

Some Variables Influencing The Jackfruit, *Artocarpus heterophyllus* Beverage Production

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ABSTRACT

Ripe jackfruit pulp contained high amount of sugar with specific aroma and taste. There is a growing market for minimally processed jackfruit. In order to increase the added value of jackfruit, we decided to turn jackfruit into one instant beverage. We performed the extraction (ratio of water: jackfruit pulp, temperature and duration of pasteurization); juice formulation; storage. Our results revealed that the jackfruit drink having the highest overall acceptance when extracting with water: jackfruit pulp ratio (50:50) at 90°C in 3 minutes. Jackfruit juice was usually cloudy and colloidal suspensions that have an unstable cloud or the turbidity. The mixture was then cooled to 37°C before the supplementation of pectinase enzyme at 0.06%. The mixture was then incubated in a water bath at 37°C in 60 minutes. After the incubation, the mixture was heated at 100°C for 3 minutes to inactivate all existing enzymes. The hydrolyzed jackfruit juice will be formulated with sugar 3.5%, citric acid 0.06%, carrageenan 1.0%. Jackfruit beverage would be extended its shelf-life for 6 months. The use of pectinase in jackfruit juice processing is essential to get better juice yield, improve filtration rate and produce clear juice.

KEY WORDS: JACKFRUIT, BEVERAGE, CARRAGEENAN, PECTINASE, STABILITY.

INTRODUCTION

Jackfruit, *Artocarpus heterophyllus* is a tropical climacteric fruit, belonging to Moraceae family. Jackfruit tree has a relatively high productivity (Loizzo et al., 2010). Jackfruit has a green to yellow brown exterior rind (Prakash et al., 2009). Jackfruit colour alters from yellowish green to yellow owing to the conversion of chlorophylls, anthocyanins, and carotenoids during ripening (Tiwari and Vidyarthi, 2015). Jackfruit pulp is rich in nutrients including

carbohydrates, proteins, vitamins, minerals, and phytochemicals such as carotenoids, flavonoids, volatile acids sterols, tannins Arung et al., 2007; Chandrika et al., 2009; Lin and Lu, 1993; Ong et al., 2006; Venkataraman, 2001; and Wong et al., 1992). These functional components have capability to control high blood pressure, heart diseases, strokes, bone loss, anti-inflammatory, anticancer, antiulcer, antiaging etc (Swami et al., 2012; S.-C. Fang et al., 2008; Wei et al., 2005). Owing to numerous health benefits, the utilization of jackfruit pulp has increased in recent years (Ruiz-Montanez et al., 2014 Ranasinghe et al., 2019).

The shelf life of the ripe jackfruit pulp is quite short at ambient condition (Andri et al., 2012). It is highly perishable and often undergoes flavour loss, tissue softening, and cut surface browning. The fruit softening makes it more susceptible to bruising and mechanical injury. Huge amount of ripe jackfruits undergo quick decomposition owing to lack of proper knowledge on postharvest practices resulting in poor handling and

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inadequacy of sanitary practices and storage facilities (Mondal et al., 2013, Jagtap et al., 2011). Application of high yielding jackfruit varieties, together with proper harvesting and postharvest manipulations such as appropriate handling, transportation and preservation, innovation of novel processing technologies, and finding for new implementations to limit postharvest and production losses as well as conversion of jackfruit waste into value-added products would be better options for popularizing the jackfruit cultivation and consumption along with waste management of jackfruit processing industries. Its pulp has been converted into various forms such as jam, jellies, marmalades, and ice creams to improve its economic value (Shamsudin et al., 2009). Fresh-cut jackfruit bulbs may remove the difficulty in separating the bulbs from the rind and conserve time (Saxena et al., 2008). The edible coating prolongs the stability of precut jackfruit (Vargas-Torres et al., 2017).

The efficacies of calcium soaking, osmo-blanching and drying methods on physico-chemical and organoleptic properties of jackfruit slices were studied (Saxena et al., 2015). Salty snacks or chips from jackfruit flesh may attract the consumers. Various products such as jam, jelly, pickle, and squash have tried to developed (Mondal et al., 2013; Shwetha and Ranganna et al., 2018). Jackfruit wine is demonstrated to have good antioxidant properties and protective effects (Jagtap et al., 2011). In order to turn jackfruit pulp into instant healthy beverage, we tried to verify the enzymatic extraction (ratio of water: jackfruit, temperature and duration of pasteurization); formulation; and preservation.

MATERIAL AND METHOD

Material: We collected jackfruit fruit in Hau Giang province, Vietnam. They must be cultivated following VietGAP to ensure food safety. Only technical ripen jackfruit without any defect was selected. After collecting, they must be conveyed to laboratory as soon as possible for experiments. The jackfruit pulp were dehusked, separated from seeds and collected by hand. Apart from jackfruit we also used other ingredients such as sugar, citric acid, carrageenan, petrilm. *Lab utensils* and equipments included thermometer, waterbath, viscometer, weight balance, refractometer, colony counter.

Effect of primary juice extraction: Jackfruit pulp was separated from seed by hand. Water was added by various ratio of 30:70, 40:60: 50:50, 60:40, 70:30 to primarily extract juice from jackfruit pulp. The mixture was filtered using a cotton cloth to collect juice. Total soluble solid (oBrix) was indicator to determine the optimal dilution ratio.

Effect of temperature and time in pasteurization: Jackfruit pulp was separated from seed by hand. Water was added by the ratio of 50:50 to primarily extract juice from jackfruit pulp. The mixture was filtered using a cotton cloth to collect juice. This juice will then be

pasteurized at different temperature and time (80oC in 5 minutes, 85oC in 4 minutes, 90oC in 3 minutes, 95oC in 2 minutes). Beta-caroten (mg/100g) was indicator to determine the optimal temperature and time in pasteurization

Effect of enzymatic hydrolysis on jackfruit juice:

After choosing the suitable dilution ratio (50:50), pasteurization (90oC in 3 minutes) in the primary juice extraction; the sample was then cooled to 37°C before supplementation of pectinase enzyme at different level 0%, 0.03%, 0.05%, 0.07% and 0.09%. The mixture was then incubated in a water bath at 37°C in 60 minutes. After the incubation, the juice was heated in a water bath at 100°C for 3 minutes to inactivate all existing enzymes. Juices were taken to verify sensory, yield, total soluble solids, and viscosity.

Effect of jackfruit juice formulation: The hydrolyzed jackfruit juice will be formulated with sugar (3.5%) different contents of citric acid (0.02%, 0.04%, 0.06%, 0.08%), carrageenan (0.5%, 0.75%, 1.0%, 1.25%). In each sample, we conducted the sensory evaluation to define the optimal contents of citric acid and carrageenan

Preservation: In order to verify the stability of jackfruit beverage during storage, we sampled the microbial (TPC, Coliform, *E. Coli*) at different intervals (2 month, 4 months, 6 months, 8 months). We also carried out the overall acceptance evaluation for jackfruit drink.

Physico-chemical and biological analysis:

Jackfruit juice was filtered on a cotton cloth on the volumetric flask. Total soluble solids (TSS) were measured by refractometer. Beta-caroten (mg/100g) was measured by on-line near-infrared spectroscopy (Tamburini et al., 2017). The viscosity (cP) measurement was made by using a viscometer. Overall acceptance was evaluated by a group of panelists using the 9-point Hedonic scale. 3M-Petrilm was utilize to measure TPC, Coliform, *E. coli*.

Statistical analysis: The experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Startgraphics Centurion XVI.

RESULTS AND DISCUSSION

Nutritional composition in jackfruit juice: We performed the primary analysis in ripen jackfruit. Our results showed in table 1. From table 1, we could see that durain had a good source of protein (1.51%), low fat (0.23%), high fibre (1.62%) and high carbohydrates (23.75%). Our results were similar to data from Ranasinghe et al., (2019), the moisture (72-94%), protein (1.2-1.9%), fat (0.1-0.4%), carbohydrate (16.0-25.4%), fiber (1.0-1.5%), vitamin A (175-540 IU). Rahman et al., (1995) have reported the presence of a high percentage of starch in jackfruit perianth. According to Goswami et al. (2011), the protein content of the flesh of different varieties of ripen jackfruit has ranged from 0.57 to 0.97%. The fiber

content of jackfruit was 0.33-0.40% with no significant changes in different portions of the fruit at different ripening stages (B. T. Ong et al., 2006).

Table 1. Nutritional composition in ripe jackfruit pulp

Composition	Value
Moisture (%)	72.89±0.03
Protein (%)	1.51±0.00
Fat (%)	0.23±0.02
Fibre (%)	1.62±0.01
Carbohydrate (%)	23.75±0.03
Beta-caroten (mg/100g)	17.36±0.02

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

Effect of primary juice extraction Effect of dilution ratio:

According to Jadhav et al. (2018), the jackfruit juice contained total soluble solid, protein as 25oBrix, 1.5% respectively. In our research, jackfruit pulp was separated from seed by hand. Water was added by various ratio of 30:70, 40:60: 50:50, 60:40, 70:30 to primarily extract juice from jackfruit pulp. The mixture was filtered using a cotton cloth to collect juice. Total soluble solid was indicator to determine the optimal dilution ratio. Our results were elaborated in table 2. From table 2, we noticed the dilution (water: jackfruit pulp) at ratio of 50:50 appropriated for juice extraction. Comparing to other research, jackfruit must was prepared by diluting the juice as per the treatments (1:1, 1:2. 1:3 and 1:4), dilution level (1:1) recorded highest (11.7 mg/100ml) ascorbic acid content (Jadhav et al., 2018).

Table 2. Effect of dilution ratio in jackfruit juice extraction

Dilution ratio (water:jackfruit pulp)	Total soluble solids of jackfruit juice (oBrix)
30:70	9.85±0.03 ^a
40:60	9.24±0.00 ^{ab}
50:50	9.02±0.01 ^b
60:40	8.31±0.00 ^c
70:30	7.43±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 ($\alpha = 5\%$).

Effect of temperature and time in pasteurization:

Beta-carotene in jackfruit pulp increased gradually with the progress of ripening. The antioxidant activities of jackfruit fresh extracts were correlated with the total phenolic and flavonoids content (Jagtap et al., 2010). Jackfruit pulp was separated from seed by hand. Water was added by the ratio of 50:50 to primarily extract juice from jackfruit pulp. The mixture was filtered using a cotton cloth to collect juice. This juice will then be pasteurized at different temperature and time (80oC in

5 minutes, 85oC in 4 minutes, 90oC in 3 minutes, 95oC in 2 minutes). Beta-carotene (mg/100g) was indicator to determine the optimal temperature and time in pasteurization. Our results were elaborated in table 3. From table 3, we presumed that optimal temperature in jackfruit juice pasteurization should be kept at 90 oC in 3 minutes. Norjana, and Aziah (2011) proved that after the incubation process, the puree was again heated in a water bath at 90°C for 10 min to inactivate the enzyme present.

Table 3. Effect of temperature and time of Pasteurization on beta-carotene (mg/100g) in jackfruit juice

Temperature (°C) and time (minutes) in Pasteurization	Beta-carotene (mg/100g)
80°C, 5 minutes	9.07±0.00 ^c
85°C, 4 minutes	13.75±0.03 ^{ab}
90°C, 3 minutes	14.59±0.00 ^a
95°C, 2 minutes	12.04±0.0 ^{2b}

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

After choosing the suitable dilution ratio (50:50), pasteurization (90oC in 3 minutes) in the primary juice extraction; the sample was then cooled to 37°C before supplementation of pectinase enzyme at different level 0%, 0.03%, 0.05%, 0.07% and 0.09%. The mixture was then incubated in a water bath at 37°C in 60 minutes. After the incubation, the juice was heated in a water bath at 100°C for 3 minutes to inactivate all existing enzymes. Juices were taken to verify sensory, yield, total soluble solids, and viscosity. From table 4, we notice that jackfruit juice should be incubated with 0.07% pectinase at 37 °C and in 60 minutes of incubation. Norjana, and Aziah (2011) proved that the juice treated with 0.05% pectinase concentration and 3 hour incubation time was the most preferred. In another report, juice and water ratio for preparation of jackfruit must should be 1:1 and for obtaining the better recovery of wine pectinase enzyme quantity should be 0.10% (Jadhav et al., 2018).

Effect of jackfruit juice formulation:

There are different types of stabilizers or thickener suitable for fruit beverage production such as alginate, pectin, carrageenan, gellan, gelatin, agar, modified starch, methyl cellulose and hydroxypropyl methylcellulose (Banerjee and Bhattacharya, 2012). In our research, the hydrolyzed jackfruit juice will be formulated with sugar (3.5%) different contents of citric acid (0.02%, 0.04%, 0.06%, 0.08%), carrageenan (0.5%, 0.75%, 1.0%, 1.25%). In each sample, we conducted the sensory evaluation to define the optimal contents of citric acid and carrageen. The present results are depicted in table 5 where it can be noted that 0.06% citric acid with 1.0% carrageenan would give the best jackfruit beverage.

Preservation: In order to verify the stability of jackfruit beverage during storage, we sampled the microbial (TPC, Coliform, *E. coli*) at different intervals (2 month,

4 months, 6 months, 8 months). We also carried out the overall acceptance evaluation for jackfruit drink. We noted that jackfruit beverage could be stable for 6 months (see table 6).

Table 4. Effect of enzymatic hydrolysis on jackfruit juice

Pectinase (%)	Sensory (score)	Yield (ml)	Total soluble solids (oBrix)	Viscosity (cps)
0	4.18±0.00 ^c	325±0.01 ^c	9.02±0.01 ^c	3.86±0.02 ^a
0.03	7.01±0.01 ^b	474±0.03 ^b	10.65±0.01 ^b	2.85±0.03 ^b
0.05	7.23±0.03 ^{ab}	491±0.00 ^{ab}	11.17±0.02 ^{ab}	2.56±0.00 ^{bc}
0.07	7.64±0.02 ^a	514±0.02 ^a	11.86±0.00 ^a	2.21±0.01 ^c
0.09	7.67±0.00 ^a	520±0.01 ^a	11.92±0.03 ^a	2.19±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 ($\alpha = 5\%$).

Table 5. Effect of jackfruit juice formulation on sensory evaluation

Citric acid (%)	Carrageenan (%)				Average
	0.5	0.75	1.0	1.25	
0.02	7.49±0.03	7.84±0.02	8.16±0.00	8.19±0.03	7.92±0.02 ^b
0.04	7.73±0.00	7.97±0.00	8.31±0.02	8.35±0.00	8.09±0.01 ^{ab}
0.06	7.98±0.02	8.21±0.03	8.49±0.01	8.52±0.02	8.30±0.02 ^a
0.08	8.00±0.01	8.25±0.01	8.63±0.03	8.63±0.01	8.37±0.02 ^a
Average	7.80±0.02 ^c	8.07±0.02 ^b	8.40±0.02 ^a	8.42±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 ($\alpha = 5\%$).

Table 6. Stability of jackfruit beverage during storage

Storage (months)	TPC (cfu/ml)	Coliform (cfu/ml)	<i>E. coli</i> (cfu/ml)	Sensory score
2	1.18x10 ² ±0.03 ^c	0	0	8.21±0.01 ^a
4	2.35x10 ² ±0.00 ^{bc}	0	0	8.02±0.03 ^{ab}
6	3.58x10 ² ±0.01 ^b	0	0	7.94±0.02 ^b
8	8.63x10 ² ±0.02 ^a	0	0	7.15±0.01 ^c

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

CONCLUSION

At peak harvesting season, the overproduction of jackfruit (*Artocarpus heterophyllus*) and its perishability have caused significant damage for farmers. High sugar content of the jackfruit pulp makes its possibility for

beverage production. We have successfully optimized some technical parameters in jackfruit drink production. Generally jackfruit drink products show more viscosity, low separation and stable shelf-life. Advanced processing technologies and sustainable waste management strategies should be considered when processing jackfruit in commercial scale.

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