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RESEARCH ARTICLE

Technical Aspects Affecting to Jackfruit (*Artocarpus Heterophyllus)* Beverage Production

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Abstract

Jackfruit (*Artocarpus heterophyllus*) is a tropical climacteric fruit. It is one of the commonly consumed foods in Vietnam. Its fesh in fully ripen stage can be eaten directly as a fruit. Jackfruit contains a wide range of phytonutrients such as carotenoids that can act as antioxidants. The jackfruit fesh is highly perishable and ofen undergoes favour loss, tissue sofening, and cut surface browning. During the jackfruit havesting season, excessive supply of the fruit causes the price of jackfruit decreasing dramatically. This fruit is underutilized in commercial scale processing. Therefore we have our tried to add value to the jackfruit fruit. One method of adding value to fresh jackfruit is processing it into drink. We carried out the investigation of extraction (ratio of water: jackfruit, temperature and time of blanching); juicy mixture; preservation. Our result showed that the jackfruit drink having the best quality when extracting with water: jackfruit pulp ratio (70:30) at 85 ^{o}C in 3 minutes. The sample was then cooled to 37°C before the addition of pectinase enzyme at 0.09%. The juice was then incubated in a water bath at 37°C in 30 minutes. After the incubation process, the juice was heated in a water bath at 100°C for 2 minutes to inactivate all enzymes present. The hydrolyzed jackfruit juice will be formulated with sugar 2.5%, citric acid 5%, carrageenan 0.06%. Jackfruit drink shelf-life could be maintained for 12 months.

Keywords: *Jackfruit, Artocarpus heterophyllus, Beverage, Carrageenan, Pectinase, shelf-life*

Introduction

Jackfruit tree belongs to the genus *Artocarpus*. Jackfruit is rich in nutrients including carbohydrates, proteins, vitamins, minerals, and phytochemicals. It contains many classes of phytochemicals such as carotenoids, favonoids, volatile acids sterols, and tannins, with varying concentrations depending on the variety.

Jackfruit (*Artocarpus heterophyllus* Lam) is a rich source of several high-value compounds with potential benefcial physiological activities [1]. It is well known for its antibacterial, antifungal, antidiabetic, anti-infammatory, and antioxidant activities [2]. Jackfruit contains functional compounds that have capability to reduce various diseases such as high blood pressure, heart diseases, strokes, and bone loss. It is also capable of improving muscle and nerve function, reducing homocysteine levels in the blood [3].

Phytonutrients such as lignans, isofavones, and saponins in jackfruit contribute to its anticancer, antihypertensive, antiulcer, and antiaging properties [4]. Several countries have developed different food products such as jam, jellies, marmalades, and ice creams

using pureed jackfruit [5]. The Modified Atmospheric Packaging along with low temperature storage can successfully extend the shelf life of minimally processed jackfruit [6].The efects of calcium treatment, osmo-blanching and drying methods on physicochemical and sensory attributes of jackfruit slices was examined. The dehydrated jackfruit bulbs in its powder form can be incorporated into other food products [7]. An attempt was taken for the development of products such as jam, jelly, pickle, and squash by processing different parts of jackfruit and to assess their nutritional quality [8].

Fermentation of surplus or over-ripe jackfruit for the production of wine would be an interesting alternative for the effective utilization of the fruit [9]. Production of spray-dried honey jackfruit (*Artocarpus heterophyllus*) powder from enzymatic liquefied puree was studied [10]. A research was carried out to study the effect of blending jackfruit jam jackfruit (65%), avocado (15%) and kokum (20%) [11] Production of fermented fruit juice using unconventional seasonal fruits through batch fermentation was carried out [12].

A study was also to investigate the effect of power level on yield and quality of extracted pectin from jackfruit rinds [13]. Different factors affecting production of fermented Jackfruit beverage was verified [14]. Bioprocessing of jackfruit (*Artocarpus heterophyllus* L.) pulp into wine: Technology, proximate composition and sensory evaluation was studied [15].

An investigation was carried out to develop the acceptable prepared yogurt using different level (5%, 10% and 15%) of jackfruit juice [16]. The functional ready-to-serve (RTS) beverage was prepared from jackfruit and aloe vera juice [17]. Studies on physico-chemical properties of developed jackfruit squash was examined [18]. The research was conducted to develop fruit yoghurt fortified with the acceptable combination of milk, soy milk (Glycine max) and ripened jack fruit (*Artocarpus heterophyllus* Lain) [19]. There was a research mentioned to processing and evaluation of carbonated beverage from jackfruit waste (*Artocarpus heterophyllus*) [20]. There are plenty of natural or synthetic additive stabilizers which find application in fruit processing as gelling agents include alginate, pectin, carrageenan, gellan, gelatin, agar, modified starch, methyl cellulose and hydroxypropyl methylcellulose [22]. The jackfruit fesh is highly perishable and ofen undergoes favour loss, tissue sofening, and cut surface browning [8].

The sofening of the fruit makes it more susceptible for bruising and mechanical injury. In order to utilize jackfruit pulp as a healthy food drink, we attempted to produce jackfruit juice. We focused on investigation of extraction (ratio of water: jackfruit, temperature and time of pasteurization); enzymatic hydrolization; formulation; and preservation.

Materials and Method

Material

We collected jackfruit fruit in Vinh Long province, Vietnam. They must be cultivated following VietGAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 8 hours for experiments. Fruits are washed thoroughly under turbulent washing to remove dirt, dust and adhered unwanted material. The fruit pulp were dehusked, separated from seeds and collected by hand.

Samples were frozen at -18°C to keep the quality prior to preparation of drink. Besides jackfruit we also used other materials during the research such as sugar, citric acid, carrageenan, petrifilm. Lab utensils and equipments included thermometer, water bath, viscometer, weight balance, refractometer, colony counter.

Figure 1: Jackfruit fruit (*Artocarpus heterophyllus)*

Researching Procedure

Effect of Primary Juice Extraction

Effect of Dilution Ratio

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 50:50, 60:40, 70:30, 80:20 to extract more juice from the pulp. The juice was filtered using a cotton cloth. Juices were analyzed for total soluble solids.

Effect of Temperature in Pasteurization

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 70:30 to extract more juice from the pulp. The juice was filtered using a cotton cloth. This juice will then be pasteurized at different temperature (75 ^{o}C, 80 ^{o}C, 85 ^{o}C, 90 ^{o}C) in 2 minutes. Juices were analyzed for total soluble solids.

Effect of Time in Pasteurization

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 70:30 to extract more juice from the pulp. The juice was filtered using a cotton cloth. This juice will then be pasteurized at 85 ^{o}C in different intervals (1 minute, 2 minutes, 3 minutes, 4 minutes). Juices were analyzed for total soluble solids.

Effect of Enzymatic Hydrolysis on Jackfruit Juice

After choosing the suitable dilution ratio, temperature and time of pasteurization; the jackfruit juice was immediately subjected to pasteurization at 85°C for 3 minutes so as to inactivate the natural enzymes or microorganism present. The sample was then cooled to 37°C before the addition of pectinase enzyme at different level 0%, 0.03%, 0.06%, 0.09% and 0.12%.

The juice was then incubated in a water bath at 37°C in 30 minutes. After the incubation process, the juice was heated in a water bath at 100°C for 2 minutes to inactivate all enzymes present. Juices were analyzed for sensory, yield, total soluble solids, and viscosity.

Effect of Jackfruit Juice Formulation

The hydrolyzed jackfruit juice will be formulated with sugar (2.5%) different contents of citric acid (1%, 3%, 5%, 7%), carrageenan (0.02%, 0.04%, 0.06%, 0.08%). In each sample, we conducted the sensory evaluation to define the optimal contents of citric acid and carrageenan.

Preservation

In order to verify the shelf-life of jackfruit drink during preservation, we carried out microbial (TPC, *Coliform, E. Coli*) sampling at different intervals (1 month, 3 months, 6 months, 9 months and 12 months). We also carried out the sensory evaluation for jackfruit drink.

Physico-chemical and Biological Analysis

Jackfruit juice was filtered on a cotton cloth and the volume (yield) of juice obtained from each sample was measured using a 500 ml volumetric flask. Total soluble solids (TSS) were measured by refractometer. The viscosity measurement was made by using a viscometer. For sensory evaluation of the juices, the product was evaluated by a panel of 30 semi trained panelists. Panelists were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely). 3M-Petrilm was used to analyze TPC, *Coliform, E. Coli*.

Statistical Analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

Result & Discussion

Nutritional Composition in Jackfruit Juice

We conducted the primary analysis in ripen jackfruit. Our results showed in Table 1.

Table 1: Nutritional composition in jackfruit pulp

Composition	Value
Moisture (%)	63.32±0.02
Protein (%)	1.44±0.01
Fat (%)	5.01±0.03
Fibre (%)	3.93±0.01
Carbonhydrate (%)	27.88±0.02

Note: the values were expressed as the mean of three repetitions

From table 1, we could see that durain had a good source of protein (1.44 %), fat (5.01 %), fibre (3.93 %) and carbohydrates (27.88 %). Our results were similar to data from another study.[5,22] Several studies have found that there is a variation in chemical composition of jackfruit in different maturity stages [23].

Effect of Primary Juice Extraction

Effect of Dilution Ratio

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 50:50, 60:40, 70:30, 80:20 to extract more juice from the pulp. The juice was filtered using a cotton cloth. Juices were analyzed for total soluble solids. Our results were elaborated in Table 2.

Table 2: Effect of dilution ratio in jackfruit juice extraction

Dilution ratio (water:jackfruit pulp)	Total soluble solids of jackfruit juice (oBrix)
50:50	5.26±0.02^{d}
60:40	6.55±0.03^{b}
70:30	**7.21±0.01^{a}**
80:20	5.92±0.03^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 2, we noticed the dilution (water: jackfruit pulp) at ratio of 70:30 approriated for juice extraction. Comparing to other research, different factors affecting production of fermented Jackfruit beverage was verified. Jackfruit was diluted at the rate of fruit/water = 1/3 to retain the flavour and aroma of the product. Soluble dry matter content suitable for fermentation was found to be 20% and the yeast ratio used is 0.05% [14].

Effect of Temperature in Pasteurization

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 70:30 to extract more juice from the pulp. The juice was filtered using a cotton cloth. This juice will then be pasteurized at different temperature (75 ^{o}C, 80 ^{o}C, 85 ^{o}C, 90 ^{o}C) in 2 minutes. Juices were analyzed for total soluble solids. Our results were elaborated in Table 3.

Table 3: Effect of temperature in jackfruit juice pasteurization

Temperature (^{o}C) in pasteurization	Total soluble solids of jackfruit juice (^{o}Brix)
75	7.01±0.03^{c}
80	7.55±0.00^{b}
85	8.12±0.02^{a}
90	7.53±0.00^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 3, we noticed that optimal temperature in jackfruit juice pasteurization should be maintained at 85 ^{o}C in 2 minutes. Different factors affecting production of fermented Jackfruit beverage was verified. The fermented jackfruit beverage should be pasteurized at 70^{o}C within 10 minutes [14].

A process for the preparation of clarified juice has been developed and involves treatment of the jackfruit waste with pectic enzyme at 0.3% concentration (vw), incubation for 2 hat 40C and subsequent filtration, giving about 60% yield of clarified juice having 23° Brix and 0.15-0.20% acidity. Sensory evaluation of ready-to-serve (RTS) beverages (12% juice, 15° Brix sugars and 0.3% acidity) without and with carbonation at 3 levels (CO_2 gas pressures 0. 775, 2.092 and 3.685 kg/cm^2) by a 15-member trained panel revealed that the product was highly acceptable either without or with carbonation at 0. 775 kg/cm^2, compared to higher levels of carbonation. It is concluded that preparation of beverage from jackfruit waste as a byproduct [20].

Effect of Time in Pasteurization

Fruit pulps were separated from seeds by hand. Water was added in the ratios of 70:30 to extract more juice from the pulp. The juice was filtered using a cotton cloth. This juice will then be pasteurized at 85 ^{o}C in different intervals (1 minute, 2 minutes, 3 minutes, 4 minutes). Juices were analyzed for total soluble solids. Our results were elaborated in Table 4.

Table 4: Effect of time in jackfruit juice pasteurization

Time (minute) in pasteurization	Total soluble solids of jackfruit juice (°Brix)
1	7.77±0.02[c]
2	8.12±0.01[b]
3	**8.69±0.02[a]**
4	8.14±0.01[b]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 4, we noticed that optimal time in jackfruit juice pasteurization should be maintained at 85 °C in 3 minutes. The research was conducted to develop fruit yoghurt fortified with the acceptable combination of milk, soy milk (*Glycine max*) and ripened jack fruit (*Artocarpus heterophyllus* Lain). Yoghurt sample prepared by incorporating 10% soy milk and 7% jack fruit resulted in superior organoleptic properties and nutritional qualities compared to control sample [19].

Effect of Enzymatic Hydrolysis on Jackfruit Juice

After choosing the suitable dilution ratio, temperature and time of pasteurization; the jackfruit juice was immediately subjected to pasteurization at 85°C for 3 minutes so as to inactivate the natural enzymes or microorganism present. The sample was then cooled to 37°C before the addition of pectinase enzyme at different level 0%, 0.03%, 0.06%, 0.09% and 0.12%.

The juice was then incubated in a water bath at 37°C in 30 minutes. After the incubation process, the juice was heated in a water bath at 100°C for 2 minutes to inactivate all enzymes present. Juices were analyzed for sensory, yield, total soluble solids, and viscosity.

Table 5: Effect of enzymatic hydrolysis on jackfruit juice

Pectinase (%)	Sensory (score)	Yield (ml)	Total sluble solids (°Brix)	Viscosity (cps)
0	4.59±0.02[e]	321±0.01[d]	8.21±0.02[d]	3.63±0.01[a]
0.03	6.23±0.01[d]	385±0.01[c]	8.50±0.03[c]	3.35±0.02[b]
0.06	7.31±0.03[b]	449±0.00[b]	9.33±0.00[b]	3.08±0.01[c]
0.09	8.28±0.02[a]	472±0.01[a]	10.19±0.01[a]	2.74±0.00[d]
0.12	6.79±0.02[c]	475±0.03[a]	10.20±0.02[a]	2.70±0.02[d]

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

From table 5, we notice that jackfruit juice should be incubated with 0.09% pectinase at 37 °C and in 30 minutes of incubation. The functional ready-to-serve (RTS) beverage was prepared from jackfruit and aloe vera juice. The blended juice was made by using the different combination of jackfruit and aloe vera juice as T0 (100:0), T1 (90:10), T2 (80:20), T3 (70:30) and T4 (60:40) to improve the flavour and therapeutic properties.

The blends were homogenized and filled into 200 ml colourless sterilized PET bottle and pasteurized at 85°C for 10 minutes, cooled and stored at refrigerated temperature. The blended RTS beverages were prepared to optimize the mixed ratio of jackfruit and aloe vera juice.

The physicochemical and sensory parameters of the mixed functional ready to serve (RTS) beverage were analyzed. Sensory evaluation was done by adopting 9 points hedonic scale after the one-month interval. Among the mixed samples the highest sensory score was (8.42 ± 0.06) obtained for overall acceptability in the T3 sample which has mixed ratio of (70:30). The mixed jackfruit and aloe vera functional RTS beverage was stored up to 5 months without notable change in chemical and sensorial parameters at refrigerated temperature [17].

Effect of Jackfruit Juice Formulation

The hydrolyzed jackfruit juice will be formulated with sugar (2.5%) different contents of citric acid (1%, 3%, 5%, 7%), carrageenan (0.02%, 0.04%, 0.06%, 0.08%). In each sample, we conducted the sensory evaluation to define the optimal contents of citric acid and carrageenan. Our results were depicted in Table 6.

Table 6: Effect of jackfruit juice formulation on sensory evaluation

Citric acid (%)	Carrageenan (%)				Average
	0.02	0.04	0.06	0.08	
1	6.49±0.01	6.74±0.01	7.68±0.02	6.15±0.01	6.77±0.02^{d}
3	7.28±0.02	8.16±0.03	8.53±0.03	6.89±0.02	7.72±0.01^{b}
5	8.41±0.03	8.57±0.02	8.91±0.01	7.42±0.03	**8.33±0.01^{a}**
7	6.92±0.01	7.09±0.00	8.96±0.03	7.52±0.01	7.63±0.02^{c}
Average	7.28±0.00^{c}	7.64±0.02^{b}	**8.52±0.02^{a}**	7.00±0.02^{d}	

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

From table 6, we noted that 5% citric acid with 0.06% carrageenan would give the best jackfruit drink. An investigation was carried out to develop the acceptable prepared yogurt using different level (5%, 10% and 15%) of jackfruit juice. Experiment showed that various types microbial (TVC, TFC) counts were reduced due to high acidity of jackfruit juice [16].

Preservation

In order to verify the shelf-life of jackfruit drink during preservation, we carried out microbial (TPC, *Coliform, E. Coli*) sampling at different intervals (1 month, 3 months, 6 months, 9 months and 12 months). We also carried out the sensory evaluation for jackfruit drink. We noted that jackfruit drink could be maintained for 12 months.

Table 7: Shelf-life of jackfruit drink during preservation

Preservation (month)	TPC	*Coliform*	*E. Coli*	Sensory score
1	2 x 10^{1e}	0	0	8.30±0.01^{a}
3	5 x 10^{1d}	0	0	8.21±0.02^{ab}
6	6 x 10^{1c}	0	0	8.01±0.01^{b}
9	9 x10^{1b}	0	0	7.88±0.03^{bc}
12	13 x 10^{1a}	0	0	7.64±0.02^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%)

A wine, from jackfruit (*Artocarpus heterophyllus* L.) pulp, was prepared by fermenting with wine yeast (*Saccharomyces cerevisiae*) as starter culture. The wine had the following proximate compositions: total soluble solids, 1.8° Brix; total sugar, 4.32 g/100 ml; titratable acidity, 1.16 g tartaric acid/ 100 ml; pH, 3.52; total phenolics, 0.78 g/100 ml; ß-carotene, 12 µg/100 ml; ascorbic acid, 1.78 g/100 ml; lactic acid, 0.64 mg/100 ml and ethanol content of 8.23% (v/v).

The jackfruit wine had a DPPH scavenging activity of 32% at a dose of 250 µg/ml [15].A study. Was conducted to develop squash from jackfruit. The results of the study revealed that the squash stored under refrigerated temperature maintained intact all the biochemical parameters such as pH, TSS, acidity, ascorbic acid, reducing and total sugars throughout the storage period when compared to samples stored at ambient condition which was stable up to one-two month in all selected genotypes with some significant differences at both storage conditions respectively [18].

Conclusion

Due to its high perishability, jackfruits are usually exported as whole fruits and more than half of the fruit consists of inedible waste materials, which make it less cost efective. The inconsistency of the size and shape of the fruit make the design of packaging very complicated and rough and thick skin and the latex makes difculties in preparation.

Adhering to correct postharvest practices and conversion of jackfruit into minimally processed products, such as beverage jackfruit, may encourage more population towards the consumption of jackfruit. We have successfully optimized some technical parameters in jackfruit beverage production. Generally jackfruit drink products show more viscosity, low separation and stable shelf-life. More researches should be devoted for discovering possible industrial applications of jackfruit.

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