24 hours at room temperature. At the end of third day, the syrup was drained off and the osmosed jackfruit slices were dried at 70^{0}C in a convective tray dryer in a single layer thickness to a storable moisture content of 5 per cent. Roughly, 0.5 kg of candy could be obtained from a kilo gram of fresh sliced bulbs which was packaged and stored at ambient. The twelve osmo-

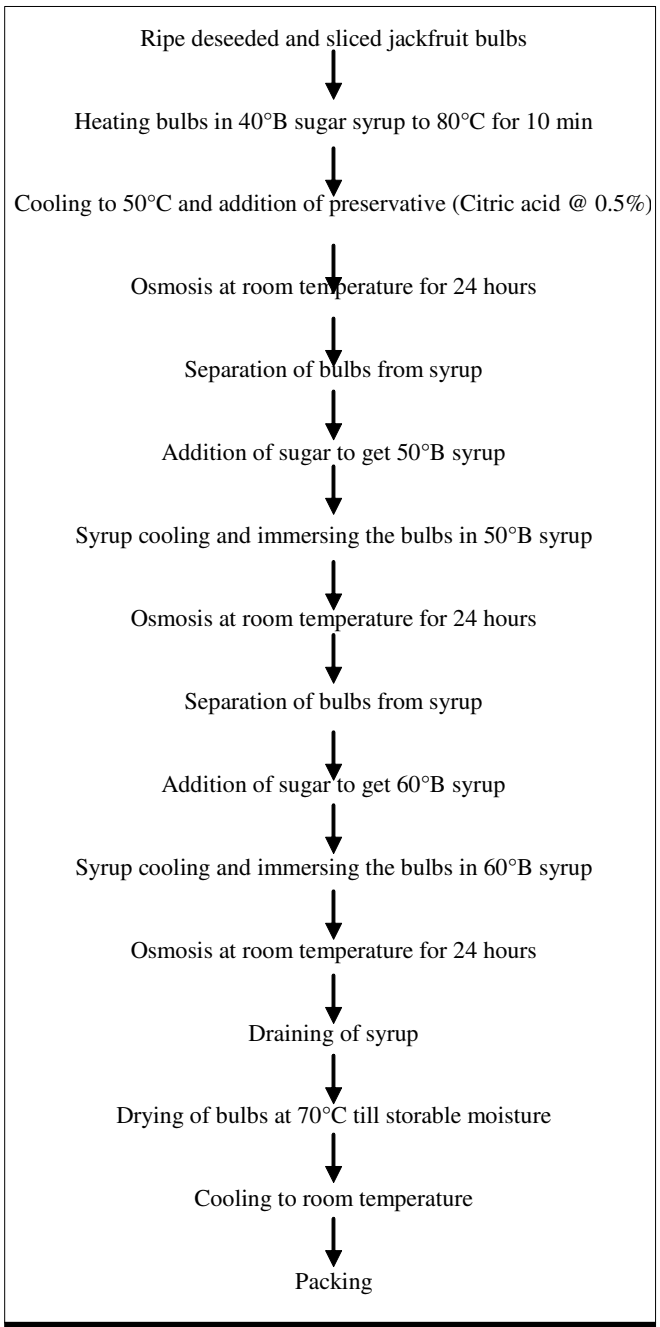

Fig. A : Process flowchart for preparation of jackfruit candy

convective dried candy products were tested for consumer acceptance in terms of colour, appearance, taste, texture and acceptability by sensory evaluation and identified 3 best products.

Jackfruit bulbs and candy were pulped or powdered as the case may be, using a pestle and mortar. This pulp or powdered candy samples were used for further analysis. The crude protein content of jackfruit bulbs and candy samples was estimated by Micro-Kjeldahl method (Ranganna,1995). Fat, ash and crude fibre content of jackfruit bulbs and candy samples were estimated as per the method outlined in A.O.A.C. (1970). Ascorbic acid of jackfruit bulbs and candy samples was determined by 2, 6-dichlorophenol indophenol visual titration method (Ranganna, 1995). Titrable acidity of jackfruit bulbs and candy samples were determined by visual titration method (Ranganna, 1995). The β-carotene content and sugars present in jackfruit bulbs and candy samples were estimated by the method outlined by Ranganna (1995).

EXPERIMENTAL FINDINGS AND ANALYSIS

The results of the present study as well as relevant discussions have been presented under following sub heads:

Physical characteristics of jackfruit and its bulbs:

The observations on physical characteristics of jackfruit and its bulbs are presented in Table 1. The average weight of jackfruit recorded was 13.40 kg. This finding is in agreement with the results (7 to 20 kg) reported by Reddy *et al*. (2004) for different clones of jackfruit. The average number of bulbs and seeds per fruit were 240.60 and 236.30, respectively. Bhatia *et al*. (1955) reported that the bulbs constitute 29 per cent and seeds constitute 12 per cent of the ripe jackfruit.

Table 1 : Physical characteristics of jackfruit and its bulbs

Sr. No.	Parameters	Observation*
1.	Weight of fruit (kg)	13.40±4.33
2.	Number of bulbs per fruit	240.60±9.71
3.	Number of seeds per fruit	236.30±9.07
4.	Weight of whole bulbs per fruit (kg)	9.78±3.42
5.	Weight of deseeded bulbs per fruit (kg)	7.42±2.68
6.	Weight of peel (kg)	6.21±2.52
7.	Edible to non-edible ratio	1.34±0.31
8.	Length of bulb (mm)	64.15±4.92
9.	Breadth of bulb with seed (mm)	40.56±5
10.	Thickness of bulb with seed (mm)	14.62±2.36
11.	Moisture content (%wb)	86.44±0.59
12.	Total soluble solids, TSS (°B)	20±1

* = Average of 10 fruits

The bulbs of fruit had 86.44 per cent (wb) moisture. According to Anonymous (2003) the edible portion (ripe flesh) of jackfruit contains 72.0 to 77.2 per cent moisture. The TSS of the pulp was found to be 20°B. The mean weights of whole bulbs, deseeded bulbs and peel per fruit were recorded as 9.78 kg, 7.42 kg and 6.21 kg, respectively. The average length, breadth and thickness of bulbs were found to be 64.15 mm, 40.56 mm and 14.62 mm, respectively. The edible to non-edible ratio was 1.34.

Nutritional quality of jackfruit bulbs (Deseeded):

The nutritional quality in terms of different biochemical parameters of jackfruit bulbs is presented in Table 2. The crude protein, fat, ash, and crude fibre contents of bulb were recorded as 1.90 per cent, 0.30 per cent, 0.94 per cent, and 0.69 per cent, respectively. These observations are in accordance with Anonymous (2003) that the edible portion of the jackfruit had protein-1.9 per cent, fat-0.1 per cent, ash-0.9 per cent, fibre-1.1 per cent. The ascorbic acid and β-carotene contents of the bulb were found to be 3.29 mg/100g and 502.70 µg/100g, respectively. Anonymous (2003) reported 8-10 mg/100g of ascorbic acid and 540 µg/100g of β-carotene. The acidity of the bulb was 0.33 per cent. The total, reducing and non-reducing sugar contents were 11.08 per cent, 3.94 per cent, 7.14 per cent, respectively. The energy content of bulb in this study was calculated as 55.51 kcal/100g. Anonymous (2003) reported that the energy of edible portion (ripe flesh) of jackfruit as 58 kcal/ 100g.

Table 2 : Nutritional quality of jackfruit bulbs

Sr. No.	Parameters	Observation*
1.	Crude protein (%)	1.90±0.1
2.	Fat (%)	0.30±0.1
3.	Ash (%)	0.94±0.04
4.	Crude fibre (%)	0.69±0.01
5.	Ascorbic acid (mg/100g)	3.29±0.07
6.	β-carotene (µg/100g)	502.7±1.82
7.	Titrable acidity (% as citric acid)	0.33±0.03
8.	Total sugars (%)	11.08±0.26
9.	Reducing sugars (%)	3.94±0.11
10.	Non-reducing sugars (%)	7.14±0.15
11.	Energy (kcal/100g)	55.51±1.11

* = Average of 10 fruits

Osmotic dehydration characteristics of jackfruit slices:

The osmotic dehydration characteristics of jackfruit slices in different concentrations of sugar syrup at 28°C are shown in Table 3. Osmotic dehydration of jackfruit slices indicated that the maximum water loss of jackfruit slices after 72 hours of osmosis at 28°C was 35.26 per cent, 33.35 per cent and 28.84 per cent, respectively for sugar syrup concentrations 40/50/ 60°B, 30/40/50°B and 25/35/45°B. The solid gain by jackfruit slices after 72 hours of osmosis was about 7.32 per cent, 6.73

Table 3 : Osmotic dehydration characteristics of jackfruit slices in different concentrations of sugar syrup at 28°C

Sugar syrup concentration (°B)	Moisture content of jackfruit slices (%wb)		Solid gain (%)	Water loss (%)
	Initial	After osmosis		
40/50/60	86.44	37.21	7.32	35.26
30/40/50	86.44	45.58	6.73	33.35
25/35/45	86.44	48.77	5.34	28.84

per cent and 5.34 per cent depending upon the sugar syrup concentrations (40/50/60°B, 30/40/50°B and 25/35/45°B) employed for osmosis.

Nutritional quality of selected jackfruit candies:

The three best jackfruit candies Candy-A (40/50/60°B), Candy-B (30/40/50°B) and Candy-C (25/35/45°B) selected based on sensory evaluation were analyzed for various nutritional quality parameters and are presented in Table 4. For candies A, B and C, the moisture contents were 4.19 per cent, 4.38 per cent and 4.76 per cent; TSS contents were 41°B, 30.33°B and 26.33°B; the crude protein contents were 1.13 per cent, 1.21 per cent and 1.37 per cent; the fat contents were 0.17 per cent, 0.41 per cent and, 0.75 per cent; the ash contents were recorded as 0.43 per cent, 0.58 per cent and 0.75 per cent; and the crude fibre contents were 1.29 per cent, 1.36 per cent and 1.43 per cent, respectively. The candies A, B and C had ascorbic acid contents of 1.47, 1.85 and 2.21 mg/100g. Fernandez *et al*. (2007) stated that the osmotic treatment of muskmelon resulted in products with decreased vitamin C concentration and water activity as the syrup concentration increased. For candies A, B and C, the total sugar contents were 18.73 per cent, 17.37 per cent and 13.67 per cent, respectively, while the reducing sugar contents were 6.03 per cent, 6.92 per cent and 8.16 per cent, respectively and the non-reducing sugar contents were 12.70 per cent, 10.45 per cent and 5.51 per cent, respectively and the energy contents were 83.72 kcal, 79.37 kcal and 66 kcal per 100 g, respectively.

Table 4 : Nutritional quality of selected jackfruit candies

Constituents	Treatments		
	A	B	C
Moisture content (%wb)	4.19±0.13	4.38±0.05	4.76±0.19
Crude protein (%)	1.13±0.24	1.21±0.26	1.37±0.19
Fat (%)	0.17±0.01	0.41±0.11	0.75±0.08
Ash (%)	0.43±0.04	0.58±0.02	0.75±0.04
Crude fibre (%)	1.29±0.04	1.36±0.01	1.43±0.03
Ascorbic acid (mg/100g)	1.47±1.12	1.85±0.00	2.21±0.00
β-carotene (µg/100g)	389.33±1.12	438.24±1.67	497.66±3.28
Titrable acidity (% as citric acid)	0.28±0.01	0.35±0.01	0.41±0.01
TSS (°B)	41.00±2	30.33±1.52	26.33±1.52
Total sugars (%)	18.73±1.71	17.37±0.82	13.67 ±0.89
Reducing sugars (%)	6.03±0.26	6.92±0.05	8.16±0.18
Non-reducing sugars (%)	12.70±1.94	10.45±0.82	5.51±0.97
Energy (kcal/100g)	83.72±6.36	79.37±4.14	66.00±3.12

Conclusion:

Candies prepared using sugar syrup concentrations of 40/50/60°B (Candy-A), 30/40/50°B (Candy-B) and 25/35/45°B (Candy-C) dried at 70°C were adjudged to be better and these three samples had obtained acceptable sensory scores for colour, appearance, taste, texture and overall acceptability. To obtain shelf-stable osmo-dehydrated jackfruit slices, it was required to dry the osmosed jackfruit slices for about 28 hours in convective tray dryer at 70°C.

The cost of production of jackfruit candy was worked out to be Rs. 76.50/ kg and the cost-benefit ratio of production of jackfruit candy was estimated to be 1: 1.95 for retail marketing and 1: 1.63 for wholesale marketing. The study indicates that processing of jackfruit into value-added product will enhance the return of 2 times compared to marketing of raw jackfruits. This would greatly benefit the rural economy, which is now being forced to become market-oriented.

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