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THE EFFECT OF PECTINASE ON THE YIELD AND ORGANOLEPTIC EVALUATION OF JUICE AND WINE FROM BANANA AND PAW-PAW

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Abstract
Banana and Paw-paw are pulpy fruits with high levels of insoluble proto- pectin. This forms slurry, causing low yield of extractable juice. Pectinase breaks down the pectin- chain thereby reducing their binding power and increasing flowability of the slurry. The study investigated the effectiveness of varying concentrations of pectinase on the yield of banana and paw-paw juice. It also evaluated the organoleptic scores of wines produced from the juice of banana and paw-paw made using the pectinase extracted juice. The pectinase juice extraction gave yields of 63.4% and 78.7% for banana and paw-paw compared to 38% and 43% for non- enzymic extractions. Maximum enzyme performance was at concentration of 6mg/ ml resulting in a slurry volume of 188.0ml for banana and 160ml for paw-paw slurries. This enzyme concentration (6mg/ml) also gave the juice with the least juice density of 0.940 for paw-paw juice and 1.003 for banana juice respectively. The reducing sugars were 1098.2mg/ 100g and 968.8mg/ 100g for banana and paw-paw. The titratable acidity were 2.0% and 0.8% for banana and paw-paw juices. The pH of the wines from paw-paw and banana were not significantly ($p<0.05$) affected by the concentration of the enzyme used in their juice extraction. Organoleptic evaluation after two weeks of ageing showed that banana wine was better accepted. This may be as a result of its higher reducing sugar content. The research clearly demonstrates the potential and applicability of pectinase in improving yield in the banana and paw-paw juice extraction process.

Keywords: Pectinase, Juice-Yield, Wine, Banana, Paw-Paw

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1. INTRODUCTION

Banana (*Musa spp*) and Paw-paw (*carica papaya*) are not optimally utilized in the processing of juice and wine. This is because the current methods of juice extraction is cumbersome and requires a significant energy cost, with attendant low yield. The methods are not efficient for large scale production (Van Rensburg and Pretorius,2000). The traditional method of fruit juice processing involves mashing the fruits by mechanical means; pressing- out the cloudy raw juices and elminating wastes in the form of chaff. This is generally achieved through the use of the mechanical press.Fruits are made-up of cells linked by middle lamella which contains insoluble proto- pectins. Pectinase hydrolyses the pectin chains, thereby reducing their binding action (Worner, et al; 1988).

Fruit cell walls are very complex molecular structures and to get the maximum breakdown of the compounds found in them, fruit juice processors use a variety of different of different treatments and enzymes to maximise the yield of their juice (Sunday, 2007).

Pectolytic enzyme preparations have been used with great success for many years in the field of Food Technology. In juice extraction, this enzyme is used to achieve more juice yieldand increase the press capacity (Jackson, 2000). Pectinases and Amylases both breakdown the insoluble proto- pectin compounds in the fruits thus decreasing the density of their slurry and producing a clearer, sweeter product (Worner, et al;1988)

The yield of pure juice has been reported to be as low as 38.1% and 43% for banana and paw-paw in non-enzymic extraction as compared to 65% and 80% respectively for pectolytic enzyme influenced extraction (Sims, et al;1994)

Banana and Paw-paw are highly perishable fruits with post- harvest losses of up- to 50% (Pilnik, 1996). These huge losses could be minimised if the fruits could be efficiently and economically processed into juices and other products.

The objective of our study therefore is to investigate the effect of the application of Pectinase on the yield of Banana and Paw-paw juice. It also evaluates the organoleptic properties of the wines processed from these juices by ageing.

2. MATERIAL AND METHODS

Sample collection

Ripe banana and pawpaw fruits were purchased at the New market in Minna. The Pectinase used was a product of Zigma Chemicals Ltd, UK and has an activity of 1.32U/mg.

METHOD

Pectinase Solution preparation

Enzyme activity (1.32U/mg): 24mg of pectinase was added to 2ml of sodium citrate buffer, and the mix was made up to 8ml with the citrate buffer. It was then properly dissolved by gentle agitation and 1ml of the mix was taken to represent enzyme concentration of 6mg/ml. The remaining enzyme/ buffer mix was further diluted to 10.5ml with the sodium citrate buffer and another 1.0ml also taken to represent enzyme concentration of 4.0mg/ml. The serial dilution continued until enzyme concentrations of 3.0mg/ml, 2.0mg/ml were gotten. The control had no enzyme content.

Banana and pawpaw juice extraction

Banana juice: Ripe banana fruits were thoroughly washed with distilled water, before peeling using a sterile knife, and the pulp were collected into different sterile plastic containers already labeled. 40g of banana pulp with 120ml of distilled water was blended using Binatone blender (model BN 622). The slurry was dispensed into 10 clean conical flasks and replicate inclusive. Enzyme concentration (2mg/ml, 3mg/ml, 4mg/ml and 6mg/ml) were added to different conical flasks containing the slurry and labeled accordingly and the control was prepared without enzyme. Each treatment was replicated. The samples were incubated in the water bath for 30 minutes at 50 ^{0}C with stirring. Clean sterile muslin cloths were used to sieve the juice from the pulp of each conical flask. The percentage yield was estimated in accordance with Bitange *et* al (2009).

Percentage Yield:

$$(\text{Total Pulp weight} - \text{Total sold waste}) \times \frac{100}{pulp\ weight} \quad (1)$$

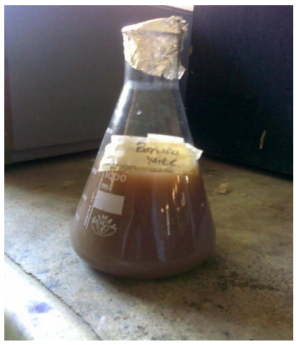
Specific Density of the juice: The specific density of the juice was determined by weighing a known volume of the juice on a weighing balance and was calculated using the formula:

$$\text{Density (g/ml)} = \frac{weight\ of\ sample(g)}{Volume\ (ml)} \quad (2)$$

Determination of Reducing Sugar: An aliquote (1.0ml) of the hydrolysate (juice) was pipetted into a test tube, 2.0ml of water and 3.0ml of Di-Nitrosalicylic (DNS) reagent were added and put into a boiling water bath for 5 minutes. The mix was cooled to room temperature, made up to 20ml with distilled water and absorbance read at 540nm. A blank was also prepared with 1ml of distilled water and 2ml of DNS. The concentration of the reducing sugar was extrapolated from a standard glucose curve of concentrations of 0, 0.25, 0.50, 0.75, 1.0, 1.25, 1.50mg/ml.

Standard and hydrolysate: All the test tubes were heated in a boiling water bath for 5 minutes to allow the reaction between glucose and DNS to occur. They were cooled and the volume adjusted to 20ml accurately with distilled water, using pipette or burette, and mixed well. The absorbance of each solution was read at 540nm using a spectrophotometer.

Calculation: A calibration graph was prepared by plotting absorbance against mg glucose per ml. A standard glucose solution containing 15mg per ml was serially diluted to give solutions of 0, 0.25, 0.5, 1.0, 1.25, and 1.5 mg glucose per ml respectively. 1ml each of the hydrolysate was also read on the spectrophotometer and the final glucose concentration was derived by multiplying the reading on the glucose curve by 20 (being the dilution factor).



Fig, 1.0 Banana juice

Pawpaw juice

The process of extraction was done as previously employed in banana juice extraction described above.

Fig, 2.0 Pawpaw juice

Preparation of banana and pawpaw wine by Ageing.: From banana and pawpaw juice produced using the highest enzyme concentration of 6mg/ml, 500 ml of the juices were measured and autoclaved at 121^0C for 15 minutes. It was corked to avoid aerobic conditions and kept in the refrigerator at 4^0C for 2 weeks for sedimentation of the particles and clarification. The products, after two weeks were a pair of clear and sparkling drinks. The P^H, organoleptic evaluation and titratable acidity were then monitored.

Fig 3.0 Pawpaw wine after 2 weeks of aging

Fig 4.0 Banana wine 2 weeks of aging

The pH was determined using a pH meter (model crison micro pH 2000) while the organoleptic evaluation of the juice was determined on the bases of taste, colour, texture and flavor using the 7 points Hedonic score reference.

The titratable acidity (T.A):

The titratable acidity (T.A) utilizes the end point of titration to determine the result. The titration was determined by taking 10ml of the banana or pawpaw wine in to the conical Flask. Two drops of phenolphthalein was added in to the sample in the conical flask, 0.1M sodium hydroxide was used to titrate the sample (banana and pawpaw wine), with shaking of the conical flask at interval so that the indicator is mixed until a change in colour occurs. The titratable acidity was calculated using:

$$\text{T.A}\ (\%) = \frac{T \times 192 \times 10}{3 \times 1000} \quad (3)$$

Where:

T is the mean titre (in ml) of 0.1M sodium hydroxide solution required to neutralize the acidity in 10.00 ml of the pawpaw and banana wine while 192 is the molecular weight (relative molecular mass) of citric acid in accordance with *Bitange et al., (2009)***.**

Statistical analysis: The experimental values for slurry, residue, percentage Juice yield, glucose, density, and pH under different enzyme concentrations are presented in Table 1.0, 2.0 and 3.0. The means were compared using MATLAB VERSION 7.9 (R2009B).

3. RESULTS AND DISCUSSION

The effect of the Enzyme on the percentage yield of the juices showed an increase in the yield as the enzyme concentration is increased. The result showed that even the least addition of the enzyme increased the juice yield.

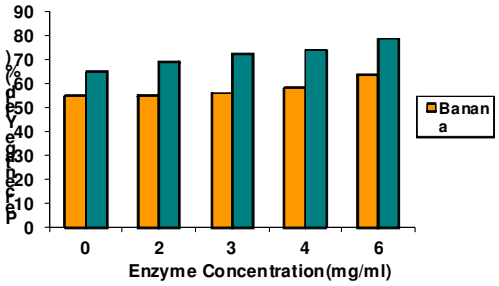


Fig 5.0: The Effect of Pectinase Concentration on the Percentage Yield of Banana and Paw-paw Juice.

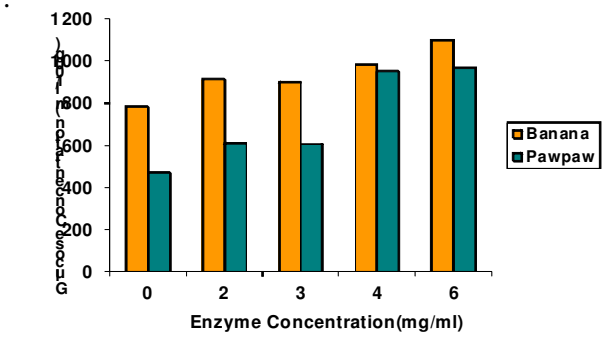


Fig 6.0: The Effect of Pectinase Concentration on the Reducing Sugar Content of Banana and Paw-paw Juice.

The increase in enzyme concentration (Fig 6.0) also showed a corresponding increase in the reducing sugar content of the juices produced as shown over leaf. This increase seemed to peak for paw-paw juice at enzyme concentration of 6mg/ml.

The graph (fig.7.0) also showed an increase in pulp slurry volume as enzyme concentration is increased. This also peaked at enzyme concentration of 6mg/ml for paw-paw juice.

The residue left behind after the juice extraction (fig. 8.0) reduced with increase in Pectinase concentration. The juice yield was increased while the quantity of residue left behind was reduced.

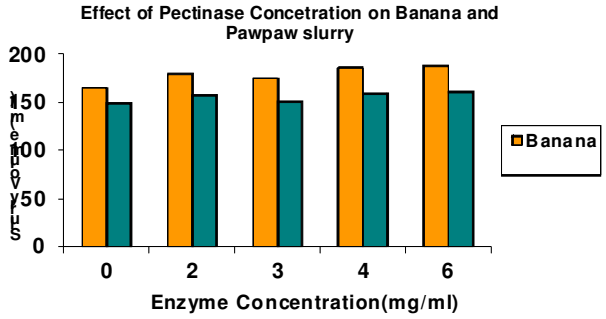


Fig 7.0: The Effect of Pectinase Concentration on Banana and Paw-paw Slurry.

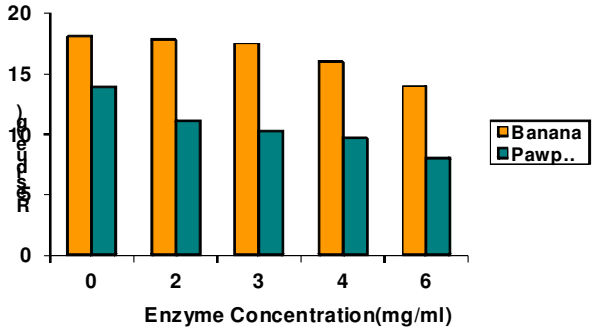


Fig 8.0: The Effect of Pectinase Concentration on Banana and Paw-paw Residue

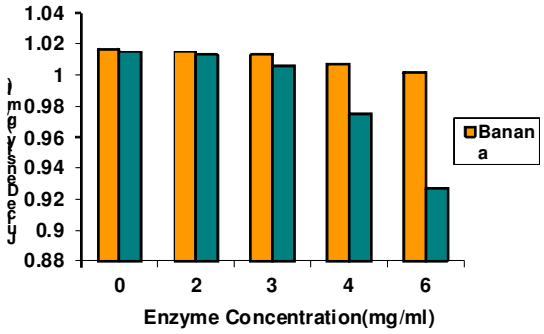


Fig 9.0: The Effect of Pectinase Concentration on Banana and Paw-paw Juice Density

Fig 9.0 also showed that the increase in Pectinase concentration has a decreasing effect on the juice density. The decrease in juice density was much more pronounced in the paw-paw juice than in the banana juice.

Table 1. 0rganoleptic evaluation of banana and pawpaw wine using 7 hedonic scale*.

Sample	Colour	Taste	Flavour	Texture	Overall acceptance
Banana wine	1^{a}±1.2	2^{a}±1.2	2^{a}±1.4 3^{b}±1.0	2^{a}±0.1 2^{a}±0.1	2^{a}±1.4 3^{b}±1.5
Pawpaw wine	2^{b}±1.3	3^{b}±1.1			

*Values followed by the same superscript alphabet along column are not significantly different at P< 0.05.

Discussion of results

Results from Fig5.0 showed that enzyme concentration have a profound effect on the percentage yield of pawpaw and banana juice. As the concentration of the enzyme increases, the percentage yield also increases. Pawpaw juice showed a higher percentage yield (78.7%) than banana (63.4%).This is caused by the higher pectin content of the banana pulp. The result obtained was in accordance with Bitange et al*;* (2009). The effect of enzyme concentration on reducing sugar of pawpaw and banana are shown in Fig 6.0. The result showed that the reducing sugar yield increased from 968.8-1098.2mg/ml for pawpaw and banana respectively, as the enzyme concentration increased. This showed that the reducing sugar of banana juice is higher than pawpaw at the same enzyme concentration (6mg/ml) for the fact that naturally, banana fruit has more sugar than pawpaw fruit and therefore banana juice can be used an energetic juice.

Results from Fig 7.0 showed the effect of enzyme concentration on the slurry volume of pawpaw and banana juice respectively. As the enzyme concentration increases the slurry volume also increases. The slurry volume of banana (188.0ml) is higher than the slurry volume of pawpaw (160.0ml). This could be explained by the fact that banana has more pectin and at the same enzyme concentration, the enzyme activity will be greater in it than in pawpaw slurry, all other conditions remaining constant.

The residue obtained from the filtration of pawpaw and banana juice were both affected by the enzyme as seen in Fig. 8.0. As the concentration of the enzyme increases, the residue decreases significantly at P<0.05. This might be due to the activity of the enzyme on pectin. By hydrolysing the pectin which is the component of the fruit cell wall. At high enzyme concentration (6mg/ml) the residue of pawpaw (8.50g) was lower than banana residue (14.625g) due to pectin degradation. Pawpaw forms a lower density slurry than banana and despite the higher enzyme activity in banana, there is still more substrate for the enzyme to hydrolyse than in pawpaw slurry.

The result obtained from Fig. 9.0 revealed that as the enzyme concentration increases the density of pawpaw and banana juice decreases with a low value of 0.9400 for pawpaw juice and 1.0030 for banana juice at high enzyme concentration of 6mg/ml.Therefore pawpaw juice have a lower density compared to banana juice as a result of the pectinase hydrolysing the pectin and reducing the viscosity of the juice.

The result of pH from table 2.0 and 3.0 showed that the concentration of enzyme have little effect on the pH of pawpaw and banana juice treated with pectinase, as also in pawpaw wine with pH 6.25 and banana wine pH 5.32.

Titratable acidity (T.A) for enzyme treated pawpaw and banana wine was calculated as given in equation (3), pawpaw wine was 0.8% and banana wine was 2.0%. The result was in accordance with Perez-Magarino and Gonzalez-SanJose, (2000) and Bhardwaj et al*., (2005).*

The organoleptic evaluation of banana and pawpaw wine was done after two weeks of aging and the ANOVA used for the analysis of the organoleptic evaluation showed a significant different at P<0.05. Using MALT AB VERSION 7.9 [R2009B] at P< 0.05, there was significant difference in the mean score of the colour between banana and pawpaw wine, and this implies that the colour of banana (like extremely) and pawpaw (like) shows a significant different at P<0.05. For the taste, banana (like) and pawpaw wine (fairly like) shows there was significant difference in the mean score of the taste at P<0.05. For the flavour of banana and pawpaw wine, there was

significant different at P <0.05. Banana wine was preferred most. The texture, there was no significant different in the mean score between banana and pawpaw wine. This implies that the texture of banana and pawpaw wine were preferred alike (like). Meanwhile the overall acceptability showed significant difference in the general acceptability between the two samples at P<0.05. This implied that banana wine was mostly preferred (like) and pawpaw wine was fairly like as shown in table 1.0.

4. CONCLUSION

From the result obtained from the production of pawpaw juice, banana juice and wine, it can be concluded that pectinase have a positive effect on the followings: slurry, residue, percentage yield, glucose and density. Increase in enzyme concentration leads to an increase in slurry volume, percentage yield, and glucose. As the enzyme concentration increases, there is decrease in residue and density with little effect on the pH. In addition, the organoleptic evaluation after two weeks of aging showed that the overall acceptance of banana wine was preferred to that of pawpaw wine.

This study therefore concludes that the use of pectinase in banana and pawpaw juice extraction is highly effective.

Following the application of commercial enzymes for the processing of juice and wine in this study, the followings are recommended:

· Production of juice and wine by industries using pectinase and other enzymes should be promoted.

· Further work/ investigations may be necessary to find out the most appropriate enzyme concentration to obtain 100% juice yield in the fruits under study.

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