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Optimization Of Potassium Extraction Method From Corncob Waste (*Zea Mays* L.) Using Aquadest

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ABSTRACT

Abstract

The purpose of this study was to determine the optimal extraction method of potassium from corn cobs in semibatch and batch. In this research, semibatch maceration is a leaching process used to obtain the time needed for the solvent to absorb alkali in corn cob ash. While the batch system maceration is a leaching process used to obtain the amount of time needed for the solvent to reach saturation point. Data collection techniques in this research are: sample preparation and drying of corn cobs, corn cobs pyrolysis, semibatch and batch maceration of corn cobs ash, and determination of alkali content by titration method. From the results, it can be concluded that corn cobss have the potential to be used as a source of alkali because the potassium (K) content in corn cob ash is 25.78%. The moisture content and yield of corn cob ash were 77.5% and 17%, respectively. The saturated solvent time for semibatch maceration was 3.5 days, while for batch maceration it was 12 days. Where at consecutive ratios of 1 gram/25 mL; 2 grams/25 mL; 3 grams/25 mL; and 4 grams/25 mL each had concentration values that still increased from 0.112 N to 0.9672 N; 0.223 N to 3.2364 N; 0.3348 N to 2.0646 N; and 0.558N to 3.6828 N. The highest alkali yield was obtained at a corn cob ash/solvent ratio of 1 gram/25 mL, which was 20.15%.

Keywords: *alkali, corn cobs, maceration, semibatch, batch*

1. INTRODUCTION

North Sumatra is one of the provinces that is rich in natural resources. Especially in the field of crop agriculture. Among the several sources of crop cultivation produced in North Sumatra are plants that contain a lot of carbohydrates such as rice, wheat, corn, and many more. Corn is one of the food commodities that is often found in various regions of North Sumatra. Sometimes corn is used as the main food ingredient to replace rice and other food ingredients. So that consumer demand for corn is increasing. According to the Central Bureau of Statistics (BPS) predicts, the national corn harvest area in 2023 recorded corn production in North Sumatra Province is 1,314,467.47ton with a harvest area of 14,460,601.32 ha and productivity (yield per hectare) of 63.05 (ku/ha)[1].

Corn cobs are one of the waste products of industrial agricultural activities. Increased corn production causes a relatively large amount of corn cob waste[2]. Corn cobs have a high cellulose content of 44.1% and hemicellulose content of 32.7% and lignin content of 19.9%. This proves that corn has the potential as a biomass that produces cellulose acetate[3].

Figure 1. Corncob Waste

Corn cob ash has a very high mineral content. Where one of the minerals contained in corncobs is potassium. The potassium content in corncobs is 38.76% in the form of K_2CO_3[4]. Considering the great potential of potassium in corn cobs, it is necessary to conduct research on alkaline maceration of corn cobs. The reason for choosing the maceration method is that it has many advantages compared to other leaching methods. The main advantages of maceration method are that the procedures and equipment used are simple, only a soaking vessel is needed, relatively economical because the solvent used is water, and does not damage the structure of the extracted ash because it is without heating, so it can be easily implemented among the community[5].

Ash is an unburnable inorganic material from a fuel source that remains after complete combustion and contains the mineral fraction of the biomass. Ash content is a mixture of inorganic or mineral components contained in a material. Organic materials burn in the combustion process, but the inorganic components do not, hence the term ash content. The ash content and its composition depend on the type of material and the method of ignition[6].

Alkali metals are a group of elements in the Periodic Table of the Elements in Group IA. The elements in this group have a valence electron that is easily lost, so these elements tend to form positive ions in chemical reactions. The alkali metal elements are Li (lithium), Na (sodium), K (potassium), Rb (rubinium), Cs (cesium), and Fr (francium). Alkali metals tend to react with water and nonmetals to form ionic compounds and strong bases. These elements also have high electrical and thermal conductivity typical of metals. The abundance of alkali elements in the buni crust is estimated to be 3.1% sodium, 2.8% potassium, 0.5% rubidium, 0.1% lithium, very little sensium, and only a little fransium because it is radiative[7].

Maceration is a simplex extraction technique performed on materials or simplexes that are not heat resistant by soaking in a specific solvent for a specific time. Maceration is carried out at room temperature of 20-25°C to prevent excessive evaporation of solvents due to temperature factors and stirring for 15 minutes so that the ingredients and solvents are mixed. Maceration is the most commonly used simple method. This method is suitable for both small scale and industrial scale[8]. The working principle of maceration is the process of dissolving the active ingredient based on its solubility in a solvent (as dissolved as)[6]. The smaller the particle size, the easier the solvent will diffuse into the tissues of the material, so the process of extracting compounds from the material is more effective[9].

The process is performed by soaking the simplisia powder in a solvent. The solvent penetrates the cell wall and enters the cell cavity containing the active ingredient. The drug will dissolve due to the difference in concentration between the drug solution inside the cell and outside the cell, causing the concentrated solution to be pushed out. The process is repeated until there is an equilibrium concentration between the solution outside the cell and inside the cell. The advantage of the maceration method is that the procedure and equipment are simple[10].

Considering the great potential of potassium in maize cobs (*Zea mays* L.), it is necessary to conduct research on alkaline maceration of maize cobs (*Zea mays* L.).The reason for choosing the maceration method is because it has many advantages compared to other leaching methods. The main advantages of the maceration method are that the procedure and the equipment used are simple, only a soaking vessel is needed, relatively economical because the solvent used is water, and does not damage the structure of the extracted ash because it is without heating, so it can be easily implemented in the community.

2. EXPERIMENTAL

2.1 Raw Materials and Tools

In this study, the main materials used were corncobs and Aquadest. While the analytical materials include hydrochloric acid (HCl), phenolphthalein and basic buffer solution. The main equipment used include an oven, porcelain beaker, Erlenmeyer flask, desiccator, glass funnel, filter paper, graduated beaker, and stirring rod. While the analytical equipment includes stands and clamps, burettes, dropping pipettes, analytical balances, pH meters, and beakers.

2.2 Procedure for Ash Preparation

The procedure for making corn cob ash is 200 kg of fresh corn cobs were dried in the sun for 3 days and then the weight of the corn cobs after drying was weighed. The dried corn cobs were cut into pieces and put into a cup, and then the cup was stacked in a muffle furnace. The incineration process of corn cobs was carried out at 550°C for 5 hours. The corncob ash was cooled using a desiccator. The ash was weighed using a digital balance and then analyzed by X-ray fluorescence (XRF) for its composition.

2.3 Procedure for Maceration of Corncob Ash

a. Semibatch Maceration System

The procedure of maceration of corncob ash with semibath system is: First research using a ratio of 1 gram of corncob ash / 25mL of distilled water. Corn cob ash was weighed as much as 16 grams and then put into Erlenmeyer (500 mL). The solvent of distilled water was added as much as 400 mL into the Erlenmeyer, then closed with aluminum foil and allowed to stand at room temperature without being treated with stirring. After 12 hours, 20 mL of the solution was sampled and then analyzed for the value of alkaline extract content of corn cobs. Samples were taken at intervals of 24 hours, 36 hours, 48 hours, 60 hours, 72 hours, and 84 hours at 20 mL each. Sampling was stopped until the alkaline extract content was constant. The same treatment was performed at the ratio of 2 g corn cob ash / 25 mL distilled water; 3 g corn cob ash / 25 mL distilled water and 4 g corn cob ash / 25 mL distilled water.

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b. Batch Maceration System

The procedure of maceration of corncob ash with batch system is as follows: First research using the ratio of 1 gram of corncob ash / 25mL of distilled water. 32 grams of corncob ash were placed in a 1000 mL conical flask. The solvent of 800 mL of distilled water was added to the Erlenmeyer, then covered with aluminum foil and allowed to stand for 3 days. The filtrate was filtered with filter paper, then the volume of the alkaline filtrate was measured and then 20 mL of the extract obtained was taken to analyze its content. Corn cob ash was then added to the filtrate from the first filtration in the same ratio of 1 gram of corn cob ash / 25 mL of distilled water and allowed to stand for 3 days. The filtrate was filtered through filter paper, then the volume of the alkaline filtrate was measured, then 20 mL of the extract was taken to analyze its content. Corn cob ash was then added to the filtrate from the second filtration in the same ratio of 1 gram of corn cob ash / 25 mL of distilled water and then allowed to stand for 3 days. The filtrate was filtered with filter paper, then the volume of the alkaline filtrate was measured and then 20 mL of the extract obtained was taken to analyze its content. The study was continued until the content of the alkaline extract was constant. The same treatment was carried out with the ratio of 2 grams of corncob ash / 25 mL of distilled water; 3 grams of corncob ash / 25 mL of distilled water and 4 grams of corncob ash / 25 mL of distilled water.

3. RESULTS AND DISCUSSION

The use of corn cobs as a source of alkali can be done in 3 stages, the first is the reduction of corn cob moisture content, the second is the process of igniting corn cobs using a furnace, and the third is the extraction process of corn cobs.

3.1 Corn Cob Moisture and Ash Content

Figure 2 shows a graph of corn cob mass reduction during raw material preparation:

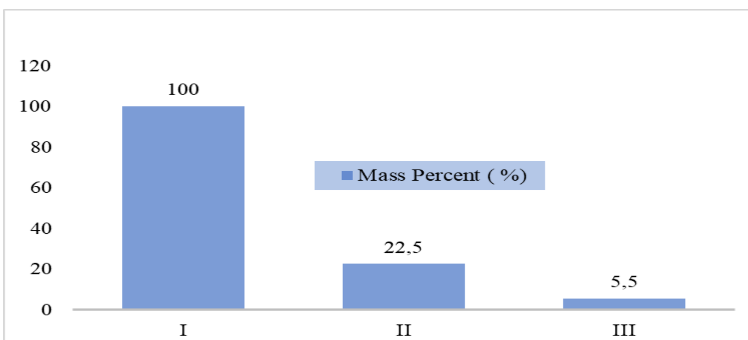

Figure 2. Mass Reduction Percentage of the Sample

In part I (wet corncob), the mass of the corncob was initially 500 grams. Then the drying process was carried out to reduce the water content of the sample. The wet corn cobs were dried in the sun for 4 days. In part II (corn cobs after drying), the results of drying corn cobs reduce the moisture content of the sample to 77.5% of the initial weight, so that the mass of corn cobs becomes 112.5 grams. Part III (corn cobs after ashing) shows the remaining mass of the corn cobs after ashing, the result of ashing removes the organic content from the sample, leaving ash.

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3.2 Mineral Content of Corncob Ash

The dried corn cobs were cut into small pieces, weighing 50 grams, and then pyrolyzed using a muffle furnace at a combustion temperature of 550 ºC for 5 hours. The pyrolysis of the corn cobs left behind 17.4% of ash from the initial weight. The resulting ash was analyzed using X-ray fluorescence (XRF) analysis to determine the components contained in the corn cob ash. The results from this analysis are shown in the following table:

Table 1. Mineral Content of Corncob Ash

Component	Weight Percent (%)
Potassium (K)	25.78
Silicon (Si)	31.336
Calcium (Ca)	22.35
Phosporus (P)	5.71
Iron (Fe)	5.07

From Table 1 above, the potassium content of corn cob ash is 25.78 %.

3.3 Effect of Time on Concentration (N) of Semibatch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

The following graph shows the change in alkaline extract concentration from the sieving results of the semibatch maceration. For the semibatch process, the ash extract was sieved every 12 hours and the filtrate was analyzed. Sampling was stopped until the extract concentration was constant (reaching saturation point). The filtrate was analyzed by the titration method using hydrochloric acid (HCl) as pentiter to determine the concentration of bases contained in the maceration results.

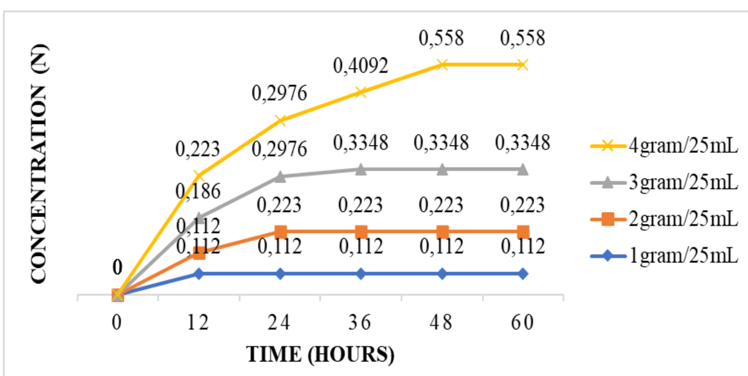

Figure 3. Graph of Effect of Time on Concentration of Semibatch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

From Figure 3, it can be seen that the longer the maceration time, the more the concentration of alkaline extract increases. The contact time between the solvent and the extracted material is very necessary. The increase in concentration indicates that the alkali diffusion process is taking place in the solvent. This shows that the greater the amount of solids to be absorbed, the longer the extraction time will be[11].

Wash time is the time required by the solvent to remove the compounds contained in the cell. The solvent will stop attracting compounds when the solvent is saturated and there is no longer a difference in concentration[5]. From Figure 3, the washing time value of semi-batch maceration at a ratio of 1 gram/25 mL is 24 hours, at a ratio of 2 grams/25 mL is 36 hours, at a ratio of 3 grams/25 mL is 48 hours, while 4 grams/25 mL is 60 hours. This value is obtained from the first time the extract has a constant concentration.

3.4 Effect of Time on Concentration (N) of Batch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

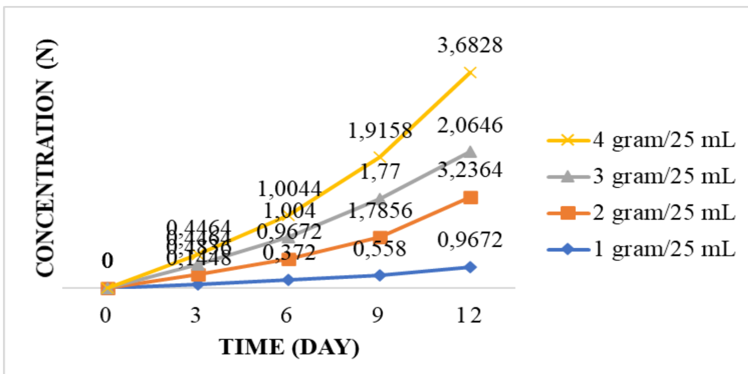

Figure 4. Graph of Effect of Time on Concentration of Batch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

The purpose of this batch maceration is to determine the amount of alkaline extract concentration experiencing saturation conditions (constant extract concentration), which is a condition of solvent saturation. Figure 4 shows the effect of solids turnover time on the concentration of alkaline ash extract produced. It is necessary to increase the contact time between the solvent and the extracted ash. The increase in concentration in this process shows that there is still a diffusion process of alkali in the solvent. The following graph shows the change in normality of the alkaline extract from the batch maceration results.

After conducting semi-batch and batch maceration experiments, differences in alkaline extract concentration values were obtained. At successive ratios of 1 gram/25 mL; 2 grams/25 mL; 3 grams/25 mL; and 4 grams/25 mL, the concentration value still increased from 0.112 N to 0.9672 N; 0.223 N to 3.2364 N; 0.3348 N to 2.0646 N; and 0.558 N to 3.6828 N. This shows that the maceration process still takes place as long as the solvent does not reach saturation conditions (alkali concentration in ash and solvent is in equilibrium state).

3.5 Effect of Time on pH of Semibatch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

The purpose of analyzing the pH of the alkaline extract in this experiment is to determine the presence or absence of alkaline content in the solution. The tool used to determine the pH of the solution is a pH meter. The following is a graph showing changes in the pH of the alkaline extract from the results of the semibatch maceration sieving.

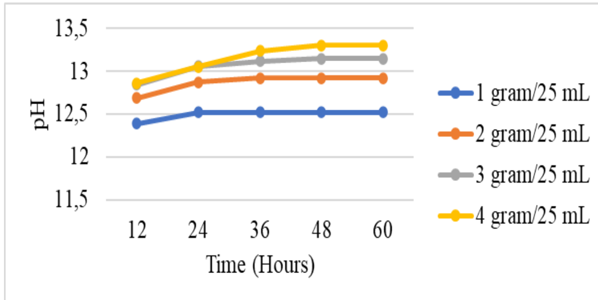

Figure 5. Effect of Time on pH of Semibatch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

Figure 5 shows that the longer the maceration time and the higher the ash ratio, the higher the pH of the extract. This is because the alkali (K) contained in the ash reacts with the distilled water solvent to form potassium hydroxide (KOH), which is alkaline[12].

Based on the experimental results, for semibatch maceration, the pH of the alkaline extract is constant at a ratio of 1 gram/25 mL; 2 grams/25 mL; 3 grams/25 mL; and 4 grams/25 mL of 12.52; 12.92; 13.15; and 13.3, respectively.

3.6 Effect of Time on pH of Batch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

Based on the experimental results, for batch maceration, it was found that the pH of the alkaline extract was constant for 12 days. In the experimental results obtained by changing the ratio, there is a significant increase in pH because the ratio of each maceration stage is increased. Thus, the alkaline content in the extract becomes higher. The following graph shows the change in pH of the extract from the batch maceration results.

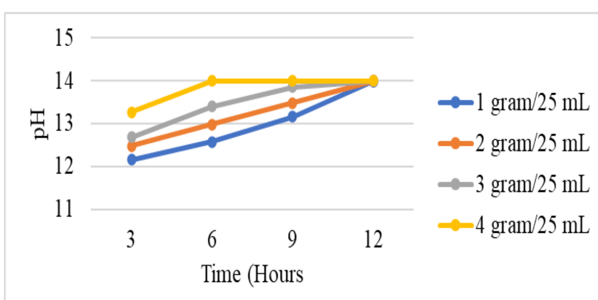

Figure 6. Effect of Time on pH of Batch Macerated Alkaline Extract at Various Corn Cob Ash/Solvent Ratios

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Figure 6 shows that the longer the maceration time and the higher the ash ratio, the higher the pH of the extract. This indicates that the alkali content in the extract becomes higher. Alkali (K) contained in the ash, when reacted with water (H_2O), produces potassium hydroxide, which is alkaline[12].

3.7 Relationship Between pH and Concentration (N) of Alkali Ash Extract in Semibatch Maceration

The following graph shows the relationship between pH and concentration (N) of alkaline extract at various ratios:

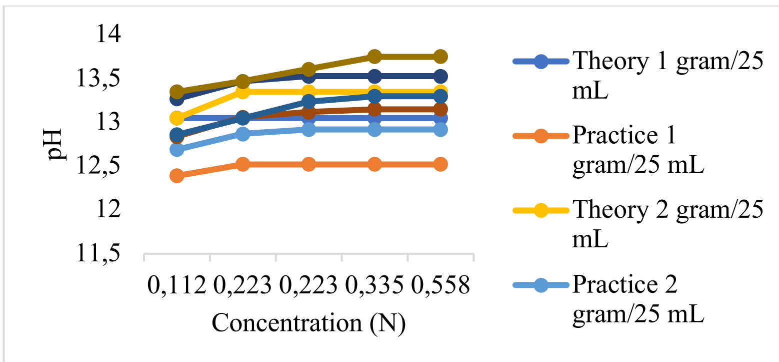

Figure 7. Graph Relationship Between pH and Concentration (N) of Alkali

Figure 7 shows the graph of the relationship between pH and concentration (N) of the produced alkaline extract. The theoretical value on the graph is obtained from the titration of the alkaline extract, while the practical value on the graph is obtained from the measurement of the pH meter of the alkaline extract. From the results of the experiments carried out, by comparing the results of the analysis in theory and practice, there are still differences in the results of obtaining alkali levels. The errors obtained from the comparison of theoretical and practical values for successive ratios of 1 gram/25 mL; 2 grams/25 mL; 3 grams/25 mL; and 4 grams/25 mL have errors of 3.98%; 3.22%; 2.81%; and 3.27%, respectively. This is due to the instability of the pH meter used during pH analysis.

3.8 Relationship Between pH and Concentration (N) of Alkali Ash Extract in Batch Maceration

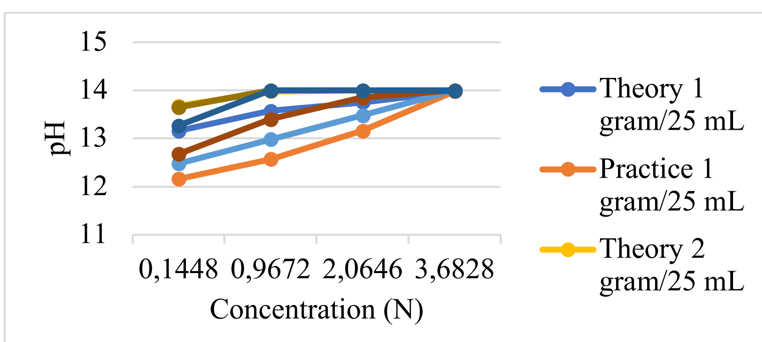

Figure 8. Graph Relationship Between pH and Concentration (N) of Alkali

Figure 8 shows the relationship between pH and concentration (N) of the alkaline extract produced. The pH and concentration are related. The higher the concentration of the alkaline extract, the higher the pH of the solution. The determination of the alkali content in the extract can be seen from the concentration value or the pH value.

4. CONCLUSION

After conducting a series of activities including methodology, testing, analysis, and discussion, several key conclusions were drawn from this experiment. Corn cobs have proven potential as a source of alkali, with potassium (K) content in corncob ash reaching 25.78%. Additionally, corn cobs exhibit high water content, at 77.5%, and an ash yield of 17%. The duration of maceration has a directly proportional effect on the concentration and pH of the alkaline extract, where longer maceration times result in higher concentrations and pH levels. The washing time for semi-batch maceration was recorded at 3.5 days, while batch maceration required 12 days. The ratio of corncob ash to solvent also directly influences the concentration and pH of the alkaline extract, with higher ratios yielding higher values. Furthermore, the concentration and pH of the alkaline extract in batch maceration experiments were higher than those in semi-batch maceration. These findings highlight the potential of corn cobs as an effective source of alkali and provide a basis for optimizing extraction processes.

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