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# Separation of Pectin from Cocoa Pods

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***Abstract***— *Cocoa is one of the plantation commodities which has an important role in the national economy. Cocoa production for 2014 in East Kalimantan reached 8106 tons/year. Cocoa production cannot be separated from the waste produced, namely cocoa shells. In the cocoa pod shell, there is a pectin content of 6-12%. This research aims to obtain pectin with the optimum yield and water content, equivalent weight and methoxyl content in accordance with the standards of the International Pectin Producers Association. The research was carried out using the hydrolysis method with the different concentration of the HCl solvent, namely 0.065N; 0.075N; 0.1N; 0.2N and 0.3N. 60g of ground dry cocoa shells were hydrolyzed with 750mL of HCl solvent for 2h at an operating temperature of 95°C. The hydrolysis results were added with 96% ethanol in a ratio of 1:1.5 (v/v) until a precipitate was formed, then filtered and washed then dried at 40°C for 8 hours. The optimum pectin yield obtained was 5.1981% at a HCl concentration of 0.1 N with an air content of 9.8452%, an equivalent weight of 1214.9930mg/mmol and a methoxyl content classified as low methoxyl pectin, namely 5.2204%.*

***Keywords***— *Cocoa, hydrolysis, pectin,yield.*

## I. INTRODUCTION

Cocoa is a plant that is widely found in Indonesia, especially from plantations that have a habitat to grow in tropical forests with a soil height of 1-600m above sea level, has good water availability, and an optimum temperature of $26.6^0$C [1]. It is one of the plantation commodities that has an important role for the national economy, namely as a provider of employment and a source of foreign exchange for the country. Cocoa production produces quite a lot of waste, one of which is cocoa husks whose production reaches 70% of cocoa fruit production [2]. So far, the part of cocoa that is more processed is the beans, while for cocoa peels, there are still not many who process them. Cocoa pods contain water and other chemical compounds. One of the chemical compounds found in cocoa pods is pectin compounds. Cocoa pods contain pectin compounds of 25-29% in young cocoa pods (mengkal) while in ripe cocoa pods by 8-11% [3]. Many industries in Indonesia use pectin, ranging from the food and beverage industry to the textile industry [4]. Pectin in the food and beverage industry is used as a thickener and stabilizer as well as a staple ingredient in the manufacture of jelly, jam and marmalade. In addition, pectin is also used in the pharmaceutical industry as a mixture in the manufacture of diarrheal drugs and as a thickening agent in the rubber industry.

Several previous researchers who conducted research on the production of pectin from cocoa shells, one of which is Akmaluddin and Kurniawan (2009)[5], with the variable being pH HCl solution as well as the hydrolysis time and temperature. From the study, the optimum pH condition was obtained at 2.8; time 2h and temperature of 95°C produced pectin with a yield of 14.18% or 2.836g and a methoxyl content of 3.534%. Furthermore, Aisyah, et al. (2020)[6] improved the quality of pectin with the formulation of extraction pH (1.5; 2 and 2.5) in cocoa shell waste. From the results of the study, pectin results were obtained with a moisture content of 11.92% – 11.96%, ash content of 4.87 – 7.87%, with a methoxyl content of 4.96% – 7.36%. Other research conducted by Nadir and Risfani (2018)[7], Erwinda (2020)[8] and Prasetyo (2023)[3] produced the highest yield of 5.74%, namely at a ratio of 1:20 with pectin characteristics, namely moisture content of 11.45%, ash content of 0.96%, equivalent weight of 621.30mg, methoxyl content of 5.17% (low methoxyl pectin), galactic acid content of 48.09%, esterification degree of 61.09% (high ester pectin). From some of the studies above, the production of pectin from cocoa shells is carried out with various variations of process variables using HCl solvents.

This study aims to obtain pectin with the best yield as well as moisture content, equivalent weight and methoxyl content in accordance with the International Pectin Producers Association (IPPA) standards with variations in HCl solvent concentration.

## II. METHODOLOGY

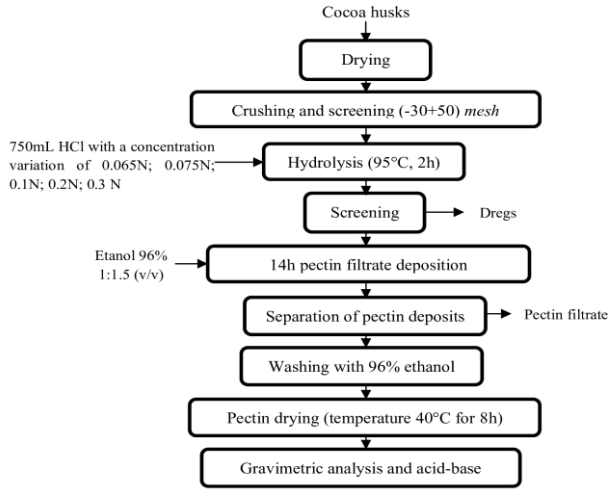


Fig. 1. Research flow chart.

Figure 1 below is a research flow chart that explains how this research was carried out. 60g of dried cocoa shells that have been mashed, hydrolyzed with 750mL of HCl solvent



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with a concentration of 0.065N; 0.075N; 0.1N; 0.2N; 0.25N and 0.3N for 2h at 95°C operating temperature. The hydrolyzed filtrate is added with 96% ethanol in a ratio of 1:1.5 (v/v) until a precipitate is formed. The sediment is then filtered and washed and then dried at 40°C for 8h. Furthermore, gravimetric analysis and acid-base titration were carried out on the pectin products produced.

## III. Result and Discussion

Pectin yield is the percentage of pectin obtained after the drying process of wet pectin from precipitation. The pectin yield of cocoa husks produced in this study ranged from 2.1617% – 5.1981% as shown in Table 1.

TABLE I. Characteristics of pectin in hydrolysis process with HCl solvent concentration variation.

| No | Characteristic | IPPA Standards | Hydrolysis Process | | | | |
|---|---|---|---|---|---|---|---|
| | | | HCl 0.065 N | HCl 0.075 N | HCl 0.1 N | HCl 0.2 N | HCl 0,3 N |
| 1 | Yield (%) | - | 2.1617 | 2.5243 | 5.1981 | 3.4830 | 2.8307 |
| 2 | Moisture content (%) | Max 12 | 8.2167 | 9.2261 | 9.8452 | 10.5517 | 11.2669 |
| 3 | Equivalent weight (mg/mmol) | 600-800 | 3072.343 | 1523.8 | 1214.9 | 386.0449 | 312.7237 |
| 4 | Methoxyl content<br>Low methoxyl<br>High methoxyl | 2.5 – 7.12<br>>7.12 | 2.7216 | 3.5794 | 5.2204 | 3.2187 | 2.8020 |

According to Sufy (2015), the higher the acid concentration, the more pectin will be produced. This is due to the overhaul of protopectin that is not easily soluble into easily soluble pectin by hydrolysis using acid. Higher concentrations of HCl will cause more hydrogen ions to substitute calcium from protopectin and cause the hydrolysis process of prototechin to pectin faster. So that with a lot of calcium substituted, the amount of pectin obtained will be more.

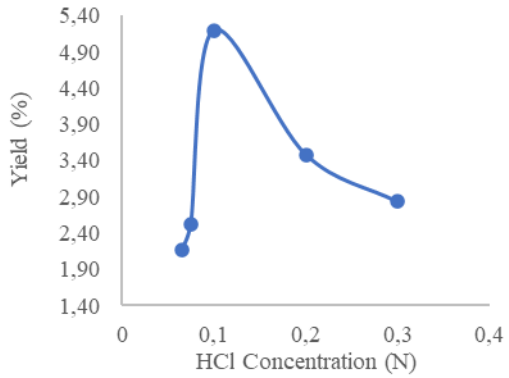


Fig. 2. Effect of HCl solvent concentration on pectin yield.

Based on Figure 2, the pectin yield obtained increased along with the increase in HCl concentration until the optimum HCl concentration was obtained (at an HCl concentration of 0.1N which resulted in a yield of 5.1981%). However, at HCl concentrations of 0.2N and 0.3N, there was a decrease in yield. It is due to high concentration of acid will cause the pectin hydrolysis into pectic acid, thus causing the yield obtained tends to decrease.

Based on Figure 3, the pectin moisture content increases along with the increase in the concentration of HCl. This results in shorter chains of pectin molecules so that the opportunity to absorb water becomes more and causes pectin to dissolve easily in water. The moisture content of pectin obtained ranged from 8.2167% - 11.2669%. The maximum pectin moisture content according to IPPA standard is 12%, thus the pectin moisture content in this study still fulfils the standard.

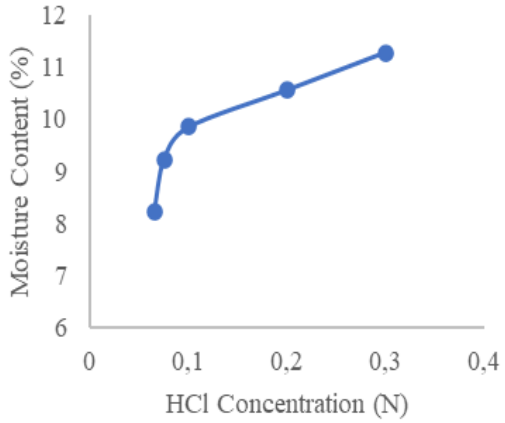


Fig. 3. Effect of HCl solvent concentration on pectin water content.

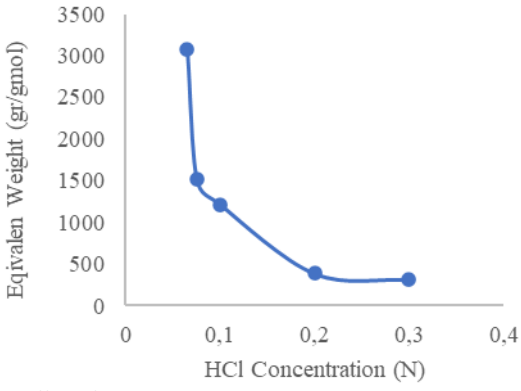


Fig. 4. Effect of HCl solvent concentration on pectin equivalent weight.

According on Figure 4, the equivalent weight of pectin decreases with the increasing concentration of HCl. This is because high acid concentrations will increase the possibility of deesterification of pectin into pectic acid, where this pectic acid has a lower equivalent weight when compared to the pectin equivalent weight. The optimum pectin equivalent weight was obtained at HCl concentration of 0.1N, which was 1214.9930 mg/mmol. The standard of pectin equivalent weight according to IPPA standard was 600-800 mg/mmol.



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Thus, the pectin produced in this study has an equivalent weight that does not fulfils the standard.

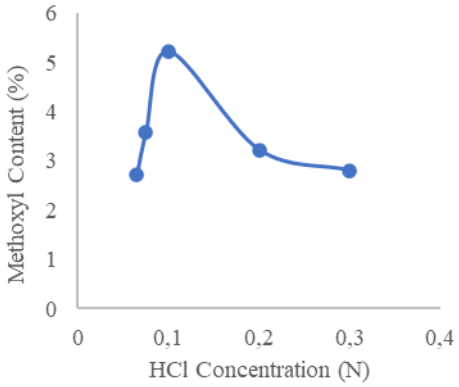


Fig. 5. Effect of HCl solvent concentration on methoxyl content.

Methoxyl pectin content is influenced by the concentration of the HCl. The higher the acid concentration, the faster the hydrolysis reaction of protopectin into pectin, so that more carboxyl groups will be esterified to become methyl esters. Based on Figure 5, the methoxyl pectin content obtained increased as the HCl concentration increased until the optimum methoxyl content was obtained, namely at a HCl concentration of 0.1 N which produced a methoxyl content of 5.2204%. At HCl concentrations of 0.2 N and 0.3 N, there was a decrease in methoxyl contents. This is because when the acid concentration is too high, pectin will experience deesterification to become pectic acid, where in pectic acid the galacturonic acid content is free from methyl ester. The contents of methoxyl pectin obtained in this study ranged from 2.7216 – 5.2204%. The low methoxyl pectin standard according to IPPA ranged from 2.5 – 7.12%, so the pectin produced in this study was included in the low methoxyl pectin category.

## IV. Conclusion

From this study, it can be concluded that the pectin with the best yield was obtained at an HCl concentration of 0.1N, which was 5.1981% with a moisture content of 9.8452%, an equivalent weight of 1214.9930mg/mmol and a methoxyl content of 5.2204%. The moisture content and methoxyl pectin content produced are in accordance with IPPA quality standards, but the equivalent weight obtained is still not fulfils with IPPA quality standards.

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