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Quality attributes of durian (*Durio zibethinus Murr*) juice after pectinase enzyme treatment

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Abstract: Durian juice was treated with pectinase enzyme at different concentrations (0, 0.025, 0.05, 0.075 and 0.1%). The incubation times were from 1-3 hour. The effects of different enzyme treatment and duration of incubation on various parameters (e.g., juice yield, pH, total soluble solids, viscosity, color and sensory evaluation) were investigated. The juice was fourel to be light yellow in color similarly to soy bean milk. The results indicated that the juice yield was increased by 35% when the pectinase enzyme was used. There was significant increased in degree of Brix and significant decrease in viscosity, L* and hue values. Sensory evaluation results showed that the juice treated with 0.05% enzyme concentration and 3 hour incubation time was the most preferred by the panelists.

Keywords: Durian juice, pectinase enzyme, juice yield, viscosity

Introduction

Durian (*Durio zibethinus Murr*) is a popular and expensive tropical fruit widely grown in South-East Asia. Durian is entitled "King of Tropical Fruit" due to the superlative flesh, which is highly nutritional and its appearance which resembles the thorny thrones of Asian kings (Subhadrabandhu and Ketsa, 2001). Durian is rich in carbohydrate, protein, fat, phosphorus, iron and vitamin A. Durian is usually used for fresh consumption. The edible portion (aril) of durian has a very strong odor and the odor has two distinct notes. Firstly, is a delicate, fruity note caused by esters, while the other is an onion-like note caused by thiols and thioesters (Baldry *et al*., 1972). During the durian season, there is excessive supply of the fruit which causes the price of durian drop to rather significantly. Attempts therefore have been made to add value to the durian fruit. One method for adding value to fresh durian is turning it into juice.

According to Jagtiani *et al*. (1988), tropical fruit juices or drinks have become important because of the increasing in consumption of 'natural fruit' juice alternated to the traditional caffeine-containing beverages such as coffee, tea or carbonated soft drinks. Fruit juices which are highly nutritional became an important source of energy in the form of sugars, glucose, fructose and sucrose. Nowadays, food technologists have been able to exploit the fruit juice flavors without adding any artificial flavors by incorporating tropical fruits into fruit-juice blends. Fruit juices are usually cloudy and colloidal suspensions. In orange and tomato juice, the cloud is desirable by the consumers (Babsky *et al*., 1986). Juices that have an unstable cloud or the turbidity are considered 'muddy' or undesirable tend to be marketed as clear juices (Floribeth and Lastreto, 1981).

Viquez *et al*. (1981) reported that producing tropical fruits juices by normal hydraulic pressing or centrifugation tend to be too pulpy and pectinaceous. Therefore, commercial pectinolytic enzymes have been used with other fruit juices such as apple and grape (Rombout and Pilnik, 1978) and banana (Kilara, 1982; Koffi *et al*., 1991; Shahadan and Abdullah, 1995; Viquez *et al*., 1981) to reduce the viscosity and aid the filtration process. However, the pectins are potential to breakdown and leads to the formation of arabinans and haze during storage resulting from enzyme pretreatment of pulp as described by Varnam and Sutherland (1999). The use of pectic enzymes in fruit processing is essential to get better juice yields, improve filtration rate and produce clear juices of high quality for the concentration process (Pilnik and Vorange, 1989). As yet, no information is available on the development of durian juice. Hence the aim of this study was to determine the physicochemical characteristics of the durian juice and to find out if the effects of enzymatic hydrolysis could increase the yield of durian juice.

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Materials and Methods

Fruits

Durian fruits (*Durio zibethinus Murr*) used in this study were obtained from a local market in Penang. The fruits were dehusked (cut open the rind), by cutting along the suture on the back of the locules. Samples were frozen at -18°C to maintain the quality prior to preparation of the puree.

Preparation of puree

Fruit pulps were separated from seeds by hand and macerated using a food blender (Faber®). Water was added in the ratio of 1:2 (wt/v) to facilitate the maceration process as well as to help extract more juice from the pulp. The maceration process was repeated three times in order to get a smooth-textured puree.

Enzyme treatment of puree

After maceration, the puree was immediately subjected to pasteurization at 90°C for 10 min so as to inactivate the natural enzymes or microbes present. The sample was then cooled to 38.5°C before the addition of pectinase enzyme. The enzyme used was Pectinex Ultra SPL (ULT) (Nov Nodised Ferment Ltd., Switzerland) at different level 0.00%, 0.025%, 0.05%, 0.075% and 0.10%. The amount of enzyme used is based on the weight of puree (v/wt). The puree was then incubated in a water bath at 38.5°C at different duration of incubation times (1, 2 and 3 hours). After the incubation process, the puree was again heated in a water bath at 90°C for 10 min to inactivate the enzyme present.

Yield of juice

The juice was filtered using a muslin cloth and the volume of juice obtained from each sample was measured using a 500 ml volumetric flask.

Determination of soluble solids content and pH

Juices were analyzed for total soluble solids (TSS) measured by portable Otago Hand Refractometer with a scale of 0-32°Brix and the values were expressed in degree Brix. The pH value was measured using a digital pH meter (Horiba Fseries, Model F21). Buffer solutions at pH 4.0 and 10.0 were used to standardize the equipment.

Determination of viscosity

The viscosity measurement was made by using a viscometer (Model LVDV –II+, Brookfield). Juice sample was filled to the 50 ml level mark in a 100 ml beaker and the reading was taken using spindle No. 2 rotated at 100 rpm.

Color analyses

Juice color was measured using Minolta Spectrophotometer CM-3500d (Osaka, Japan), the L^*, a^*, b^* values were determined using the CIELAB system. a is a measured of red tones and it varies from -a to +a (-a = green, +a = red), and b is a measure of yellow tones and it varies from -b to +b (-b = blue, +b = yellow). Hue angle is the qualitative attribute of colour and it defines the difference of a colour with referent to grey, L represent the brightness measure and the luminosity at range from 0 to 100 (100=white, 0= black). Zero calibration and white calibration were carried out with zero calibration tile and white calibration tile, respectively on the target mask for petri dish.

Sensory evaluation

For sensory evaluation of the juices, the product was evaluated by a panel of 20 semi-trained panelists which comprised postgraduate students from Food Science and Technology Division, Universiti Sains Malaysia. 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) (Shashi and Khurdiya, 2004). Juice samples were allowed to equilibrate in room temperature (27°C) for 1h prior to sensory evaluation session. Testing was done in the sensory laboratory. Each panelist was served with randomly coded of juice sample.

Statistical analysis

The data were analyzed with an analysis of variance (ANOVA) with significance defined as $p \leq 0.05$, and the means were separated with Duncan's multiple range tests using the Statistical Package for Social Science software version 12.0 (SPSS Inc., Chicago, Illinois, USA).

Results and Discussion

Effect of enzymatic hydrolysis on the yield of cloudy durian juice

Figure 1 indicated the effects of different level of enzyme concentrations and duration of incubation on the volume of juice yield. Greater yield of juice was obtained when the amount of enzyme used was higher with longer incubation time. Imungi *et al*. (1980) also reported that yield of cloudy juice is significantly affected by the temperature and time used for enzyme treatments. Enzymatic hydrolysis of the cell wall constituents is claimed to offer a number of advantages in producing carrot juice such as high yield, better colour and cloud stability (Qin *et al*.,

2005).

The juice amount obtained was higher when using a 0.1% enzyme concentration with 3 hour incubation. Highest levels of enzymes used with the highest incubation time did increase the juice yield. This result was in agreement with those reported by Chang *et al*. (1994) that the yield of plum juice was significantly ($p \leq 0.05$) improved with increasing concentrations of pectinase enzymes from 0.05% to 0.6%. The time of incubation is also a main factor to be considered. The juice yield slightly decreased during the 2 hour and 3 hour incubation period and apparently increased during the 1 hour incubation period at 0.075% enzyme level. According to Qin *et al*. (2005), enzymes are able to degrade the polysaccharide gel formed, hence reduced the viscosity and also improved the juice filtration. Brown and Ough, (1981) also reported that the pectinases enzymes could increase the grape juice clarity by four fold and filterability by 100%.

From 700 g of puree, the juice obtained was only 389 ml while the treated sample produced a maximum of 524 ml. The difference is about 35%. Similarly with these found by Acar and Özdemir (1996) that carrot juice production yields were increased up to 20% by using pectolytic enzyme. For the purpose of comparison, the juice obtained were weighed and recorded as shown in Figure 1.

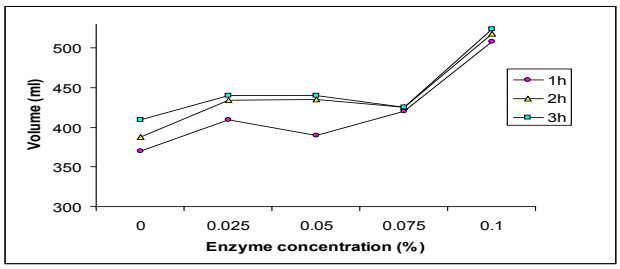

Figure 1. Effects of enzyme concentration and time of incubation on yield (volume) of durian juice

Total soluble solid (TSS)

The effect of enzyme concentration and time of incubation on the total soluble solids (TSS) content is shown in Figure 2. Different levels of enzyme increased the TSS content from 6.5°Brix to 9.0 °Brix within the three hour of incubation. At 0.025% and 0.05% levels of enzyme concentration, increasing an incubation time to 2 hour and 3 hour did not increase the TSS content. At 0.075% enzyme concentration and 3 hour of incubation time showed an increased in TSS content. At 0.1% enzyme level and 2 hour of incubation time showed an increase in TSS.

Higher degree of Brix levels in pectinase treated durian juices may attribute to the greater degree of tissue breakdown. It released more components that contributing to soluble solids. Pilnik *et al*. (1975) and Mc Lellan *et al*. (1985) also reported the same condition happened in apple, pears, apricots and carrot juice. When treated with enzyme, the cell walls were collapsed, separated and the nutritional components released from the interior of the cells (Qin *et al*., 2005). According to Singh *et al*. (1999), total soluble solid (°Brix) content of the enzyme-treated pulps increased slightly with increased in incubation time from 30 to 120 min.

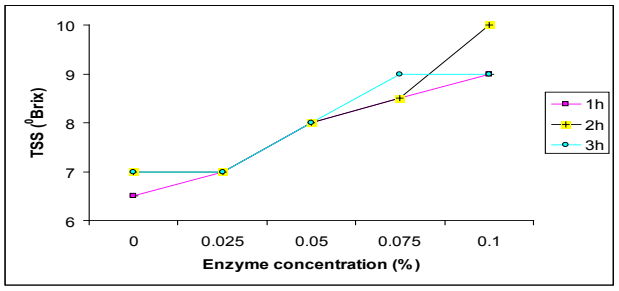

Figure 2. Effects of enzyme concentration and time of incubation on total soluble solids content of durian juice

pH

Figure 3 showed the effects of enzyme concentrations and duration of incubation on the pH of durian juice. The pH of durian juice was high, approaching neutrality and this result was similar as reported by Galeb *et al*. (2002) in cantaloupe juice. The pH for 0.025% enzyme level did not decreased significantly ($p \geq 0.05$) during 1 hour and 2 hour of incubation time but decreased significantly ($p \leq 0.05$) after 3 hour of incubation. At 0.05% enzyme level, pH was significantly increased ($p \leq 0.05$) after 2 hour of incubation time. At 0.075% enzyme level, pH was significantly increased ($p \leq 0.05$) after 3 hour of incubation. The pH for enzyme extracted juice only decreased significantly ($p \leq 0.05$) at 1, 2 and 3 hour duration of incubation at the control (0.0%) and 0.01% enzyme level (Figure 2). This observation could be due to the release of carboxyl groups from the pectin molecules. This is similar to the report by Singh *et al*. (1999), in which the acidity of the enzyme-treated mango pulp was slightly increased.

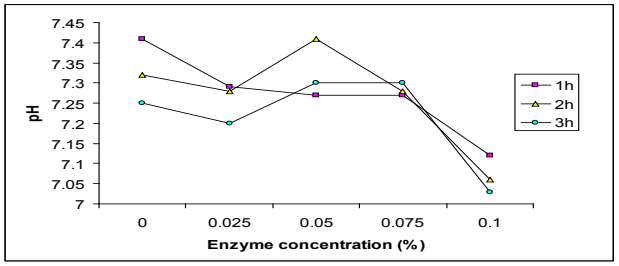

Figure 3. Effects of enzyme concentration and time of incubation on pH of durian juice

Viscosity

Figure 4 showed the effect of using different enzyme concentration and incubation time on the viscosity of durian juice. No significant difference ($p \geq 0.05$) in viscosity at 0.00% enzyme level for all incubation time. As for 0.025% enzyme level, the viscosity of juice was significantly increased ($p \leq 0.05$) after 2 hour of incubation but decreased significantly ($p \leq 0.05$) after 3 hour of incubation time. The viscosity was decreased significantly ($p \leq 0.05$) for 1, 2 and 3 hour of incubation at enzyme level of 0.05%. The 0.075% and 0.1% enzyme level had no significant different ($p \geq 0.05$) for the 1 hour and 2 hour of incubation time but the viscosity decreased significantly ($p \leq 0.05$) after 3 hour. According to Chopda and Barret (2001), ultimate increased in enzyme concentration and incubation time, resulted in gradual increase in °Brix with decreased in pH and viscosity. Similar results were obtained by other researchers in the guava juice (Imungi *et al*., 1980; Askar *et al*., 1992; Brasil *et al*., 1995).

The viscosity of the juice generally decreased after enzyme treatment as noted by other researchers (Baker and Bruemmer, 1972; Braddock, 1981). This is due to the hydrolytic action of enzymes on the cellulosic and pectic materials presence in the juice. The pectinaceous substances possess a high water holding capacity and developed a cohesive network structure. Degradation of pectin by enzyme led to the reduction in water holding capacity and thus released the free water into the system which led to further reduction in the viscosity (Sin *et al*., 2006). Screenath *et al*. (1987) reported that enzyme Pectinex Ultra reduced the viscosity of mango juice by 74%. Loss in viscosity is undesirable in ready to drink juices or concentrates because the product will lose its body and resulted in destabilization of the colloid systems. However, in juice concentration it is important to reduce viscosity in order to increase the effiency of the concentration process (Rombouts *et al*., 1971). Viscosity is usually considered as an important physical property related to the quality of liquid food products.

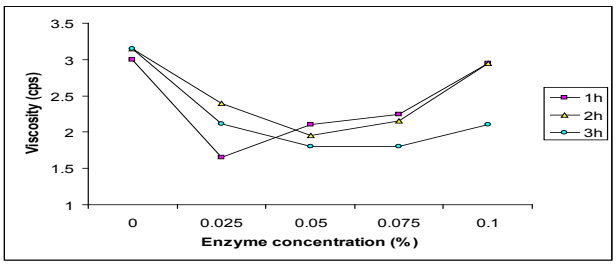

Figure 4. Effects of enzyme concentration and time of incubation on viscosity of durian juice

Colour

The L^* value is a measurement for lightness and if the value is high, it indicated that the juices are clarified. Color is an important sensory attribute (Brimelow and Groesbeck, 1993). A dark product is usually less attracting the consumers as it may indicate deterioration. L^* value generally showed similar trends as turbidity (Qin *et al*., 2005).

It was observed that L^* values for the control (0.00% enzyme) were increased significantly ($p \leq 0.05$) after 2 hour of incubation time (Table 1). The hue values were increased significantly ($p \leq 0.05$) after 2 hour and 3 hour of incubation time. Increased in hue value indicate that the juice was changing towards yellowish tinge.

Table 1. Effect of enzyme on the CIE L^* a^* b^* and Hue angle values for durian juice

Incubation time (h)	Enzyme concentration (%)	*L**	*a**	*b**	*hue*
1	**0.00**	80.01^{h}	0.22^{i}	14.80^{k}	89.20^{a}
	0.025	79.64^{g}	-0.39^{c}	14.73^{j}	94.49^{h}
	0.05	83.39^{k}	-0.08^{g}	10.73^{a}	90.42^{b}
	0.075	84.32^{l}	-0.07^{g}	11.49^{d}	90.37^{b}
	0.1	71.05^{a}	-0.21^{e}	23.22^{p}	90.53^{c}
2	**0.00**	81.94^{j}	-0.18^{f}	12.81^{f}	90.81^{d}
	0.025	75.93^{d}	-0.65^{a}	18.17^{m}	92.03^{i}
	0.05	81.72^{i}	-0.20^{ef}	11.89^{e}	90.92^{e}
	0.075	79.53^{f}	-0.34^{d}	14.23^{i}	91.37^{g}
	0.1	72.85^{b}	0.27^{j}	19.70^{n}	90.76^{d}
3	**0.00**	80.01^{h}	-0.36^{d}	14.09^{h}	91.44^{gh}
	0.025	84.92^{m}	-0.20^{ef}	10.80^{b}	91.11^{f}
	0.05	78.92^{e}	-0.50^{b}	13.94^{g}	92.06^{i}
	0.075	84.29^{l}	-0.19^{f}	10.89^{c}	91.00^{e}
	0.1	75.15^{c}	0.17^{h}	16.85^{i}	90.72^{d}

* Data presented in means with different superscripts in the column indicating statistically significant difference at $p \leq 0.05$.

At 0.025% enzyme level, L^* value increased significantly ($p \leq 0.05$) after 3 hour of incubation time while the hue value decreased significantly ($p \leq 0.05$) after 3 hour of incubation time. Decreased in hue value reflect to the presence of darker grey-black color.

L^* value for juice at 0.05% enzyme level was decreased significantly ($p \leq 0.05$) after 2 hour and 3 hour of incubation time. The decreasing of L^* value generally indicates the juice is losing the brightness and lightness. However, the hue value was increased significantly ($p \leq 0.05$) after 2 hour and 3 hour of incubation time. The hue value of the juice increased

Table 2. Mean scores for aroma, colour, taste, sweetness and overall acceptance of the durian juice

Incubation time (h)	Enzyme concentration (%)	Aroma	Color	Taste	Sweetness	Overall acceptance
	0.00	5.20^{a}	5.25^{a}	4.55^{a}	4.60^{a}	5.00^{a}
	0.025	6.30^{bc}	6.35^{bc}	6.35^{c}	5.75^{abcd}	6.00^{ab}
1	**0.05**	6.60^{bc}	6.20^{abc}	5.64^{abc}	6.20^{bcd}	5.75^{ab}
	0.075	6.55^{bc}	6.05^{abc}	4.95^{ab}	5.40^{abcd}	5.00^{a}
	0.1	7.00^{c}	6.09^{c}	6.10^{abc}	6.25^{bcd}	6.05^{ab}
	0.00	5.65^{ab}	5.35^{ab}	5.40^{abc}	5.05^{ab}	4.95^{a}
	0.025	6.35^{bc}	6.65^{c}	6.10^{bc}	6.20^{bcd}	6.20^{ab}
2	**0.05**	6.20^{abc}	6.55^{c}	5.55^{abc}	6.10^{bcd}	5.60^{ab}
	0.075	6.75^{c}	6.85^{c}	5.55^{abc}	5.90^{bcd}	6.00^{ab}
	0.1	5.65^{ab}	6.55^{c}	5.45^{abc}	5.65^{abcd}	5.45^{ab}
	0.00	6.05^{abc}	6.95^{abc}	5.30^{abc}	5.70^{abcd}	5.50^{ab}
	0.025	5.60^{ab}	5.85^{abc}	5.40^{abc}	5.15^{abc}	5.10^{a}
3	**0.05**	6.90^{c}	6.85^{c}	6.20^{bc}	6.55^{d}	6.40^{c}
	0.075	6.85^{c}	6.35^{bc}	6.10^{bc}	6.30^{cd}	6.05^{ab}
	0.1	6.20^{abc}	6.40^{c}	5.20^{abc}	5.10^{abc}	5.15^{ab}

* Data presented in means with different superscripts in the column indicating statistically significant difference at p≤0.05, (n=20).

significantly after processing. This indicated lesser red color and become more yellow with greater color saturation.

At 0.075% enzyme level, L* value decreased significantly after 2 hour of incubation time and hue value increased significantly after 2 hour of incubation time. Lee *et al*. (2001) reported that a slightly decreasing in L* value when the orange juice was subjected to pasteurization. Lee and Coates (1999) also found a slight decrease in L* value when they studied red grapefruit juices processed by heat treatments and they attributed it to partial precipitation of unstable particles in the juice, as described by Genovese *et al*. (1997).

The L* value for 0.1% of enzyme level increased significantly (p≤0.05) after 2 hour and 3 hour of incubation time. However, the hue value was increased significantly (p≤0.05) only after 1 hour of incubation time. Increasing in L* values, could probably be due to the non-enzymatic browning. According to Mackinney and Chichester (1952), color deterioration in strawberry fruit was due to the formation of brown pigments. Heating can creates an opportunity for oxidative reactions, which cause a degradation of the pigments (Markakis *et al*., 1957).

Sensory evaluation

The panelist's average scores at different enzyme concentration and time of incubation for durian juice are presented in Table 2. The average score for the juice treated with 0.05% enzyme at 3 hour was highest, 6.40 and most preferred by the panelists. The highest scores for overall acceptance are mainly due to the sweetness and aroma that contributed to the juice. The sweetness and aroma were rated the highest, 6.55 and 6.90 by the panelist. According to Khurdiya *et al*. 1996, the sample with the score of 5.50 and above was considered acceptable. The panelist acceptance was also in agreement to color measurement as high in hue and b* value, the color of juice was more yellowish.

Conclusion

In conclusion, it was found that yield of the juice extracted was able to increase by 35% by using the enzyme Pectinex Ultra SPL. Enzyme treatment of the pulp at 0.1% concentration for 3 hour incubation time was the most adequate in achieving the maximum yield. The use of enzyme resulted a significant increase in TSS and caused a significant decrease in viscosity, L* value and hue values. Sensory results indicated that durian juice at 0.05% enzyme concentration at 3 hour incubation time was the most acceptable.

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