Journal of Postharvest Technology
2021, **09**(3): 17-28
www.jpht.in

RESEARCH ARTICLE

Formulation and standardisation of jack fruit functional candy

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Received: 19.06.2021 Accepted: 25.07.2021

ABSTRACT

The jack fruit (*Artocarpus heterophyllus Lam*) is a multi-purpose tree that provides food, fodder, timber, fuel. Both immature and mature fruits are consumed in different local dishes; soft-type ripe fruits remain underutilised due to poor shelf life despite their immense potential. The present investigation developed fruit-based hard candy that showed better acceptability, storage stability for more than 10months, rich mineral composition, and consumer safety. The study proved that it is possible to convert jackfruit pulp into functional candies instead of wastage. The water activity(a_w) ranged from 0.46 to 0.58 during 14 months of ambient storage and was found acceptable. The nutritional composition were moisture (2.45g/100g), protein (1.30g/100g), total ash (0.59g/100g), carbohydrates(94.57g/100g) and energy (393.30 K.Cal/100g). Calcium (42.38mg/kg), Potassium (3309.42mg/kg), Magnesium (263.75mg/kg), and Sodium (239.08mg/kg). Among the trace minerals, Chromium (2.04mg/kg), Copper (3.00mg/kg), Iron (40.19mg/kg), Gallium (0.155mg/kg), Manganese (2.47mg/kg) and Zinc (3.64mg/kg). Others elements like Lithium(0.04mg/kg), Gallium (0.15mg/kg), cobalt (0.05mg/kg), Cadmium(0.007mg/kg), Barium(1.02mg/kg), Silver (0.02mg/kg), Nickel (0.31mg/kg) and Strontium (0.59 mg/kg) found in traces and Bismuth, Indium and Thallium was found below the detection limits. The process is cost-effective to converts waste into a new product range of longer shelf-life.

Keywords: Hard-boiled candy, functional fruit candy, jack fruit candy

Citation: Ray, B.R.M., Narasaiah, B.T., and Suresh, C. 2021. Formulation and standardisation of jack fruit functional candy. *Journal of Postharvest Technology*, **9**(3): 17-28.

INTRODUCTION

The jack fruit *Artocarpus heterophyllus Lam* is a multi-purpose tree grown without much care, provides food, fodder, timber, fuel, medicinal and industrial products. Both immature and mature fruits were used in different products; despite the immense potential and organic nature, it remains an underutilised fruit. The fruit contains free sugar (sucrose), fatty acids, ellagic acid and amino acids like arginine, cystine, histidine, leucine, lysine, methionine, threonine, tryptophan etc. (Pavanasasivam and Sultanbawa, 1973; Swami et al., 2012). Seeds are rich in starch (Singh et al., 1991). Jackfruit growers commonly distinguish two major types such as firm-fleshed and soft-fleshed varieties called Waraka and Wela. The primary fruiting season is March to June (Medagoda and Tennakoon, 2001), individual jack fruit weight varies between 2.10 and 10.22 kg (Mitra and Mani, 2000) some trees reported nearly 50 kg (Reddy et al., 2004). Fresh bulbs cannot be stored for a long time due to poor shelf-life; deseeded bulbs deteriorate fast (Lorina et al., 2017**)**. The wastage is estimated to be around 75%. In India, Kerala alone wastes

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ISSN2348-4330

about 35 crore jackfruits worth Rs. 214.4 crore food annually **(**Apaari, 2012), and it needs to be promoted for its practical utility in various commercial products.

The fruit is a deliciously sweet taste, appealing flavour, and colour, making it suitable for processing and value addition (Panja et al., 2016). Ripe jackfruit bulbs (flakes) are consumed as a dessert fruit or processed into various forms like canned segments, drum-dried powder, osmotic dried segments and candy, juice, jam, spread, ready to serve beverage (RTS), squash, syrup, nectar, slab or bar, to flavour ice-creams and beverages.

The Indian food industry is a major business unit for chocolates and confectionery products (Manjula and Suneetha, 2014), including sugar-boiled confectionery, hard-boiled candies and toffees. The projected chocolate market is around 33,000 tons worth Rs 8.0 billion at present. The candy market is growing at an annual rate of 12-14%. The candy market worth Rs.6000 crore is growing at 1.5 times the FMCG industry in India. Where consumers usually buy them in exchange for loose cash. Hard candies, including lollipops, toffees and gumdrops, the list is endless, which are made of sucrose, fructose, glucose or maltose; Colour and flavour are popular among all age groups. Chocolate confectionery, sugar confectionery and gum items. Each of the three classes is described by the utilisation of a lot of sugar and sugar substitutes. Although confectioneries are commonly low in micronutrients but are wealthy in calories and starches

Indian confectionery shows sluggish growth due to lack of innovativeness (India times.com 2017 online); new types and varieties are driving the candy growth sector to a level of 15%, presently hard-boiled candies (HBCs) accounts for nearly half of the total confectionery market compared to jellies which constitute 1%, introduction of latest flavours. Innovative approaches are the two key growth drivers for product movement in the market. In this background, the present investigation was undertaken to formulate and standardise jack fruit pulp based hard boiled confectionery of better storage stability, particularly the soft type jack fruit pulp, which is presently wasted due to poor shelf life into hard caramel candies of acceptable attributes (Akib et al., 2016). This can also be taken as rural entrepreneurial activity in the production catchment by the rural farming community and self-help groups as an innovative product for additional income.

MATERIALS AND METHODS

Procurement of ingredients

Fully ripened soft juicy type jack fruits were procured from the Gandhi Krisi Vijyan Kendra, University of Agricultural Sciences, Bangalore. The fruit was washed with chlorinated water and air-dried and cut into two halves, edible bulbs separated from the rind. Seeds and seed sacks manually, the recovered pulp total solid content was measured using a hand refractometer at 25^0C (Model Erma) and mashed using kitchen grinder into a fine paste and preserved in the refrigerator for further studies. Other ingredients used were cane sugar, syrup and citric acid were procured from the local market.

Analytical methods

The hard-boiled candies (HBCs) were standardised with several preliminary trials before standardising the final formulation and method of preparation. The raw materials such as sucrose, syrup or confectioner's glucose, and jack fruit pulp was accurately weighed using digital balance and transferred onto a wide mouth stainless steel vessel. The required quantity of reverse osmosis water was added from the known quantity to dissolve the contents on a medium flame by continuous stirring. The mixture was boiled on a medium flame by continuous stirring and checking the temperature of the boiling mixture using a non-contact infrared digital thermometer until the contents become softball consistency by leaving the sides. When the temperature of the mixture

touches 135^{0}C, the mixing speed should be continuous. As soon as the mixture touches138±1^{0}C, immediately the hot soft mass transferred onto a clean granite table, previously dissolved citric acid in a small quantity of distilled water was poured on the hot mixture and mixed by folding the hot mass to mix thoroughly, and immediately moulded into a required shape and names as jack fruit functional candy (JFFC).

Table 1. Jack fruit functional candy (JFFC) formulations

Ingredients (%)	T1	T2	T3	T4	T5	T6	T7
Syrup (%)	40	35	30	25	20	15	10
Sucrose (%)	35	35	35	35	35	35	35
RJFP (%)	35	35	35	35	35	35	35
Water (ml)	95	95	95	95	95	95	95

RJFP-Ripe Jack fruit pulp

The procedure repeated for all the treatments formulation (Table.1) (T2, T3, T4, T5, T6 and T7) and the resulted product was packed in HDPE pouches and preserved at ambient temperatures for further studies.

Sensory evaluation

The prepared candies were subjected to organoleptic evaluation using a 9-point hedonic scale (Sidel and Stone, 2006) for its acceptability by a semi-trained panel of 21 judges for taste, appearance, colour, texture, aroma, mouth feels and overall acceptability during 14 months storage duration.

Proximate composition

The best-accepted candies were subjected to proximate composition using standard AOAC procedures in fresh and after ten-month storage in HDPE packing material at ambient conditions.

Elemental or minerals analysis

The presence of mineral elements in foods is of significant scientific interest since some of these elements are toxic at low concentrations (e.g. Cd and Pb). Some are essential(e.g. Fe, Co, Mn, Ni, Cr, Cu and Zn) and required for the body's normal functions. The prepared jack caramel candies were subjected to 23 mineral or elemental analysis using Inductively coupled plasma mass spectrometry (ICP-MS), Make-PerkinElmer, USA (Model NexION 350 X) with microwave sample digestion (Model-Titan MPS) with standard protocols (AOAC 2013).

Water activity (a_w)

The water activity of any food product is essential in maintaining its chemical and storage stability. Water activity ranges from zero (water absent) to 1.0 (pure water). The water activity of the fresh and stored jack fruit candies was measured using a rotronic water activity meter (HygroLab C1) at room temperature every two months interval.

Colour Measurement

Food colour is the essential parameter and a noble gauge for successful quality evaluation [Ivana Markovic]. The colour of the jack fruit candies was measured using Konica Minolta Spectrophotometer CM-5 after calibrating using the standard black cap, and white plate supplied. The values of L*, a*, b* were recorded, the L* scale indicates light to dark colour, the low number L(0-

50) indicates dark, and a high number L(51-100) indicates light grey to white colour L(100). The scale a* indicates red to green, where positive +a* indicates red and negative -a* indicates green colour. The scale b* indicates yellow to blue, positive +b* number indicates yellow and negative -b* indicates blue colour (as a* and b* values increase, i.e., values move from the centre to outer periphery as the colour saturation also increases).

Microbial Analysis

Microbial analysis of fresh and stored Jack fruit candies (JFFC) was carried for Escherichia coli (cfu/g), Yeast (cfu/g), Moulds (cfu/g) using their respective culture media and standard plate count methods.

Statistical analysis

The data obtained from different sensory tributes were pooled and subjected to analysis of variance (ANOVA) using the IBM statistical package for social sciences (IBM-SPSS) version 23. Means were separated using New Duncan's Multiple Range Tests at a 95 per cent confidence level ($p \leq 0.05$).

RESULTS AND DISCUSSION

The different formulations of jack fruit functional candies (JFFC) were presented and discussed here. The jack fruit pulp TSS reported being 28-29^0 Brix which is not sufficient to obtain a complex mouldable structured product. Sucrose and a syrup lend sweetness, structure and stability to the product in transparency and hygroscopicity. Corn syrup or acid-converted syrup serves as an essential ingredient that retards the migration of micro-crystals by reducing crystal growth. Preparation of candy based on fused sugars (sucrose and syrup), the addition of colour, flavours, acids and other raw materials specific to each kind of candy.

Table 2. Sensory score and acceptability of stored JFF-Candies

Variation	Appearance	Texture	Colour	Flavour	Taste	Overall Acceptability
T1	7.71 ± 0.56	7.52 ± 0.51	6.95 ± 0.66	7.04 ± 0.86	7.78 ± 0.60	8.33 ± 0.57
T2	7.33 ± 0.65	7.57± 0.50	7.09± 0.53	6.69± 0.64	6.80± 0.67	7.50 ± 0.52
T3	7.23 ± 0.70	7.23 ± 0.78	7.45 ± 0.66	7.47 ± 0.51	7.60 ± 0.56	7.59 ± 0.56
T4	8.33 ± 0.65	7.71 ± 0.43	8.52 ± 0.51	7.64 ± 0.85	8.04 ± 0.47	8.15 ± 0.43
T5	8.50 ± 0.50	8.00 ± 0.45	8.52 ± 0.51	7.73 ± 0.53	8.34 ± 0.53	8.66 ± 0.48
T6	4.85 ± 1.06	6.28 ± 0.64	4.38 ± 0.92	5.95 ± 0.58	6.09 ± 0.30	6.02 ± 0.40
T7	4.47 ± 1.16	5.42 ± 0.87	4.52 ± 1.66	4.07 ± 1.70	5.61 ± 0.86	6.00 ± 0.63
Mean ± SD	6.92 ± 1.68	7.10 ± 1.04	6.77 ± 1.80	6.65 ± 1.49	7.18 ± 1.12	7.46 ± 1.12
F Value	86.76	45.93	80.64	43.65	62.98	88.72
T-Value	1.97	1.97	1.97	1.97	1.97	1.97
MSS	0.63	0.38	0.76	0.81	0.35	0.27
SED	0.42	0.33	0.46	0.48	0.31	0.27
CD	**	**	**	**	**	**

Note: * Significant, ** Highly significant

Sensory evaluation studies

The results of the sensory evaluation (Table 2) have highly differed significantly among the formulations. However, the treatments T1 to T5 were accepted. The formulations T4 and T5 were best accepted in terms of overall acceptability scores 8.15 and 8.86, mainly due to appearance, texture, colour contributed to the product's taste. Hence, a maximum of 35 % jack pulp and sucrose with 20% to 40% syrup contributed hardness and acceptable colour. Similar studies reported that the setting of pumpkin juice-based candy with 50% pumpkin juice incorporated product was most acceptable in all the sensory attributes compared to 40% and 60% (Manjula and Suneetha, 2014). Whereas in tamarind pulp-based hard candy, 100% tamarind pulp with 200% sucrose and 400% syrup(1:2:4) was best rated (Kiranmai et al., 2018). Similarly1% red-ginger extract combined hard-boiled candy reported to be best accepted as reported by Nur Illiyyin Akib et al. (2016).

Proximate composition

The results are presented in the table-3. The moisture content of fresh JFFCs reported being 2.45g/100g against stored product 1.83g/100g due to moisture loss during storage. The protein content was 1.30g/100g and 1.03g/100g in the fresh and stored product. The fat content was reported to be nil in both samples. The total ash content was 0.59 and 0.19g/100g in fresh and stored candies, the carbohydrate content of fresh candy was 94.57g/100g with a slightly increased value of 96.95g/100g in the stored sample.

Table 3. Proximate composition of fresh and ten months stored JFF-Candies

Parameters	Fresh product	Stored product
Moisture (g/100g)	2.45	1.83
Protein(g/100g)	1.30	1.03
Fat(g/100g)	Nil	Nil
Total ash(g/100g)	0.59	0.19
Carbohydrates(g/100g)	94.57	96.95
Energy(K.Cal/100g)	393.30	391.90

Concerning energy, both fresh and stored samples reported more or less the same energy values 393.30 K.Cal/100g and 391.90 K.Cal/100g. The study conforms with the findings of Vissotto and Luccas (1999). They reported that hard brittleness with a transparent to translucent nature is the key feature of the hard candy besides its soluble solids varying between 97 and 98/100g and the moisture below 2g/100g, respectively.

The Monthly organoleptic evaluation and the microbial load were assessed for the preserved candies for 14 months. The results of the microbial load during ambient storage (Table.4) indicated that even after 10-14 months of storage, the product was microbiologically safe. The findings conform to the standardisation of halva and toffee found stable and highly acceptable during 12 months of storage (Ukkuru and Pandey, 2005). Similar results were also reported in tamarind and mango blended candy with negligible microbial growth and accepted up to three months of storage without significant difference in the sensory attributes (Kiranmai et al., 2018) due to low moisture and sugar concentration in the samples.

Table 4. Microbial load in the fresh and stored JFFC-Candies

Microbial load	Months of storage				
	1	4	7	10	14
Escherichia coli (present/absent/cfu/25g)	Absent	Absent	Absent	Absent	Absent
Yeast (cfu/g)	Not detected	Not detected	Not detected	Not detected	Not detected
Moulds (cfu/g)	Not detected	Not detected	Not detected	Not detected	Not detected

The results of the water activity (a_w) of the JFFCs were within the acceptable limits during initial 0.45(T1to T3), 0.46(T4),0.48(T5), 0.52(T6) and 0.54(T7), and duration ten months storage slightly elevated levels of water activity (T4 a_w, 0.58) reported. A significantly elevated range of water activity was observed during the 14 months in the treatment T1(0.60), and T2(0.62), which is undesirable compared to T3(0.59), T4(0.58), T5 and T6(0.59); this variation may be due to frequent opening of the container. The microorganisms will not grow when the water activity is <0.60 (Beuchat,1981; Fontana, 2006; Minifie,1999) since the lower aw limit for the growth of mould and yeast is around 0.61, and that of mycotoxigenic moulds is at 0.78 a_w (Beuchat, 1981). Hence the hard-boiled functional candies with water activity 0.58 in the treatment T4(0.58a_w) having caramel colour naturally (*L=41.42, *a=12.08, *b=21.49) observed even after ten months of storage (Table.5).

Table 5. Water activity (a_w) and Colour of JFFCs

Sl. No.	Water activity (a_w) during the storage months					Colour		
	1	4	7	10	14	*L**	*a**	*b**
T1	0.45	0.47	0.59	0.58	0.60	32.01	4.91	7.78
T2	0.45	0.48	0.56	0.55	0.62	35.02	6.86	13.29
T3	0.45	0.46	0.52	0.56	0.59	34.02	5.23	11.25
T4	0.46	0.46	0.49	0.58	0.58	41.62	12.08	21.49
T5	0.48	0.49	0.55	0.59	0.59	41.43	12.55	21.77
T6	0.52	0.55	0.59	0.66	0.59	44.92	11.87	21.61
T7	0.54	0.56	0.58	0.64	0.60	53.83	10.13	25.41

The above observations are mean values of three replications

Elements or minerals

The results of the elemental or minerals estimation (Table.6 and Fig.1) of jack fruit candies using ICP-MS revealed different levels of major and minerals such as Calcium (42.38mg/kg), Potassium (3309.42mg/kg), Magnesium (263.75mg/kg) and Sodium (239.08mg/kg). Among the trace minerals, Chromium (2.04mg/kg), Copper (3.00mg/kg), Iron (40.19mg/kg), Gallium (0.155mg/kg), Manganese (2.47mg/kg) and Zinc (3.64mg/kg) were also found. The other elements such as Lithium(0.04mg/kg), Gallium (0.15mg/kg), Cobalt (0.05mg/kg), Cadmium (0.007mg/kg), Barium (1.02mg/kg), Silver (0.02mg/kg), Nickel (0.31mg/kg) and Strontium (0.59mg/kg) was found in traces, elements such as Bismuth, Indium and Thalium was found to be below detectable limits.

The calcium content of JFFCs was reported to be 42.38mg/kg, which is lesser than RDA, i.e., for children 550mg/day(4-6yr) to 850mg/day (10-12year children), 1000 mg/day for adult men and women (ICMR-NIN, 2020).

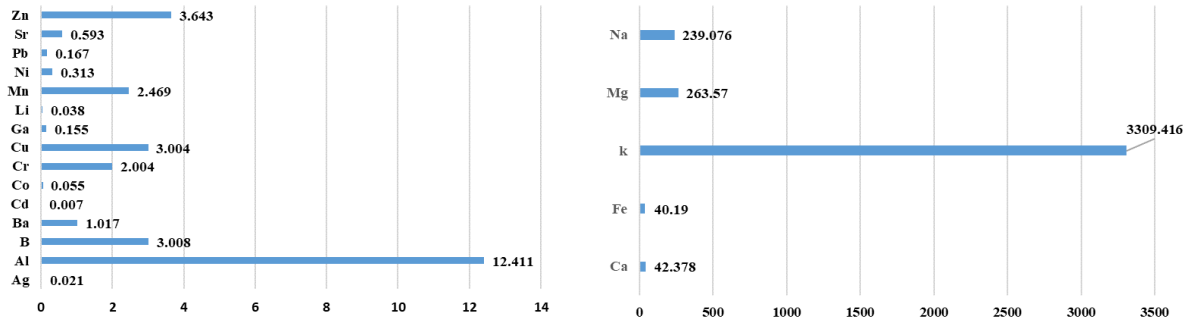

Fig 1. Mineral composition in jack fruit functional caramel candies(mg/kg)

The mineral zinc plays a vital role in the healthy working of various body systems and biochemical pathways, healthy immune system, skin and resistance to infection (Falah et al., 2017). The Zn content of JFFCs was reported to be 3.64 mg/kg against 2.52±2.49 µg/g in several chocolate candies (Devi et al., 2016). Which is lesser than the RDA of 5.5mg/day for children(4-6yrs), 17 to 13mg/day for adult men and women **(**ICMAR NIN, 2020). A higher level of zinc, 40.1-42.5mg/g, was reported in lollypops by other workers (Ochu et al., 2012). However, the maximum Zinc requirement for Hard candy is 5mg/kg (ISI, 2004), which is lesser than the reported value.

Copper (Cu) was found to be 3.00mg/kg of JFFCs compared to 0.22-1.42 µg/g in fruit-based candies (Duran et al., 2009); however, a maximum requirement of 5mg/kg for Hard candy (ISI 2004), is an essential trace element, RDA is 1.7 to 2mg/day for normal adults (ICMR.NIN, 2020; NRC, F NB, 1980) (NRC, F NB, 1980). Iron (Fe) reported being 40.19mg/kg in JFFCs, the most abundant mineral in the human body, with a recommended level of 19mg/day (men aged 65 years) to 29mg/day (women aged 55yeras) for children 11mg/day (4-6 yrs.), 15mg/day (7-9yrs) and elevated levels adolescent boys and girls (ICMR-NIN, 2020; FNB, IMNAS, 2001). The sodium content of 239.08mg/kg was reported in JFHBC against the recommended safe intake of 2000 mg/day (5 g/day) (ICMR-NIN,2020).

The Magnesium (Mg) was found to be 263.75mg/kg of JFFCs. It is necessary for various biological functions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation **(**IOM, 1997; Rude, 2012**)** also a cofactor in more than 300 enzymes to regulate biochemical reactions. About 20-25g magnesium is present in the adult human body. About 60-70% of it occurs in the bone, important for maintaining electrical potential in nerves and muscle membranes; deficiency leads to neuromuscular dysfunction. The RDA of magnesium for children is 155mg/day (4-6 years having body weight 18kg), 215 mg/day (7-9yeras with 25kg body weight), 270-255mg/day (10-12years of weight 35kg boys-36 girls), 385mg/day (Men weighing 65kg) and 325mg/day (55 kg women) (ICMR-NIN, 2020).

Manganese (Mn) was found to be 2.47mg/kg of JFFCs. The acceptable intake is 4 mg/day (ICMR NIN, 2020)**,** 2.3 mg/day for adult males and 1.8 mg/day for adult females (IOM,1997). a trace vital mineral present in tiny quantities in the body helps form connective tissue, bones, blood-clotting factors and sex hormones (Palacios 2006; Fraga 2005) for normal brain and nerve function and a key component of enzyme systems.

Nickel (Ni) was found to be in traces (0.313mg/kg of JFFCs) against 0.17±0.22 µg/g reported in 69 types of candies and chocolate samples in Haryana state (Parmila Devi et al., 2016). This element may help in prolactin production and may be helpful in human breast milk production (Anke et at., 1995; Sydor and Zamble, 2013). There is no established RDA for a nickel. However, the

estimated daily intake of nickel from food and water is 80-130 µg/day (Roger, 2011) globally. Small quantities of nickel are essential for the body; too high uptake cause some health problems (Poonkothai and Vijayavathi, 2012; IPCS, 1992).

Chromium (Cr) was found to be 2.00mg /100g of JFFCs**,** required in trace quantities for humans, most foods provide in small amounts, against the acceptable intake of 50 µg/day(0.05mg/day) (ICMR-NIN, 2020).

Cobalt (Co), found to be in traces (0.055mg/100g of JFFCs), is an essential trace element and a fundamental constituent of cobalamin (vitamin B12) (Falah et al., 2017). The estimated intake from food is 5-40 µg/day, a maximum of which is inorganic and toxic to the human body (Unice et al., 2012).

Lead (Pb) is found in traces (0.17mg/kg of JFFCs) compared to 0.03-2.46 µg/ g in fruit candies by other workers (Duran *et al.,* 2009) and 20.03-2.46 µg/g in most candies and chocolates of Haryana state (Parmila Devi et al., 2016), without any health benefits or biological role in the human body except toxic. However, the maximum requirement for Hard candy is 20mg/kg [ISI 2004].

Table 6. Elemental or mineral composition of jack fruit Functional Caramel Candies

Mineral Element	Results (mg/kg)	Mineral Element	Results (mg/kg)
Silver (Ag)	0.021	Gallium (Ga)	0.155
Aluminium (Al)	12.411	Potassium (k)	3309.416
Boron(B)	3.008	Lithium (Li)	0.038
Barium (Ba)	1.017	Magnesium (Mg)	263.570
Calcium (Ca)	42.378	Manganese (Mn)	2.469
Cadmium (Cd)	0.007	Sodium (Na)	239.076
Cobalt (Co)	0.055	Nickel (Ni)	0.313
Chromium (Cr)	2.004	Lead (Pb)	0.167
Copper (Cu)	3.004	Strontium (Sr)	0.593
Iron (Fe)	40.190	Zinc (Zn)	3.643

The highest potassium (K) content of 3309.42mg/kg (3.3mg/gm) was reported in JFFCs against recommended daily allowance of 3510 mg/day for adults, 2250mg/day(4-6 year children to 2825mg/day(7-9 year children)(WHO 2012; ICMR-NIN.,2020)[39,21] increased intake lowers blood pressure in adults (Whelton, 1997) and risk of stroke (WHO, 2012) similar potassium levels range from 300mg/kg (fruits and vegetables) to 1300mg/100g(beans and peas) (Cashel, 1989; USDA, 2011) were reported], which is essential for the upkeep of total body fluid volume, acid, electrolyte balance and normal cell function (Young, 2001) increased intake of potassium-rich foods lowers stroke risk (Willey et al., 2017; Du et al., 2013). Hence the name- jack fruit functional-candy.

The aluminium level was found to be 12.41mg/100g in JFFCs; naturally, present aluminium is considered safe and not harmful (ATSDR, 2018). Similar aluminium levels were reported in herbal-teas (14 and 67 mg/kg), 5 and 15 mg/ kg (dry soups**)** (Stahl et al., 2011).

Other trace mineral elements found in the JFFCs are Boron (3.01), Gallium (0.155), Silver (0.021mg/kg),Strontium (0.59), Cobalt (0.05), Lithium(0.04),Nickel(0.31).Cadmium(0.007 in JFFCs) as compared to 0.03-0.43 µg/g cadmium reported in fruit-based candies (Duran et al., 2009). The other trace elements such as Bismuth (Bi), Indium (In), Thallium (Tl) were found to be below the detectable limit. Candies' trace elements could be toxic when taken in excess amounts (Parmila et al., 2016).

The presence of different mineral elements might be due to processing procedures of raw materials (Duran et al., 2009), unsafe storage of raw material during the production chain (Ochu et al., 2012) and their packing materials (Duffy et al., 2006).

Cost of production

The production cost is computed by taking the actual cost of the ingredients on a retail basis. Jack pulp at the rate of Rs.25 per kg and selling cost of ready to eat jack caramel or lollypops compared with commercially available imly (tamarind) candy (i.e., Rs.5.0 per 5.0g) in the market (Table.7), a profit of about four times the investment could be achieved by adding value to the pulp.

Table 7. Approximate production cost as per ingredients used at retail price

Ingredients	Rate /kg (Rs.)	Production cost (Rs.)	Output(g.)	Total Income (Rs.)	Profit (Rs.)
Sucrose	40	0.210X Rs.40 = 8.40	356.33g ready to eat candies	If the selling price is Rs.5.00 per 5.0g 356.33/5.0= 71 pcs. 71pcs X Rs.5.0 = 335.00	(335-70.34)
Syrup	225	0.150 gXRs.225 =33.75			
Gas (14kg)	597.69	0.150g =7.34			
Fruit Pulp	25	0. 210 X Rs.25 =5.25			
Labour(one)	300/day of 8 hours	25min.X 300 =15.62			
	Total	70.34	356.33	335.00	284.00

CONCLUSION

The shelf life and quality of ripened jack fruit are poor. Most of the soft flesh fruit type varieties get wasted in the production catchment. The findings of the investigation showed the availability of new product choices for consumers with better storage stability. Micronutrient deficiencies are a significant public health concern in developing countries (Batra and Seth, 2002). The candy showed an excellent source of essential minerals. In this line, the wasting jack fruits may be an excellent raw material for value addition. The product is shelf-stable and acceptable for more than a year, with appropriate packing, may be marketed as functional candy during the off-season. The study suggested that this could be an affordable low-cost technology in the production catchment during the season and sold as an innovative product in the off-season besides promoting jack fruit crop in the backyards and barren lands of the community as a multi-use, valuable food source to eliminate nutritional deficiencies and poverty.

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