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Stabilization of Locally Produced Orange Juice Using Extracted Pectin from Banana Peels

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***Abstract*:** *The extraction of pectin from ripe Banana peels was done using 0.5M of hydrochloric acid (HCl) under the same temperature of 95oC at different time intervals; 1hour, 2hours, 3hours and 4hours successively at pH 2.7. Qualitative and quantitative analysis were carried out to determine the colour and the texture respectively of the extracted pectin. Characterization of the extracted pectin shows that the pectin was insoluble in cold water but dissolved when heated. Also, the pectin formed yellowish precipitates in Alkali solution and dissolves when heated. The pectin yield at different time interval is as follows: 3.5% for 1hr, 5.9% for 2hrs, 9.5% for 3hrs and 9.2% for 4hrs; indicating that at 95oC; ripe banana peel pectin has its highest yield when heated for three (3) hours with moisture content of 8.33 and a minimal ash content of 0.77%. The degree of esterification (45.56%) shows that the extracted pectin is low methoxyl pectin with Anhydrouronic acid content of 56.32% and equivalent weight of 881.06. These values showed that the pectin is low methoxyl pectin; which is characteristic of ripe banana peel. The pectin was found to stabilize fresh orange juice when 0.4grams of the powdered pectin was added to 100mL of the orange juice. It was also observed that the non-treated juice fermented after 24hours while the pectin-treated juice stayed for two more days before the traces of fermentation was noticed.*

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I. Introduction

Pectin is a word derived from Greek;meaning "congealed, and curdled". It is a structural heteropolysaccharide contained in the primary cell walls of terrestrial plants. It was first isolated and described in 1825 by Heneri Bracannot [1]. It is a mixture of polysaccharides that originated from plants, containing pectinic acids as major components, it is water soluble and able to form gels under suitable conditions [1, 2]. Pectin is subdivided according to their degree of esterification (DE); a designation of the percent of carboxyl groups esterified with methanol. Pectins with DE greater than 50% are high methoxyl pectin; those with DE lesser than 50% are low-methoxy pectin (LM-pectins). The degree of amidation (DA) indicates the percent of carboxyl group in the amide form. The gelatinization temperature ranges from 74-83oC [3]

Pectin is one of the main components of plants cell wall. This polysaccharide is composed of a back bone of (1-4) –linked α-D - galacturonic acid units [4]. The smooth, homogalacturonic regions are interrupted by having rhamogalacturonic regions where galacturonic units are interspaced with (1-2) – linked Rhamnosyl units which can be substituted by side chains containing arabinose and galactose [4]. Pectin has been reported to be well suited for applications in acidic food products, in dairy applications, Pharmaceutical and cosmetic applications [5].This research however, aims at extracting crude pectin from banana peels and using the extract for the stabilization of fresh orange juice.

II. Materials And Methods

Sample collection and identification

The sample was collected fresh from Agila, Ohimini Local Government, Benue State Nigeria and was identified in the department of biological sciences of Benue State University as *Musa accuminata.*

Sample preparation and storage

The sample was prepared using Castillo method with a little modification [6]. The Banana peels were dried under mild sun for two days and then the dried peels were cooled at ambient temperature according to "Castillo-Israel" [6] and were made into flour by pounding into homogeneity. The powdered banana peels were then stored in an air tight plastic container in a fume cupboard, ready for extraction.

Pectin extraction

The method by Emaga, Robart, Ronkart, Walhelet and paquot [3] was used for the pectin extraction. 5g banana peels powder was added to 150mL of 0.5 M HCl, pH 2.7. This was then heated with continuous stirring at 95°C in a stirring hot plate for 1, 2, 3 and 4 hours successively. The solutions were then cooled and filtered through an ordinary screen with 1-mm mesh size with two-layer cheesecloth. The filtrate was collected then

added with twice its volume of absolute ethanol. The precipitates were filtered through a Mira cloth sieve. The residue was oven dried for 2 days at 55°C and then weighed.

Pectin yield

The pectin yield was calculated using the equation:

Pectin yield (%) = P/Bi x 100

Where p = extracted pectin in gram and Bi = weight of alcohol-insoluble-residue (AIR) in gram

Pectin characterization

The dried pectin samples obtained from banana peels were subjected to quantitative test in order to determine the following characteristics.

Colour

This was done with visual observation

Solubility of dry pectin in hot and cold water

0.25g of the pectin extract each was placed in two separate sterilized conical flasks. 10mL of ethanol was then added to dissolve the pectin. Thereafter, 50mL of distilled water was added to both samples. The mixture in the second conical flask was shaken vigorously until a suspension was formed and was heated for 15minutes at 95oC [7].

Solubility of dry pectin in cold and hot alkali

1mL, 0.1M sodium hydroxide (NaOH) added to 5mL of pectin solution was carefully poured into two conical flasks. One of the flasks was heated at 90oC for 15minutes to dissolve the precipitates formed [7].

Equivalent weight

Equivalent weight is determined by titration with sodium hydroxide (NaOH) to pH 7.5 using phenol red. Pectin sample (0.5 g) was weighed into a 250mL conical flask and moistened with 5mL ethanol. 1.0 g sodium chloride was then added to the mixture followed by 100mL distilled water and three drops of phenol red indicator. Finally six drops of phenol red was added and titrated against 0.1 M NaOH until the colour of the solution changed to a pink at the end point. The colour change was persisting for 30 seconds [8]. Equivalent weight is calculated using the following equation:

$$\text{Equivalent weight (EW)} = \frac{\text{weight of sample (g)} \times 100}{\text{ML of alkali} \times \text{N of alkali}}$$

Methoxyl content

Methoxyl content is an important factor in controlling the setting time of pectin, the sensitivity to polyvalent cations and their usefulness in the preparation of low solid gels and fibers. Methoxyl content is determined using the neutralized solution obtained during the equivalent weight determination, containing 0.5g of pectin substance. 25mL of 0.25N NaOH was added to the neutralized solution used in the equivalent weight determination. The mixture was stirred thoroughly and allowed to stand for 30 minutes at ambient temperature. 25mL of 0.25N HCl (or an amount equivalent to base added) was then added and titrated against 0.1N NaOH to the same end point [9]. The methoxyl content is calculated using the equation below:

$$\text{Methoxyl content} = \frac{\text{mL of alkali} \times \text{normality of alkali} \times 31}{\text{weight of sample}}$$

Where 31 is the molecular weight of methoxyl (CH_3O)

Total Anhydrouronic Acid Content (TAUA)

Total anhydrouronic acid content is essential to determine the purity and degree of esterification, and to evaluate the physical properties. By using the values of the equivalent weight and the methoxyl content, the Anhydrouronic acid content is calculated by the expression given below [10]

$$\text{TotalAUA} = \frac{176 \text{ x } 0.1z \text{ x } 100}{w \text{ x } 1000} + \frac{176 \text{ x } 0.1y \text{ x } 100}{w \text{ x } 1000}$$

where:

Molecular unit of AUA (1 unit) = 176 g

z = mL (titre) ofNaOHfromequivalent weight determination

y = mL (titre) of NaOH frommethoxyl content determination

W = weight of sample

Degree of Esterification (DE)

The degree of esterification (DE) of pectin was determined according to the formula below [11].

$$\text{DE (\%)} = \frac{176 \text{ x MeC} \times 100}{31 \text{ x AUA (\%)}}$$

Where;MeC = methoxyl content.

Moisture content determination

In determination of moisture content, 1g of pectin sample was weighed, ground to pass 80-mesh screen, and placed into a metal dish (5cm in diameter with cover). The sample was dried in an oven for 5 hours at 100°C, cooled in a desiccator and then weighed. This was repeated until a constant sample weight was obtained. .

The moisture content was determined using the equation:

$$\text{Moisture content (\%)} = \frac{(\text{Weight of sample}) - (\text{weight of residue})}{\text{Weight of sample}} \times 100$$

Ash content determination

1g of pectin was ground to pass 80-mesh screen and placed into tarred crucibles then ignited in a furnace for 4 hours successively at 600°C. For the determination of the alkalinity of the ash, ash was dissolved in 25mL of 0.1 N HCl, heated gently to boiling and then cooled. It was then titrated with 0.1 N NaOH using phenolphthalein as an indicator [11] and the ash content determined using the formula below:

$$\text{Ash content (\%)} == \frac{\text{weight of Ash}}{\text{weight of sample}} \times 100$$

Pectin stabilization of fresh orange juice

100mL portion of the fresh orange juice was stabilized by adding 0.1-1g pectin with stirring. This was allowed to stand for 10minutes at 35oC. The same volume of the fresh orange juice which was not treated with pectin was used as a control.

III. Results

Table 1: Quantitative test

Parameter	Banana peels
Colour	Brown
Solubility in cold water	Insoluble
Solubility in hot water	Soluble
Solubility in alkali	Precipitates formed
Solubility in hot alkali	Soluble

Table 2: Qualitative test

Parameter	Banana peels
Pectin yield (%)	9.50
Moisture content (%)	8.33
Ash content (%)	0.77
Equivalent weight	881.06
Methoxyl content (%)	4.52
Anhydrouric acid (%)	56.32
Degree of esterification (%)	45.56

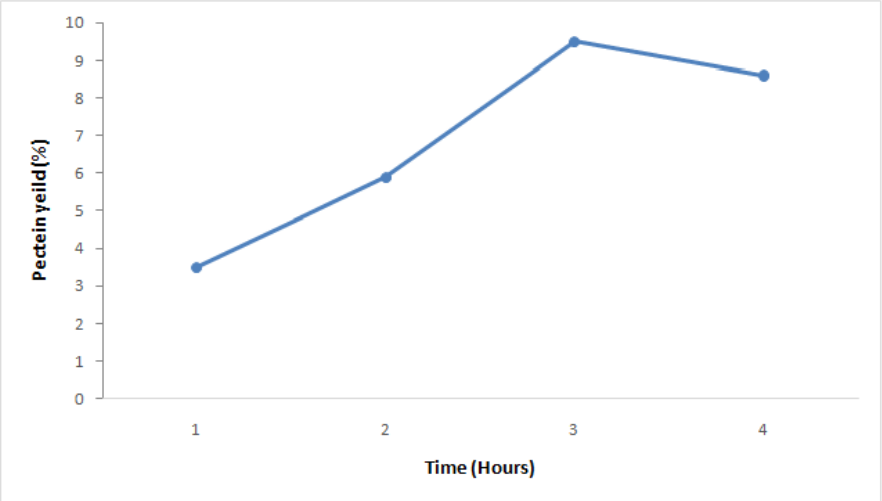

Figure 1: Effect of time on pectin yield at 95°C

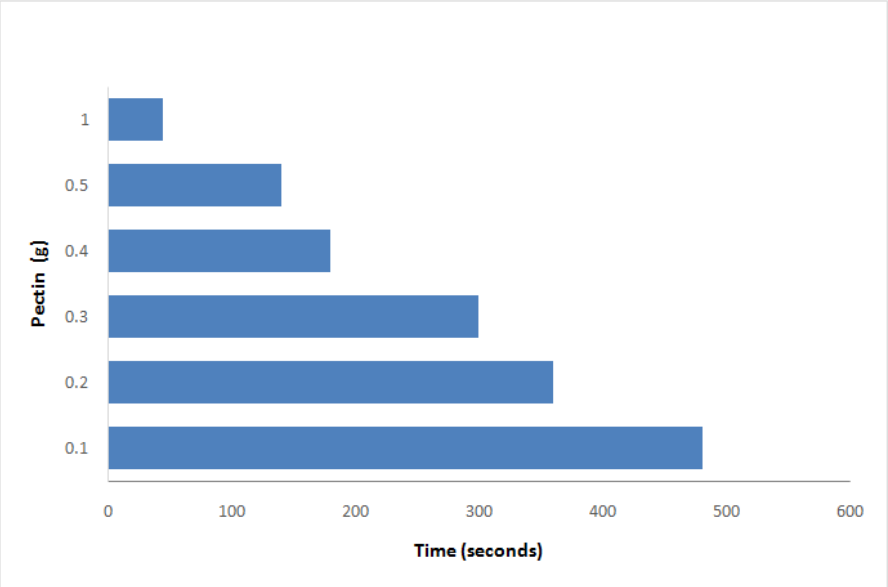

Figure 2 Effect of time on pectin-juice stabilization

IV. Discussion

From table 1, the colour and texture of pectin obtained from banana peels was brown. However, the quality seems to have deteriorated after seven days, as indicated by the change in colour from brown to dark brown. This could be due to environmental factors such as surface contamination, or due to the type of fruit samples used for the extraction [4].

Pectin from banana peels was insoluble in cold water but readily dissolved at temperature 80-95°C. When added to cold alkali solution it formed yellowish precipitation at the bottom of the conical flask, but when added to a slightly hot alkali it dissolved completely. This agreed with the fact that pectin is unstable in alkali solution [12].

The physicochemical characterization of pectin as shown in table 2 depends mainly on the raw material, source and conditions selected for isolation and purification of the pectin. The percentage yield of pectin from banana peel was 9.5%, which falls within range as reported by Ermias and teshom [12].The percentage yield of pectin using H2SO4 (which is a strong acid as the HCl used in this work) for banana peel powder, ranges from 5.82-11.33% [13]. Methoxyl content is an important factor in controlling the setting time of pectin, the sensitivity to polyvalent cations and their usefulness in the preparation of low solid gels and fibers which was calculated to be 8.33.The result shows that the anhydrouronic acid (56.32) and methoxyl (4.52%) contents were dependent on the material used and pH while equivalent weight (881.06) depends on extraction time. The high value of the equivalent weight is typical of banana peel pectin [13]. The degree of esterification of pectin can be classified as low methoxyl pectin (LMP) with DE of ≤ 50% and high methyl pectin (HMP) with DE of >50%. Therefore, the pectin extracted in this study is low methoxyl pectin normally used to gel low sugar juice, glazes and jams. The moisture content of the pectin is similar to that reported in literature. Low methoxyl pectin is necessary to inhibit the growth of microorganisms that can affect the quality due to the production of pectinase enzymes [13]. Ash content is used to determine the inorganic impurities in pectin and low ash content indicates good quality of pectin. Figure 1 above shows the effect of time on pectin yield, the pectin yield increased with increase in the extraction time at a constant temperature. A relatively long period of extraction would cause a thermal degradation effect on the extracted pectin. In addition, the colour of the pectin extract became dark brown for longer periods of extraction; which indicated that the extract might have required a higher amount of alcoholic washing of the precipitate.

The gelatizing (or stability) strength of the pectin extracted as seen in figure 2 shows that, the larger the amount of pectin added, the faster the juice was stabilized. The pectin was found to stabilize fresh orange juice best when 0.4g of the powdered pectin was added to 100mL of the orange juice at 35^{o}C. When 0.5 g of pectin was added to the same volume of orange juice, the colour of the juice was altered. It was also observed that after 24 hours, the pectin-untreated juice which was used as control, was found to ferment while the pectin-treated juice was stabilized for two more days before the traces of fermentation was noticed.

V. Conclusion

The degree of esterification of the extracted pectin from banana gave yield of less than 50%, indicating that the extracted pectin in this work is a low methoxyl pectin. This does not require the addition of sugar or acid (as in the case of highmethoxyl pectin) to gel but gel faster in the presence of Calcium. Conclusively, apart from the pectin being a good juice stabilizer among several other uses, it was found that the pectin could also preserve and increase the shelve life of juice.

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