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Enzymatically Treated Soursop Juice and Jackfruit Juice: Comparison in Quality

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Abstract: As public awareness of health issues grows, the market for tropical fruit juices expands as well. Soursop and jackfruit juice demand is increasing due to their nutritional properties, which include a high carbohydrate content and mineral and micronutrient content. When consumer demand for fruit juices increases, the demand for high-quality, clarified juices increases and even. The quality of soursop and jackfruit juices were evaluated in terms of maximum clarity, juice yield, and viscosity using different ratios of enzyme mixture. Three mixtures of enzyme ratios were obtained for each fruit juice by macerating pectinase (0.5 – 1.5 % v/w) and cellulase (0.5 – 1.5 % v/w). The clarity of both fruit juices was determined using a spectrometric technique. The extraction yield and viscosity of enzymatically treated juices were measured. Both jackfruit and soursop juices exhibit a significant decrease in absorbance and viscosity. In jackfruit juice the absorbance decrease from 0.84 to 0.167 and viscosity decreased from 0.202 Pa.s to 0.020 Pa.s when 0.5:1.5 (pectinase:cellulase) enzyme mixture used while in soursop juice the absorbance reduce from 0.667 to 0.087 and viscosity reduce from 0.163 Pa.s to 0.031 Pa.s when 1.0:1.0 (pectinase:cellulase) enzyme mixture was used. The juice yield extraction increased significantly in both fruit juices when using 0.5:1.5 (pectinase:cellulase), in jackfruit juice rises up to 83 % while soursop juice rises up to 65 %. For jackfruit juice, a 0.5:1.5 (pectinase:cellulase) enzyme mixture was found to produce high-quality juice, whereas a 1.0:1.0 (pectinase:cellulase) enzyme mixture produced high-quality juice for soursop juice. This research demonstrates that when jackfruit and soursop juices are enzymatically treated with an enzyme mixture, the quality of the juices improves in terms of clarity, juice yield, and viscosity when compared to untreated samples.

Keywords: Soursop Juice, Jackfruit Juice, Pectinase, Cellulase, Enzymatic Treatment

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1. Introduction

Consumption of tropical fruits has many health benefits, such as antioxidant and vitamins [1]. There are many types of tropical fruits such as soursop, avocado, jackfruit, banana and so on. The tropical fruits are unacceptable for further processing as they have very limited shelf life due to their high sugar and moisture content. Therefore, they need to be processed further into intermediate products such as juices, to avoid the postharvest losses [2].

According to Kumar [3], the market for tropical fruit juices is growing as people's health consciousness grows. The demand for soursop and jackfruit juice is increasing due to their nutritional properties such as high in carbohydrates and contain minerals and micronutrients [3]. As the demand for fruit juices increases among consumers, the demand in obtaining good quality and clarified juices are also increases. This prompted further research into better fruit processing methods [4].

The enzymatic method has many advantages over the mechanical method in order to obtain high quality of juice. Based on the study by Singh *et al.* [4], without the use of enzymes, producing high-quality juice is very challenging. This is because enzymes play a crucial role in the juice extraction process. They help to speed up the production of juice and improve its recovery. Macerating enzymes also known as enzyme mixture such as pectinase and cellulase are widely use as they increase the process performance and juice yield without any additional capital investment [5].

The quality of the jackfruit juice is affected when the juice is concentrated by multi-stage vacuum evaporation in the membrane technology, such as loss in the flavors, degradation of color and a ‘cooked’ taste is produced in the jackfruit juice due to thermal effect. Meanwhile, soursop fruit has a lot of fibres and it is a pulpy fruit with mushy white flesh which leads to high viscosity and less clarity when the juice is mechanically extracted. It also can be stated that fruit juice industries undergo difficulties in producing satisfactory quantity and quality of fruit juices [3]. It is because the majority of juice extraction processes do not produce sufficient consistency of fruit juices.

This research aims to investigate the quality of jackfruit juice and soursop juice after being treated with pectinase and cellulase at three different ratios which are pectinase and cellulase (0.5 - 1.5 % v/w) during extraction. The fruit juices quality was evaluated based on the clarity, viscosity and yield of jackfruit juice and soursop juice by using different ratios of enzyme mixtures.

2. Materials and Methods

2.1 Materials

Mature jackfruit and soursop fruit were bought from a shop in Johor Bahru, Johor. The matured jackfruit had a dull hollow noise when tapped and had a strong odour [6] while matured soursop fruit showed color changes to light yellowish-green [7]. Two commercial food-grade enzymes, Sigma's Pectinase Ultra Clear and Celluclast, were purchased and stored at -80 °C until use.

2.2 Jackfruit Juice and Soursop Juice Preparation

According to Chang *et al*. [8], three formulations of enzyme maceration were used to treat the jackfruit and soursop juices. Once added the formulated ratios into each fruit samples, they were incubated for 2 hours at 50 °C. Then, the samples were heated up to 90 °C for 10 minutes to inactivate the enzyme activity. By using the muslin cloth, the samples were filtered and the samples were collected for clarification, juice yield extraction and viscosity. Figure 1 shows the overall flowchart designed of jackfruit and soursop fruit for this study.

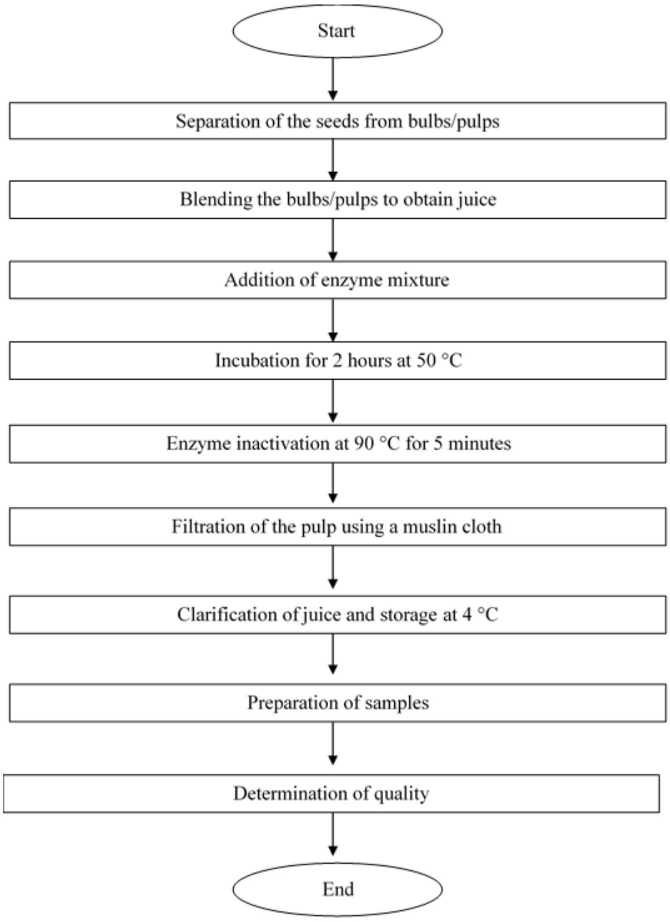

Figure 1: Flowchart designed for jackfruit and soursop juice for this study

2.3 Design of Experiment

Based on the literature, two different enzymes, pectinase and cellulase, were chosen as independent variables in the both fruit juice extraction. Table 1 presents the different formulation of enzyme mixtures that were used for the jackfruit juice and soursop juice.

Table 1: Different formulation of enzyme mixture for Jackfruit and Soursop Juices

Jackfruit and Soursop fruit	Pectinase (% v/w)	Cellulase (% v/w)
Sample 1 (control)	0	0
Sample 2	0.5	1.5
Sample 3	1.0	1.0
Sample 4	1.5	0.5

2.4 Enzymatic Treatment on Jackfruit and Soursop Juices

According to Chang *et al*. [8], for each experiment, 100 g of fruit pulp was blended and divided to various enzyme mixture treatments. The enzyme mixture was added to the both fruit pulps and stirred with a glass rod separately. The concentration of enzyme mixture for the enzymatic treatment process were prepared between 0.5 - 1.5 % v/w and incubated at 50 °C for 120 min in a water bath (WNE 29, Memmert, Germany). For enzyme inactivation, post-treatment fruit juices were heated to 90 °C for ten minutes. The treated juice was then filtered via muslin cloth, and then the obtained samples were stored at 4 °C and used for further study. One fruit juice sample were prepared without enzymatic treatment and referred to as the control sample. The quality parameter of both fruit juices were measured and compared.

2.5 Juice Clarity

From the 40 ml of sample, the pulpy material of jackfruit juice was separated by centrifugation (5804 R, Eppendorf, Germany) at 3000 rpm for 15 min at 4 °C and filtered using a muslin cloth. The filtrate juice was filled into the appropriate cuvettes, and the clarity of the jackfruit juice was determined using a UV-vis spectrophotometer (T60 U, PG Instruments, UK) at absorbance 660 nm. Distilled water was used as reference [8]. This method was also conducted for soursop juice.

2.6 Fruit Juice Yield

The weight and volume of the filtered jackfruit juice from the previous analysis were determined. In a 100 ml measuring cylinder, the volume of jackfruit juice after filtering for each sample was determined. Once volume measured, the weight of jackfruit juice was measured by using mass balance. This method was also conducted for soursop juice. The clarified juice yield for both juices were calculated as shown in Eq. 1 [9]:

$$Yield\ of\ Juice = \frac{Volume\ of\ clear\ juice}{Volume\ of\ sample} \times 100\% \quad Eq.\ 1$$

2.7 Determination of Viscosity

The viscosity analysis was conducted using a rheometer (Discovery HR-1, TA Instruments, US) for both juices. On the surface of the rheometer, 2 ml of clear juice was poured until the measuring bob (60 mm, 2.006 °cone plate, Peltier plate Steel) was completely submerged [8]. Then, the rotation took place at a shear rate of 0.50 to 1001.00 s^{-1} with a temperature of 30 °C, and a reading of 100.00 s^{-1} was obtained for the juice viscosity expressed in Pa.s.

3. Results and Discussion

3.1 The Clarification of Jackfruit Juice and Soursop Juice

Among the consumers, juice that has clear appearance is the dominant factor in determining the quality of juice before purchasing it [10] [11]. Fruit juices normally differs in degrees which leads to natural cloudiness as there is the presence of polysaccharides compounds such as pectin, cellulase, hemicellulose, starch and lignin [10]. This prompts the turbidity reaction in the fresh fruit juices. Based on both Figures 2 and 3, the absorbance of jackfruit juice and soursop juice increased significantly ($P \leq 0.05$) in term of clarity of the juices.

From Figure 2, enzyme ratio of 0.5:1.5 (pectinase:cellulase) shows the lowest value of absorbance (highest clarity) of jackfruit juice with the reduction up to 80 % with the control. Meanwhile in Figure 3, the lowest value of absorbance (highest clarity) shows in the 1.0:1.0 (pectinase:cellulase) in the soursop juice up to 87 % reduction compared to the control. High absorbance value indicated the sample is much cloudier compared to the samples that show least reading of absorbance. It is due to the lighter absorption leads the absorbance rise up.

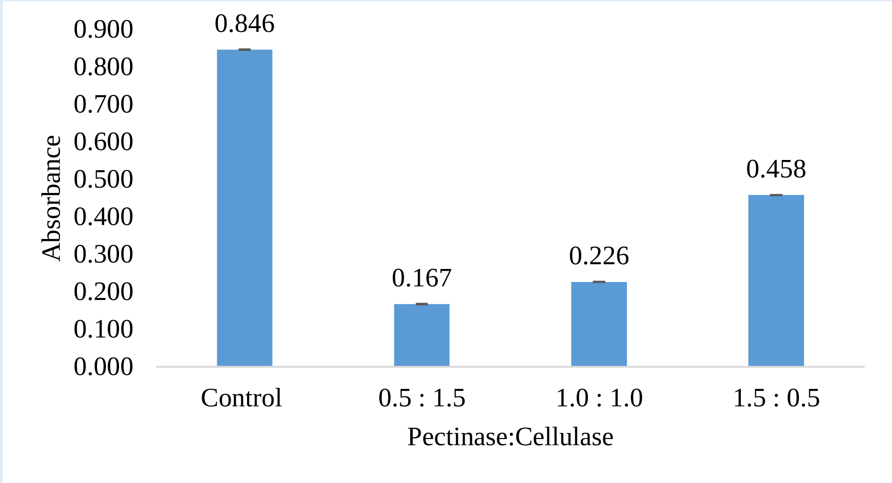

Figure 2: Absorbance of jackfruit juice after treated by pectinase:cellulase enzyme

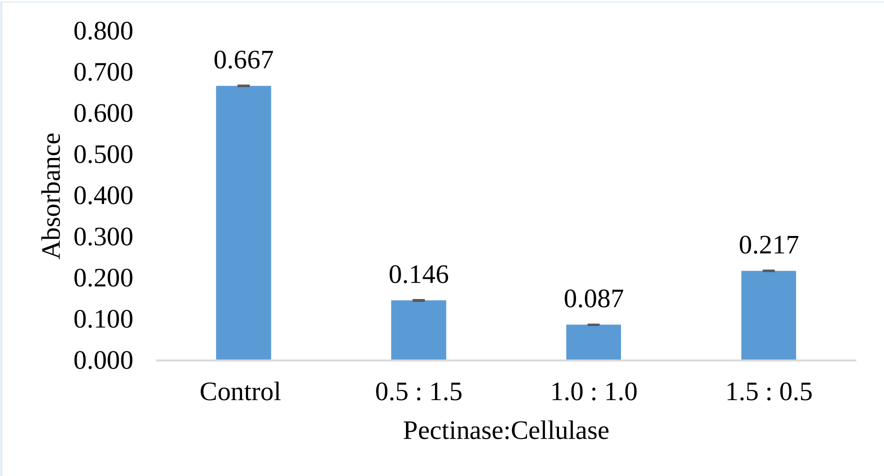

Figure 3: Absorbance of soursop juice after treated by pectinase:cellulase enzyme

Temperature is an important factor in in the enhancement of juice clarification process. In this study the temperature is set below denaturation period (40 – 60 °C) of the enzymes which is 50 °C [10]. The usage of enzyme maceration improves the rate of clarification when the positively charged protein beneath is exposed in the fruit juices. Consequently, the electrostatic repulsion among the cloud molecules will be reduced and these leads the molecules to accumulate into bigger molecules and settle down [10]. According to Arsad *et al*. [12], the pectin molecules are break down by the pectolytic enzymes during the enzymatic treatment and enhance the pectin-protein floc production and remove the colloidal aspect of the juices significantly by leaving a clear supernatant. Mostly in the fruit juices, the cellulase degrade the inside of the cell wall while the pectins are hydrolyzed by pectinase and it allows the complexes of pectin protein to accumulate.

3.2 The Extraction Yield of Jackfruit Juice and Soursop Juice

The yield of juice that is extracted from mechanical extraction is low compared to enzymatic extraction because enzymatically treated fruit juices enhance their juice recovery significantly [10]. From Table 2 and Table 3, it can be clearly seen that enzymatically treated jackfruit juice and soursop juice differ significantly in the juice yield extraction. Based on both tables, enzyme ratio of 0.5:1.5 (pectinase:cellulase) shows significantly ($P \leq 0.05$) high yield in both fruit juices compared to the untreated juices. The extraction yield of jackfruit juice rises up to 83 % while for the soursop juice yield it increases up to 65 %. The highest juice that obtained from the 40 ml of jackfruit sample (28.33 ml) and soursop juice (34.67 ml) compared to the untreated jackfruit juice (4.93 ml) and soursop juice (12.00 ml).

Table 2: Extraction yield (% v/v) of enzymatically treated jackfruit juice

Formulation	Pectinase (% v/w)	Cellulase (% v/w)	Weight (g)	Volume (mL)	Juice Yield (% v/v)
Control	0	0	3.48 ± 0.18	4.93 ± 0.40	12.33 ± 1.01[d]
0.5 : 1.5	0.5	1.5	28.74 ± 0.97	28.33 ± 1.53	70.83 ± 3.82[a]
1.0 : 1.0	1.0	1.0	20.22 ± 0.30	15.33 ± 0.58	38.33 ± 1.44[b]
1.5 : 0.5	1.5	0.5	21.76 ± 0.20	20.00 ± 1.00	50.00 ± 2.50[c]

Table 3: Extraction yield (% v/v) of enzymatically treated soursop juice

Formulation	Pectinase (% v/w)	Cellulase (% v/w)	Weight (g)	Volume (mL)	Juice Yield (% v/v)
Control	0	0	11.17 ± 0.34	12.00 ± 1.00	30.00 ± 2.50[c]
0.5 : 1.5	0.5	1.5	37.43 ± 0.06	34.67 ± 0.58	86.67 ± 1.44[a]
1.0 : 1.0	1.0	1.0	25.75 ± 0.05	22.67 ± 0.58	56.67 ± 1.44[b]
1.5 : 0.5	1.5	0.5	32.90 ± 0.56	29.67 ± 0.58	74.17 ± 1.44[b]

In the fruit processing technology, the usage of the pectinase and cellulase enzyme mixture has been a necessary component because these enzymes not only enhance the juice recovery and juice yield yet they also assure to produce the highest quality of final products [10]. These enzymes aid to soften the plant tissue in the fruit juices as well as helps to release the cell contents in the fruit juice to enhance their fruit juice recovery. During the enzymatic treatment in fruit juices, it degrades the middle lamella and cell wall pectin of the samples with exogene enzymes. Once done, it converted into soluble materials such as acid and neutral sugar. Although 0.5:1.5 (pectinase:cellulase) gives the highest juice yield for both jackfruit juice and soursop juice yet jackfruit juice's yield is lesser compared to soursop juice's yield. The incubation time plays a major role as it is important to degrade the pectin which leads to lowered water holding capacity [13].

Based on Sethi *et al*. [14], compared to the standard mechanical juice extraction method, the mixture of enzyme can produce juice yield more than 90 % which also gives impact on the organoleptic properties as it enhances those properties such as flavor, and colour. The combination of pectinase and cellulase has been found to boost juice extraction production by more than 100 % [15]. It clearly shows that the interaction between the pectinase and cellulase as well as appropriate usage of the enzymes quantity do a key role on producing high juice yield which is useful for the fruit juice industries.

3.3 Viscosity of Jackfruit Juice and Soursop Juice

Enzymes plays an important role in reducing the viscosity of the fruit juices as they tend to degrade the jelly like structure in the fruit juices and make it easy to obtain the fruit juices [10]. The results of viscosity for the jackfruit juice and soursop juice samples are shown in Figure 4 and 5. The enzymatically treated jackfruit juice and soursop juice show significant ($P \leq 0.05$) reduction in their viscosity. From Figure 4, jackfruit juice treated with 0.5:1.5 (pectinase:cellulase) shows the least viscosity (0.020 Pa.s) nearly up to 90 % of reduction compared to the untreated jackfruit juice (0.202 Pa.s). Meanwhile, from Figure 5 the soursop juice treated with 1.0:1.0 (pectinase:cellulase) shows the least viscosity (0.031 Pa.s) with the reduction of 80 % compared with the untreated soursop juice (0.163 Pa.s). This is linked to the result of clarity, where lower viscosity is associated with better juice clarity [16].

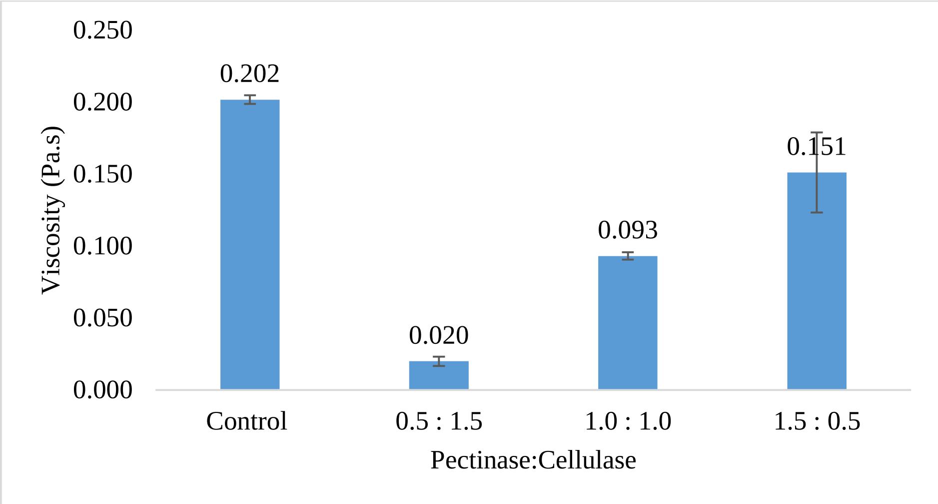

Figure 4: Viscosity (Pa.s) of jackfruit juice after enzymatic treatment by pectinase:cellulase enyzme

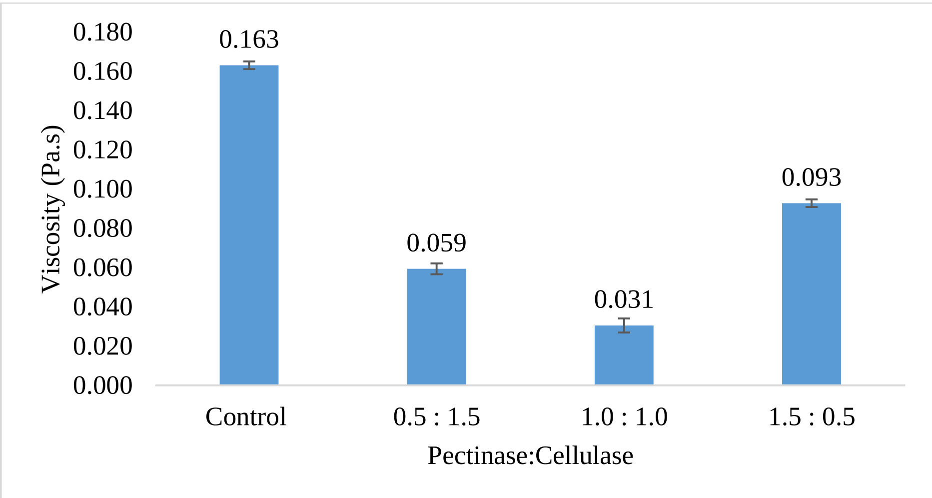

Figure 5: Viscosity (Pa.s) of soursop juice after enzymatic treatment by pectinase:cellulase enzyme

According to Sharma *et al*. [10], when the fruit juices are enzymatically treated there is an occurrence of hydrolytic action by enzymes take place on the cellulosic and pectic components that appears in the fruit juices. In order to reduce the viscosity in the jackfruit juice and soursop juice the combination of pectinase and cellulase enzymes are crucial. It is because the enzyme maceration degrades the pectic material in the cell wall of the fruit and separates the pectinase matrix of the lamella which can reduce the effects of these substances in the viscosity of the fruit juices [3].

Next, the reduction in the viscosity varies for both fruit juices, jackfruit juice has lowest viscosity when treated with 0.5:1.5 (pectinase:cellulase) while soursop juice has lowest viscosity when treated with 1.0:1.0 (pectinase:cellulase). The factors that impact the result are incubation period, incubation time and enzyme concentration. These factors differ depending on the type of fruits [17]. In this study, the incubation period is optimized to 50 °C for 2 hours which might differ for the jackfruit juice and soursop juice in order to achieve the lowest viscosity with different ratios of enzyme mixture.

Additionally, it has been found that the viscosity of normal cloudy juices fluctuates between 0.095 Pa.s to 0.134 Pa.s [10]. Based on Naga Padma *et al.* [18], the addition of the enzyme mixtures not only reduce the viscosity of the fruit juices yet it enhances the extraction of the pulp as well as it tends to produce high quantity of juice without any mechanical pressing helps. Therefore, it enhances the quality of the fruit juices by producing more juice yield, and less viscous fruit juices.

4. Conclusion

Maceration with pectinase and cellulase enzymes improves the quality of jackfruit juice and soursop juice by increasing the clarity of the fruit juices, maximize the efficiency of juice extraction, and decreasing the viscosity of the jackfruit juice and soursop juice. Different ratio of enzyme mixtures produced different results for the jackfruit juice and soursop juice. The enzyme ratio of 0.5:1.5 (pectinase:cellulase) produces the highest clarity but also lowest viscosity for jackfruit juice. Additionally, it increases juice yield extraction. Furthermore, for soursop juice, a 1.0:1.0 (pectinase:cellulase) enzyme mixture results in the highest clarity and lowest viscosity when compared to other enzyme ratios, while increasing juice yield extraction. This research demonstrates that enzymatic treatment with enzymes classified as pectinase and cellulase improves the quality of jackfruit and soursop juices in terms of maximum juice clarity, juice yield, and viscosity reduction when compared to untreated juices. This research can be expanded upon by enzymatically extracting and spray drying of jackfruit and soursop juice to become powder form. Apart from that, additional research can be conducted to determine the acceptance of enzymatically treated jackfruit and soursop juices in terms of organoleptic properties such as bitterness and odour, as well as their rheological behaviour.

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