# COMPARISON OF PHYSICO-CHEMICAL AND SENSORY CHARACTERISTICS OF PAWPAW JUICE EXTRACTED WITH LOCALLY PRODUCED AND COMMERCIAL PECTIN ENZYMES

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## ABSTRACT

***Fruit juices are often extracted more efficiently (faster rate of extraction or higher yield) by the application of pectin enzymes which are commercially available. A survey of small scale juice processors in Ghana indicated low level of production due to inefficient methods of extraction. These processors could therefore benefit from use of pectin enzymes in their operation. Our laboratory has been investigating the activity of pectin enzymes produced locally from Saccharomyces cerevisiae (ATCC 52712) in fruit juice processing. In this report, pawpaw juice was extracted with the Saccharomyces cerevisiae enzyme as well as a commercial pectin enzyme, Rohapect D5L under previously determined optimum conditions. The characteristics of the juices were then compared in order to evaluate the usefulness of the locally produced yeast enzyme to the local fruit juice industry. Fixed quantities of the yeast and commercial enzymes were added to a known amount of pawpaya mash and the samples held at room temperature for 30 minutes after which the samples were filtered to obtain the juice. Sensory analysis as well as physical and chemical properties of the juices were then determined on each sample. Physico – chemical characteristics of pawpaw juice such as pH, titrable acidity and color were not different when compared to control or the commercial enzyme extracted juice. Similarly, important sensory characteristics of the juice such as aroma, color, taste, cloudiness and acceptability were also comparable to that of the control and those extracted with the commercial enzyme. The results indicate the possibility of using locally produced pectin enzymes for fruit juice extraction. The potential applicability of the method to the industry is being evaluated in a scale – up extraction process.***

**Keywords**: *pectin enzymes, sensory characteristics; Rohapect D5L*

## INTRODUCTION

Enzyme processing of foods form one of the major applications of biotechnology in the food industry. The major advantage of the enzymatic processes are the enzymes' specificity of both the substrate and products generated. The enzymes are able to selectively transform only one molecule from a mixture of similar molecules with near100% efficiency of transformation. Thus enzymes are widely used to improve process technologies such as preparing products with

more consistent properties, minimizing extensive heat treatments as well as improving the quality of the end products (Simpson, 2000).

In the fruit juice industry, pectin enzymes are widely used to improve juice extraction and clarification. Commercial pectin enzymes are therefore widely available for this purpose (Bundesen, 1994). In Ghana, the fruit juice industry is rather young but expanding rapidly. A survey carried out among the small scale juice producers indicated generally low efficiency of juice extraction (Ntim-Gyakari, 2004). Enzyme assisted extraction of juice however leads to increase in juice yield as well as faster rate of extraction (Bundesen, 1994; Dzogbefia *et al.*, 2001; Dzogbefia and Djokoto, 2006). For local juice processors to benefit from the use of enzyme technology, there is need to have access to enzymes that are readily available and stable under factory conditions. Pectin enzymes produced by a strain of *Saccharomyces cerevisiae (ATCC 52712)* which was previously isolated from fermenting cocoa in La Cote d'Voire (Sanchez *et al.*, 1984) has been demonstrated to have broad pH and temperature ranges between 3.5 -5.0 and 25 - 40$^0$C respectively (Buamah *et al.*, 1997; Ameko, 1998). The yeast grows adequately in a number of fruit juices at room temperature without the need for the adjustment of the pH of juice (Dzogbefia *et al.*, 1999; 2001). Application of such enzymes to the extraction of pineapple and pawpaw juices resulted in rapid extraction rates of between 65 – 85 % respectively (Dzogbefia *et al.* 2001; 2006). In a previous report (Djokoto *et al.* 2006), the commercial enzyme, Rohapect D5L, gave much higher rate of extraction than the *Saccharomyces cerevisiae* enzyme, but its application to the local fruit juice industry is limited in the sense that it was imported and required continuous refrigeration to remain active. The *Saccharomyces cerevisiae* enzyme on the other hand could be produced at room temperature and used under factory conditions with minimal effect on its activity (unpublished observation). In the current report, the physico-chemical and sensory attributes of pawpaw juice extracted using both enzymes was compared with the view of evaluating the usefulness of the yeast enzyme to the local fruit juice industry.

## MATERIALS AND METHODS

*Saccharomyces cerevisiae* ATCC 52712 was purchased from American Type Culture Collection, USA, while the commercial pectin enzyme, Rohapect D5L, was obtained from Rhom, Germany. All other chemicals of analytical grade were obtained from Sigma Chemical Company, St Louis, MI. Papaya fruit (*Carica papaya*) of the "Solo" and "local" varieties with red and yellow flesh respectively, were used for the analysis. The yellow variety was obtained from a private farm on Kwame Nkrumah University of Science and Technology campus while the red variety was obtained from a farmer in Ejisu-Juaben, Ashanti Region.

Based on preliminary studies, a pre-determined dosage of 40mg and 10mg protein respectively, of the yeast and commercial enzyme (Rohapect D5L) preparations per 200g of pawpaw mash were used for the comparative studies. A uniform reaction time of 30min which had been previously established in an earlier report as the optimum (Djokoto, 2001; Dzogbefia *et al.*, 2006) was employed for the comparative studies. The effect of the two enzymes on juice pH, titrable acidity, total soluble solids, color as well as sensory attributes such as taste, cloudiness, aroma and acceptability were compared. The pH of the juice was measured with a pH meter (Corning Model 240). For titrable acidity, 10ml of juice diluted to 100ml was titrated with 0.1N NaOH solution using 0.3ml of 1% phenolphthalein in alcohol as the indicator and the acidity expressed as percentage citric acid, that is, gram anhydrous citric acid/100ml juice (Codex Alimentarius, 1992). Total soluble solids were determined with the Abbe refractometer at 20°C whereas color (objective measurement) was determined with a chromameter (Lovibond

Nessleriser 2150 Daylight 2000) using 10ml juice samples diluted to 50ml with distilled water.

**Sensory Evaluation of juices**

Owing to the non- availability of papaya juice locally on the market, the sensory properties of the juices were determined using a 30 member panelists who were all regular consumers of papaya fruit and therefore quite familiar with its sensory attributes. Questionnaire for panelists using a 5- point Hedonic scale to indicate the various characteristics of the juices were used for the sensory evaluation. The papaya juices were freshly prepared and maintained at 10°C before being served to the panelists. Frequency distribution graphs of the responses were plotted and analysed.

**Statistical Analysis**

Data was analysed using the statistical package for Social Scientist (SPSS).

## RESULTS AND DISCUSSION

Enzyme processing of foods is a major impact of biotechnology to the food industry. Enzymes can be used in the form of whole cells, purified or unpurified preparations depending on the intended use. In the fruit juice industry, technical enzymes are widely employed for efficiency of juice extraction as well as clarification of juice, the major enzymes being pectin enzymes and cellulases (Novo Nordisk 2005). Over the past few years, we have been investigating the effectiveness of pectin enzymes produced locally from a strain of *Saccharomyces cerevisiae* (ATCC 52712) in many food processing applications including fruit juice extraction, cocoa fermentation, etc. (Dzogbefia *et al.*, 1999; 2001; Dzogbefia and Djokoto 2006; Djokoto *et al.*, 2006; Buamah *et al.*, 1997). In order for the enzyme to be beneficial to local fruit juice processors, it should not have any major change in the characteristics of the juice extracted both in terms of physico-chemical and sensory properties. This paper therefore assessed the effect of the enzyme treatment on these parameters as compared to a commercial enzyme, Rohapect D5L which has been used in the industry for years.

Table 1 shows the results of the physico-chemical properties of juice extracted with the two enzymes and a control. For both varieties of papaya used, there were no significant differences in the pH and titrable acidity when the enzyme treated juices were compared to the controls ($P > 0.05$). The total soluble solids were however higher for the enzyme treated samples and significantly different from the controls ($P<0.05$). The pH range for edible papaya is 5.0 – 6.0 (Seymour *et al.*, 1993), thus the values for all the treatments fell within this range (Table 1), indicating that the enzyme treatments had no effect on this characteristic of the juice. The predominant acid in papaya fruit is citric acid fol-

**Table 1: Physico – chemical properties of pawpaw juice extracted using Locally produced yeast enzyme and a commercial enzyme, Rohapect D5L**

| | Yellow flesh variety | | | Red flesh variety | | |
|---|---|---|---|---|---|---|
| **Properties** | **Control** | **Commercial enzyme** | **Yeast enzyme** | **Control** | **Commercial enzyme** | **Yeast enzyme** |
| pH | 5.569 | 5.587 | 5.611 | 5.533 | 5.519 | 5.548 |
| Total titrable acidity (%) | 0.098 | 0.098 | 0.099 | 0.096 | 0.095 | 0.095 |
| Total soluble solids (%) | 7.860 | 8.130 | 8.070 | 7.710 | 7.980 | 7.980 |

lowed by malic acid and α- ketoglutaric acid (Chan *et al.*, 1971). The total titrable acidity is normally measured as percent anhydrous citric acid (Codex Alimentarius, 1992). The acidity of papaya as reported by Chan *et al.* (1971) was 0.099%, whereas Purseglove (1969) reported the same to be 0.1%. The values obtained in this work thus agree with literature reports (Table 1).

Significant differences ($P< 0.05$) were observed in the total soluble solids content between the enzyme-treated samples and the controls (Table 1). The treated samples had higher values due to the dissolution of protopectin in the papaya flesh as a result of the enzyme treatment (Baumann, 1981). The dissolution of protopectin which increases the dissolved pectin content contributes to the higher viscosity observed for enzyme treated fruit mash (Pilinik and Rombouts, 1981). Chan and Tang (1979) reported the total soluble solids content of papaya puree as 7.6%-8.0%. The values obtained in this work (7.9-8.2) therefore are in agreement and also fell within the standard for fruit juices (Codex Alimentarius, 1992). In general, the commercial enzyme and the locally produced yeast enzyme both showed the same trend on these parameters.

In addition to the increase in total volume of juice extracted when fruit mashes are treated with enzymes (Bundesen, 1994; Ameko, 1998; Dzogbefia *et al.*, 2001; 2006), extraction of color into the juice is also an additional objective of enzyme assisted juice extraction (Neubeck, 1975). The color of the juices extracted were therefore subjected to objective color measurement. The results showed that there were no significant differences in the color of control and enzyme extracted juices for both the commercial and local enzyme. For the yellow flesh variety a value of 80°H was obtained while the red flesh variety gave a value of 95°H. It appears therefore that enzyme treatment did not have any significant effect on the amount of fruit color extracted in this study.

The color of the yellow flesh variety, according to Muthukrishnan and Irulappan (1990), is due to chryptoxanthin instead of the generally accepted pigment, carotene. Yamamoto (1964) however reported that the red flesh variety has 63.5% of its color being due to lycopene instead of chryptoxanthin. Significant differences were therefore observed in the color of the two varieties but these differences were not due to the enzyme treatments.

**Sensory evaluation**

Sensory characteristics of any food item contribute significantly to its consumer acceptance or rejection. Thus sensory evaluation of food using panelists is routinely carried out by Food Scientists to help evaluate the acceptability or otherwise of any new food product.

The juices extracted with and without enzymes were therefore subjected to sensory evaluation using 30 panelists, all of whom were regular consumers of papaya fruit and thus very conversant with its attributes. The majority of the panelists rated the color of the yellow juice as moderate, while the red juice was rated as strong (Fig. 1). Similarly, with respect to taste and aroma, both were rated moderate for the yellow variety but strong for the red variety (Figs. 2 and 3). There were however no significant differ-

(Values are averages of 3 determinations on 10 fruits. Significant differences ($P< 0.05$) were observed between enzyme treated juices and the controls only for total soluble solids)

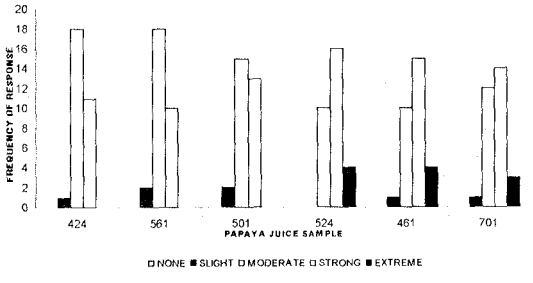


**Fig.1: Frequency Distribution of Panelist Response to Colour**

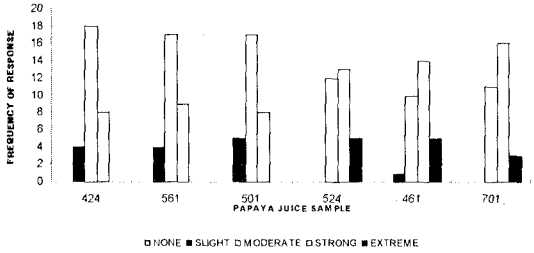


**Fig.2: Frequency Distribution of Panelists Response to Taste**

**Yellow Flesh Variety**
424: Control Juice
561: Yeast Enzyme Extracted Juice
501: Commercial Enzyme Extracted Juice

**Red Flesh Variety**
524: Control Juice
461: Yeast Enzyme Extracted Juice
701: Standard Enzyme Extracted Juice

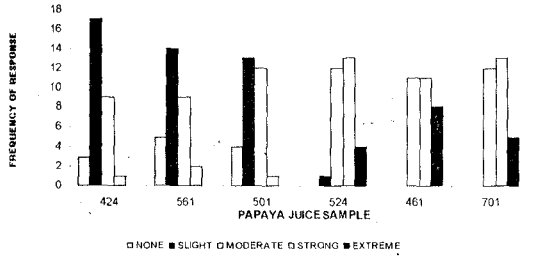


**Fig. 3: Frequency Distribution of Panelists Response to Acceptability**

ences between the control and the enzyme treated juices ($P>0.05$) indicating that panelists could not detect any differences between the commercial enzyme and the yeast enzyme treated juices when compared to controls. The degree of cloudiness of the enzyme treated juices as well as the controls were all rated as moderate with no significant differences observed (Fig.4). Panelists rated the overall acceptability of the juice as slight for the yellow variety, but strong for the red variety, but with no significant differences among the various juices

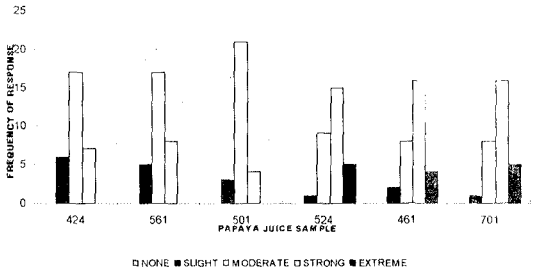


**Fig.4: Frequency Distribution of Panelists Response to Aroma**

**Yellow Flesh Variety**
424: Control Juice
561: Yeast Enzyme Extracted Juice
501: Standard Enzyme Extracted Juice

**Red Flesh Variety**
524: Control Juice
461: Yeast Enzyme Extracted Juice
701: Standard Enzyme Extracted Juice

(Fig.5). It is worth mentioning that panelists' rating of the red juices for color, aroma and

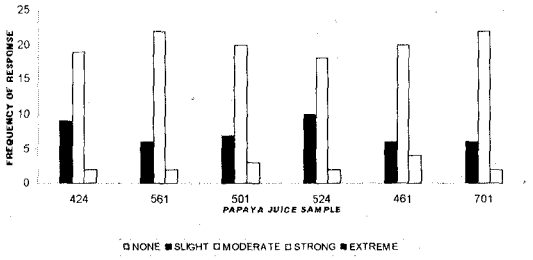


**Fig.5: Frequency Distribution of Panelist Response to Cloudiness**

**Yellow Flesh Variety**
424: Control Juice
561: Yeast Enzyme Extracted Juice
501: Standard Enzyme Extracted Juice

**Red Flesh Variety**
524: Control Juice
461: Yeast Enzyme Extracted Juice
701: Standard Enzyme Extracted Juice

overall acceptability as strong showed that the juice from the red variety was preferred to that of the yellow one. The panellists' overall response to taste, color, aroma, cloudiness and acceptability therefore showed that no significant differences existed between the enzyme-treated juices and the controls (Figs. 1–5). This was true for both the commercial enzyme and the locally produced yeast enzyme.

Based on the overall results, it is concluded that pectin enzymes produced locally and applied to pawpaw juice extraction could be as good as any commercial enzyme and thus should be investigated further on a semi-pilot scale to evaluate its possible use by local juice processors.

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