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Cooking ability of *Manihot esculenta crantz* as new pulp raw material with *Eucalyptus* and *Acacia mangium* wood comparison using kraft pulping method

B Irawan, V Ardina, D H Prajitno, A Roesyadi[1]
Department of Chemical Engineering, Faculty of Industrial Technology Sepuluh Nopember Institute of Technology (ITS)
Kampus ITS Sukolilo, Surabaya 60111, Indonesia

E-mail: aroesyadi@yahoo.com

Abstract. This research used *manihot esculenta crantz* of 8-10 months old, *eucalyptus* and *acacia mangium* wood of 5-year-old. The active alkali (AA) charge variations of 16% to 20% with 1% intervals. The sample position of composition of *manihot esculenta crantz* wood was 0-22 cm above ground level. The density of *manihot esculenta crantz, eucalyptus* and *acacia mangium* were 480 g/cm^3, 483 g/cm^3 and 499 g/cm^3, respectively. Base on FTIR analysis, have the same dominant functional groups. The average total yield *manihot esculenta crantz* were lower than *eucalyptus* or *acacia mangium* of 12.422% and 24.92% respectively and screen yield *manihot esculenta crantz* were lower than *eucalyptus* or *acacia mangium* of 13.678% and 26.85% respectively. Each AA charge increase of 1% in *manihot esculenta crantz, eucalyptus* and *acacia mangium* can decrease the total yield by 0.635%, 0.803% and 1.14% , the screen yield decreased by 0.543%, 0.563% and 2.196% respectively. The mean of KaNo difference of *manihot esculenta crantz* higher than *eucalyptus* or *acacia mangium* of 7.038 and 5.236 respectively. Each 1% increase in AA charge may decrease the average KaNo of *manihot esculenta crantz, eucalyptus* and *acacia mangium* were 7.693%, 3.778% and 6.628% also decreased viscosity by 3.70%, 2.99% and 0.974% respectively.

Keywords: *Manihot esculenta crantz*; Kraft Pulping; KaNo; Active Alkali; Delignification.

1. Introduction

Paper is an indipensable material in daily lie. The raw material of paper making is pulp. While the raw material of pulp is cellulose (fiber) which in this case is taken from wood. A*cacia mangium, acacia crasicarfa* and *eucalyptus* used as raw material in the pulping process [1]. The availability of raw materials used in the pulping process needs a sustainable system. About 91% of pulp and paper production in the world have been used wood as raw material, especially in developing countries [2]. Recently there have been efforts to replace wood from non-wood materials [3]. Non-wood used as pulp and paper raw material has increased by 10% over the last two decades, while the use of wood fiber has increased by only 4% [4]. To create a sustainable condition, it is necessary to look for some

[1] To whom any correspondence should be addressed.

alternative raw materials as a replacement or a mixture of raw materials that already exist. As an alternative raw material, it can be used other types of wood such as cassava wood (*manihot esculenta crantz)*. Unused cassava stems are lignocellulose waste, which is an organic component. Based on laboratory analysis, the plant stems contained 56.82% α cellulose, lignin 21,72%, ADF 21,45% and fiber length 0,05 - 0,5 cm [5]. To ensure the eligibility of *manihot esculenta crantz* wood, it is necessary to evaluate the wood cooking capability. The *manihot esculenta crantz* stems of 90% are rejected as waste, while 10% of the stems are used as seed for replanting [5]. This research used *manihot esculenta crantz* composite wood was 8 to 10 months old. *Eucalyptus* and *acacia mangium* wood 5 years old as a comparison. Pulping is performed to reduce wood or other fibrous material into a fibrous mass through chemical reactions. During pulping, lignin, cellulose and hemicelluloses are attacked and degraded by chemicals [6]. Kraft pulping is a chemical pulping method using sodium hydroxide and sodium sulfide to separate cellulose with lignin [7]. The alkali consumed in the impregnation stage affected the alkali profile of the cooking stage. The more alkali consumed in impregnation, the lower the demand in cooking. Higher alkali consumption in the impregantion stage also led to faster delignification in the cooking stage [8] Lignin will be extracted by NaOH during heating the cooking process by following the difference in NaOH concentration [9]. Delignification can be influenced by various reaction parameters such as temperature, reagent loadings and time [10]. The kraft process was chosen because it has several advantages over other mechanical or chemical pulp processes. Some of the advantages kraft process are [11].

1. Able to process various types of wood both similiar and mixed
2. Cooking time is relavely short.
3. The yield and quality of pulp produced is quite high

The phenomenon that occurs in the kraft pulping process is the consumption of alkali with events such as [12]:

1. Reaction with lignin
2. Dissolve carbohydrates
3. Reacting with some organic acids, whether derived from wood or derived from the process.
4. React with resin in wood
5. Absorption by fiber.

The effect of kraft cooking occurs at the impregnation stage takes place at 130ºC for 30 minutes [11]. Kraft pulping, which cleaves the β-O-4 linkages between the C9 units in lignin by sulfide at alkaline environment and up to 170 °C [13]:

O-R1-O-R2 + OH−→O=R1OR2

O=R1OR2+HS−→O-R1S+R2Ona (fragmented)

The degree of polymerization indicates the level of cellulosic degradation during the cooking process. The higher the DP value, the stronger cellulose (fiber) in cellulose degradation events. The solubility of cellulose in soda decreases as the degree of polymerization increases [9].

2. Methodology

2.1. Material

In this research, *manihot esculenta crantz* wood, *eucalyptus* and *acacia mangium* were taken from Jambi province. Wood age *manihot esculenta crantz* was 8-10 months, while *eucalyptus* and *acacia mangium* were 5 years old. The chips size of the three woods was 10-30 mm long 3-6 mm thickness.

2.2. Methods

The purpose of this research is to know the quality of pulp from kraft pulping process for *manihot esculenta crantz* wood as new pulping raw material. The *eucalyptus* and *acacia mangium* were comparator. Wood test parameters are wood composition, FTIR and density.

The pulp test parameters are total yield, screen yield, KaNo and viscosity. The cooking process condition were variation of AA charge 16% to 20% and variation 1% , sulfidity 25%, liquid ratio 3,5, H-factor 800 and maximum temperature 165ºC. The washing process was done by adding water and agitated. The aims to decipher the pulp that was formed. The screening process was done in two stages with screen 0,15 mm slot and 325 mesh.

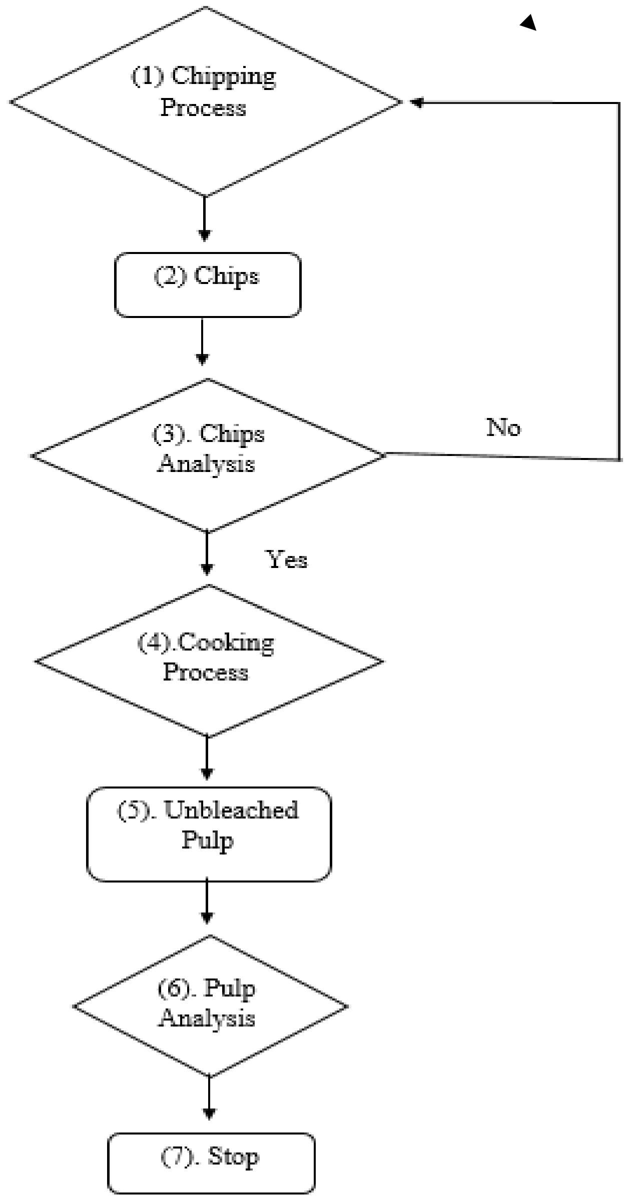

Figure 1. A series of pulping process workflow.

2.3. Instrumentation

This research the main equipment was a set of rotary digester and filter pulp with screen size of 0.15 mm slot and screen 325 mesh used sequentially as Figure 2.

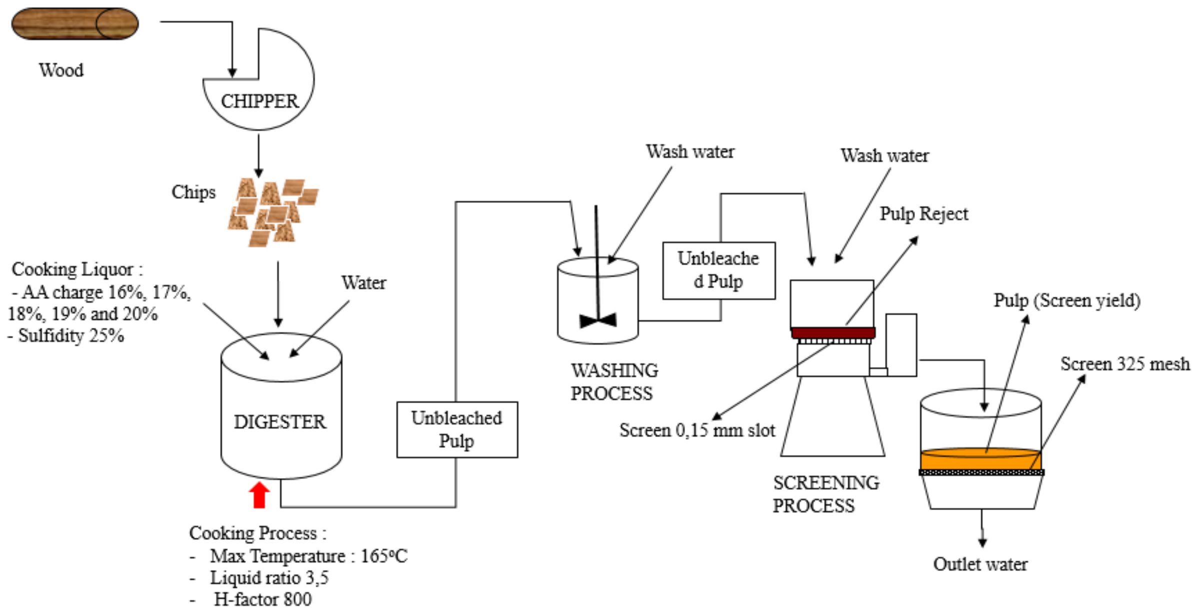

Figure 2. A series of work tools and pulping process flow including cooking, washing and screening processes.

2.4. Wood analysis

Parameter of wood gravimetry analysis in this research was wood composition in the tree, basic density of wood and FTIR analysis of wood. The wood composition in the tree was analyzed based on the proportion of dry weight of the wood component to the total weight with the sample position along the 22 cm distance from above the soil surface with a variation of 2 cm. Basic density was analyzed by using TAPPI-T258-om 2 analysis method in maximum moisture condition [14].

2.5. Cooking process

Cooking process was done by using mini digester Haato 6 chamber with maximum capacity 300 gr each of OD chips. OD (oven dry) is the condition of dry wood oven with 0% water content. Cooking conditions were maximum temperature 165ºC, liquid ratio 3,5, sulfidity 25.0%, active alkali charge variation 16%, 17%, 18%, 19% and 20% and H-factor 800.
Calculation of cooking time based on the delignification rate defined as k_T / k373 where k is the delignification rate constant at T (K) and k_{373} is a constant at 373K. From the Arrhenius equation it is found

$$k = A.\ e^{-Ea/RT}$$

Where,
Ea: Activation energy, determined with the value of 32 Kcal / mol, for kraft pulping.
T: Absolute temperature
R: Common gas permeability, 8,314 J / mol.K

Thus, k_T / k_{373} = e-Ea / R (1 / T-1/373)

The value of k is calculated starting at temperature 100ºC (k = 1), from the calculation obtained the relative rate constant becomes [15]

$$k = kr = \exp (43.2 - 16.113 / T)$$

H-Factor is defined as an integral of constanta relative rate (kr) with time [16].

Formula:
$H = \int kr\, dt = \int \exp (43.2 – 16.113 / T)\, dt$
Based on the applied cooking conditions, the temperature observed during the cooking process and relative rate constanta was shown in figure 3.

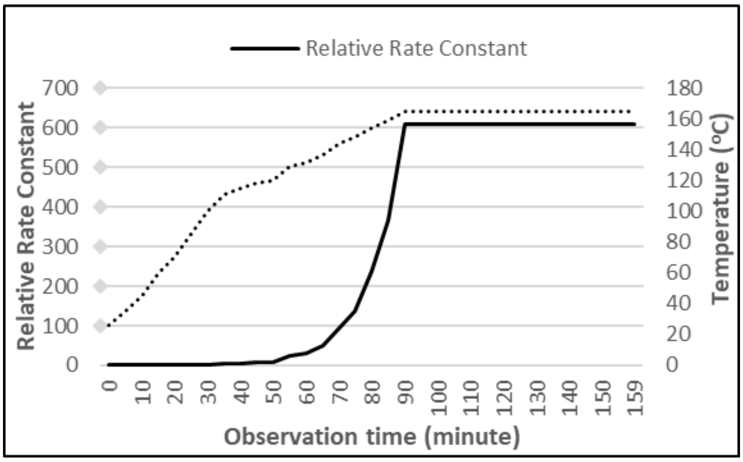

Figure 3. Observation of temperature and relative rate constanta on cooking *manihot esculenta crantz, eucalyptus* and *acacia mangium* with H-factor 800.

From Figure 3, it can be explained that the relative rate constant value can be applied at 30-minute observation with temperature of 100ºC. Furthermore, the temperature continues to be observed and converted in relative rate constants to a maximum temperature of 165 ° C. At temperature of 165°C, the temperature is kept steady during cooking time. For the calculation of total cooking time to note is, the highest relative rate constant (608.3), H- Factor value and total average accumulated relative rate constant (1266.45) to be considered for calculation of total cooking time. Calculation of cooking time can be explained by the in the following steps.
Cooking Time Calculation:
H-Factor = 800
Calculation: 1266.45 x 5/60 = 105.5375
(800 – 105.5375) x 60 / 608.3 = 68.498 minutes
Cooking time = 68.498 minutes + 90 minutes = 158.498 minutes (= 2 hours, 38 minutes)

2.6. Analysis of cooking pulp

Cooking analyze was done among others. Total yield was difference between total pulp weight (OD) and total weight of wood sample (OD).
Screened yield was the difference between the weight of the filtered pulp (OD) by the total weight of the wood sample (OD). Kappa Number test method use TAPPI-T236-cm85 method [17] and viscosty use TAPPI-T230-om04 method [18].

3. Result and Discussion

3.1. Result of wood analysis

3.1.1. Gravimetric analysis of wood composition in trees.
The percentage of wood and non-wood in a tree to consider in the cooking process. Percentage of wood can be analysed by comparing between wood and non-wood components in certain positions.

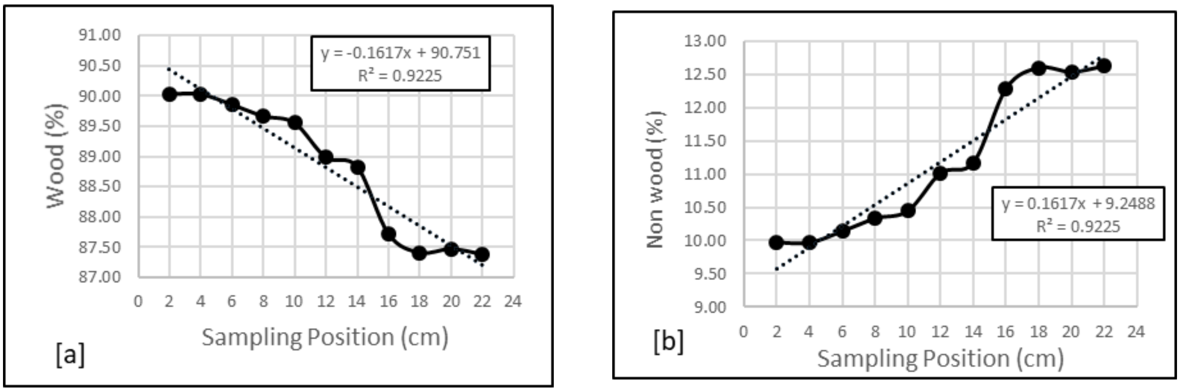

Figure 4. (a) Percentage of wood (% w) and (b) non-wood (% w) in *manihot esculenta crants.*

In Figure 4.a, it can be seen that the percentage of wood on the stem of *manihot esculenta crants* the higher the sample position, the lower the percentage of wood. The average percentage of wood at 22 cm above the ground is still above 87%. With the correlation degree between the sampling position (cm) and % w wood of 0.9225 with the correlation equation Y = -0.1617x + 90.751. The height of wood that can be recommended for the pulping process is up to 22 cm above ground level. Figure 4.b. shows the percentage of non-wood in the *manihot esculenta crants* , the sampling position the higher the non-wood percentage in the stem. The correlation degree between the height of the sampling position with percentagenof non-wood was 0.9225 with correlation equation Y = 0.1617x + 9.2488. From the graph, it can be explained that at a height of 22 cm above the soil surface of non-wood content was 12.5%.

3.1.2. Wood basic density analysis
In the pulping process, one of the main parameters to be considered in the main material is the wood density value. This wood density value shows the density of wood components, including fiber and lignin in certain volumes. The higher the density value, the higher the cellulose content in the wood.

Table 1. Wood density analysis results

Sample	Density (g/cm^3)	Average (g/cm^3)	Deviation. Std.
Manihot esculenta crantz	0.477 0.476 0.489 0.471 0.487	0.480	0.0078
Eucalyptus	0.494 0.472 0.481 0.480 0.479	0.483	0.0085
Acacia mangium	0.510 0.499 0.489 0.509 0.490	0.499	0.0100

Based on the density analysis, the *manihot esculent crantz* wood density was 0.480 g/cm^3 while the *eucalyptus* and *acacia mangium* wood density values were 0.483 and 0.499 g/cm^3 respectively. The standard deviation of *manihot esculenta crantz*, *eucalyptus* and *acacia mangium* were of 0.0078, 0.0085 and 0.0100, respectively.

3.1.3. Result of FTIR analysis of wood

This FTIR analysis aims to track the structure of organic molecules. The result of the FTIR analysis of *manihot esculenta crantz, eucalyptus* and *acacia mangium* wood can be seen in figure 5 to 7.

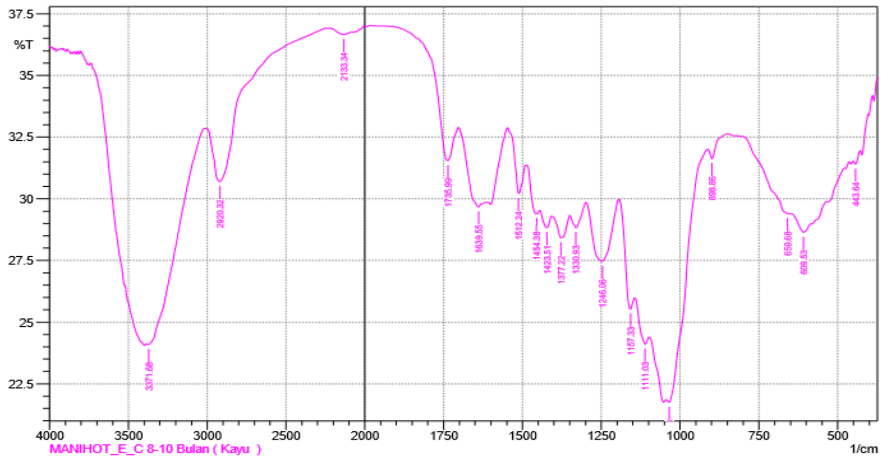

Figure 5. FTIR analysis results of *manihot esculenta crantz* wood

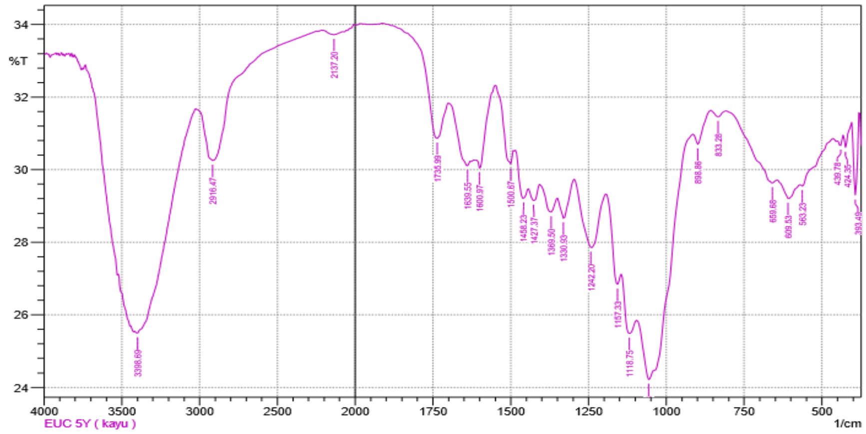

Figure 6. FTIR analysis results of *eucalyptus* wood

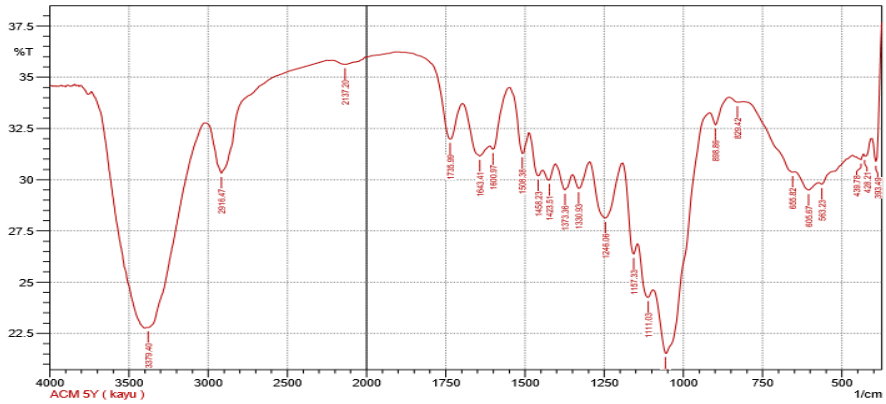

Figure 7. FTIR analysis results of *acacia mangium* wood

Base on figure 5 to 7, the comparison of FTIR analysis results can be seen that *manihot esculenta crants, eucalyptus* and *acacia mangium* have the same dominant functional groups.The functional groups were carboxylic acid (wavelengths 3500-3300 cm^{-1}), CH group (wavelengths 2970-2850 $cm^{-1)}$, alkuna (wavelengths 2260 - 2210 $cm^{-1)}$, carboxylic groups (wavelengths 1760 - 1690 $cm^{-1)}$, alkene groups (wavelengths 1650 - 1450 $cm^{-1)}$, CH3 groups (wavelengths 1470 - 1340 $cm^{-1)}$, and compounds aromatic.

3.2. Result of cooking process

In this research, total yield, secreen yield, KaNo, and viscosity parameters were analyzed. From the results of this analysis, it can be seen the differences of the quality of the products. The cooking conditions in this study based on the difference of active alkali charge of 16%, 17%, 18%, 19% and 20%. The difference of NaOH concentration based on the active alkali charge concentration.

3.2.1. Total yield

Total yield is the ratio of the weight of the pulp obtained before entering the screening stage with the weight of the chips sample in dry weight condition (OD). This total yield can illustrate the high level of wood component dissolved in the cooking liquid. Hemicellulose are more easily degraded under alkaline conditions than cellulose due to their low degree of polymerization [19]. From the result of total yield, it can be seen the total yield difference of *manihot esculenta crantz* , *eucalyptus* and *acacia mangium*, as shown in Figure 8.

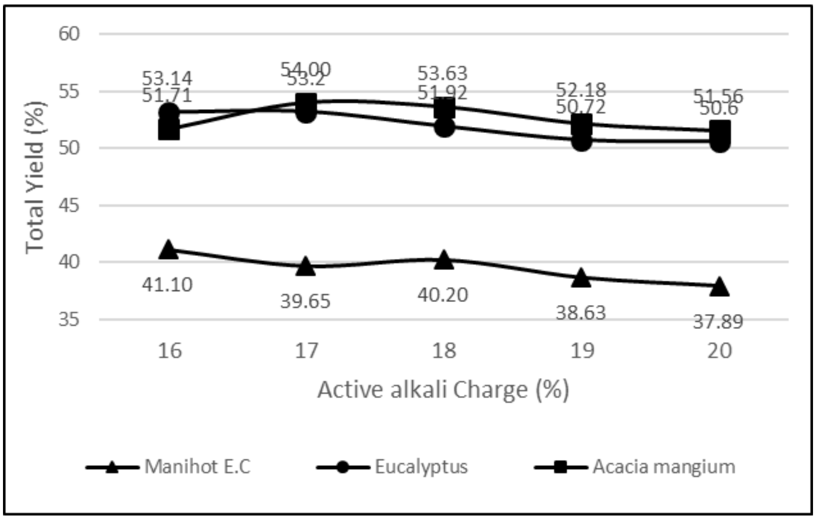

Figure 8. Effect of AA charge on total yield in cooking process of *manihot esculenta crantz, eucalyptus* and *acacia mangium.*

From Figure 8, it can be seen the difference of total yield between *manihot esculenta crantz* wood with *eucalyptus* and *acacia mangium*. Total yields of *eucalyptus* and *acacia mangium* woods were higher than that of *manihot esculenta crantz* on AA charges of 16% to 20%. The total yield difference between *manihot esculenta crantz* and *eucalyptus* at AA charge 16%, 17%, 18%, 19% and 20% were 12.04%, 13.55%, 11.70%, 12.09% and 12.71% respectively. Mean difference in total yield between *manihot esculenta crantz* and *eucalyptus* in cooking with variation of AA charge of 16%, 17%, 18%, 19% and 20% were 12,422%. The difference of total yield between *manihot esculenta crantz* and *acacia mangium* on AA charge 16%, 17%, 18%, 19% and 20% were 20.52%, 26.57%, 25.04%, 25.97% and 26.51% respectively. The average of total yield difference between *manihot esculenta crantz* and *acacia mangium* on AA charge variation of 16%, 17%, 18%, 19% and 20% was 24.92%.

Based on wood species, any increase in AA charge can affect the total yield decrease. The decrease of total yield of the *manihot esculenta crantz* , with an AA charge increase of 16% to 17%, 18% to 19% and 19% to 20% were 1.45%, 1.57% and 0.74% respectively, except for AA charge changes of 17% -18%, with slight increase of 0.55%. Any increase in AA charge of 1% in *manihot esculenta crantz* may result the reduction of the total yield of 0.803%. For *eucalyptus*, the AA charge increase of 17% to 18%, 18% to 19% and 19% to 20% may result the decrease of the total yields of 1.28%, 1.20% and 0.12% respectively, except for the AA charge of 16% to 17% with the total yield increased of 0.06%. Every 1% AA charge increase in the sample *eucalyptus* may result in the total yield decrease of 0.635%.

For *acacia mangium,* AA charge increase of 17% to 18%, 18% to 19% and 19% to 20% resulted in the decrease of total yield of 0.685%, 2.70% and 1.19% respectively. AA charge of 16% to 17% increase the total yield of 4.43%. Every 1% AA charge increase in the *acacia mangium* may result the decrease of average total yield of 1.14%.

3.2.2. Screen yield

Screen yield is calculated by comparing the weight of OD pulp that has passed through the screen process with the weight of OD chips. The AA charge influence the quality of pulp. From the screen yield results, it can be seen the screen yield difference between *manihot esculenta crantz, eucalyptus* and *acacia mangium* as shown in Figure 9.

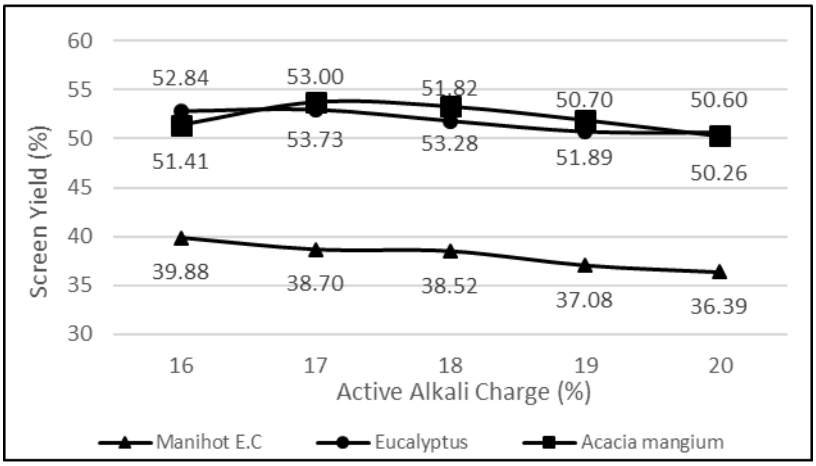

Figure 9. Effect of AA charge on screen yield (%) in cooking process of *manihot esculenta crantz, eucalyptus,* and *acacia mangium.*

Figure 9 shows, that screen yield of *manihot esculenta crantz* wood has a lower value compared with *eucalyptus* and *acacia mangium*, with AA charge of 16% to 20%. Screen yield between *manihot esculenta crantz* and *eucalyptus* with AA charge 16%, 17%, 18%, 19% and 20% were 12.96%, 14.3%, 13.3%, 13.62% and 14% respectively. The average difference of screen yield between *manihot esculenta crantz* with *eucalyptus* was 13.678%. Meanwhile, screen yield when compared with *acacia mangium,* the AA charge of 16%, 17%, 18%, 19% and 20% were 22.43%, 27.97%, 27.70%, 28.54% and 27.60 % respectively. The average difference of screen yield between *manihot esculenta crantz* with *acacia mangium* was 26.85%.

For *manihot esculenta crantz,* an AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% resulted in a decrease in screen yields of 1.18%, 0.18%, 0.12%, and 0.69% respectively. Every 1% AA charge increase in *manihot esculenta crantz* may result in a 0.543% decrease in screen yield. For *eucalyptus,* the AA charge of 17% to 18%, 18% to 19% and 19% to 20% can decrease the screen yield by 1.18%, 1.12% and 0.01% respectively, except for the AA charge of 16% to 17%, with a slight increase of 0.06%. Every 1% increase in AA charge in *eucalyptus* can result in a decrease in screen yield of 0.77%. For *acacia mangium,* 16% to 17% increase in AA charge caused a 4.51% increase in screen yield, while with AA charges of 17% to 18%, 18% to 19% and 19% to 20% can decrease screen yield of 0.838%, 2.61% and 3.14% respectively. Every 1% AA charge increase in the *acacia mangium* can decrease the average screen yield by 2.196%.

3.2.3. Kappa number (KaNo)

The kappa number or KaNo is a non-unit number indicating the remaining lignin content in the pulp of a pulping process. The kappa number indicates the level of maturity and whiteness or degree of delignification of the pulp [2]. KaNo pulp values in *manihot esculenta crantz, eucalyptus* and *acacia mangium* can be seen in Figure 10.

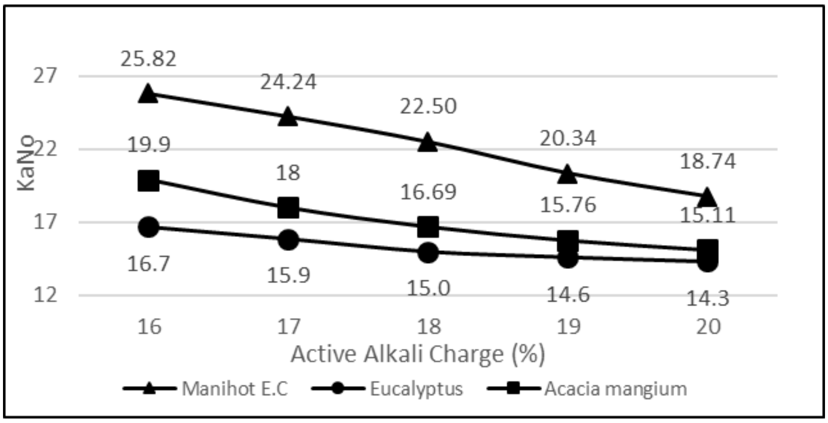

Figure 10. Effect of AA Charge on KaNo in cooking process of *manihot esculenta crantz, eucalyptus* and *acacia mangium.*

Figure 10 shows, that the kappa number of *manihot esculenta crantz* was higher than *eucalyptus* wood and *acacia mangium*. The KaNo differences between *manihot esculenta crantz* with *eucalyptus* on AA charge of 16%, 17%, 18%, 19% and 20% were 9.13, 8.37, 7.51, 5.74 and 4.44 respectively. The difference of KaNo between *manihot esculenta crantz* and *eucalyptus* was 7.038 averagely. Meanwhile, KaNo when compared with with *acacia mangium* with AA charge of 16%, 17%, 18%, 19% and 20% were 5.92, 6.24, 5.81, 4.58 and 3.63 respectively. Mean difference of KaNo was 5,236. The *manihot esculenta crantz* on AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% resulted decrease KaNo were 6.12%, 7.18%, 9.60% and 7.87% respectively. Every 1% AA charge increase may result 7.693% KaNo decrease averagely. For *eucalyptus*, the AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% can decrease KaNo were 4.91%, 5.55%, 2.60% and 2.05% respectively. Every 1% AA charge increase may result 3,778% KaNo decrease averagely. For *acacia mangium,* the AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% can decrease KaNo were 9.55%, 7.27%, 5.57% and 4.12% respectively. Every 1% increase in AA charge may result 6.628% KaNo decreased averagely.

3.2.4. Viscosity Value

Viscosity value is a measure of fiber strength to fiber degradation process by the influence of AA charge on cooking process. Comparing the intrinsic viscosity of cellulose suspensions or solutions, before and after a chemical treatment, is a very valuable way to estimate the changes in molecular weight [20]. The higher the viscosity value indicates the higher the fiber resistance to the degradation process. The effect of AA charge on pulp viscosity in cooking process *manihot esculenta crantz, eucalyptus* and *acacia mangium* can be seen in Figure 11.

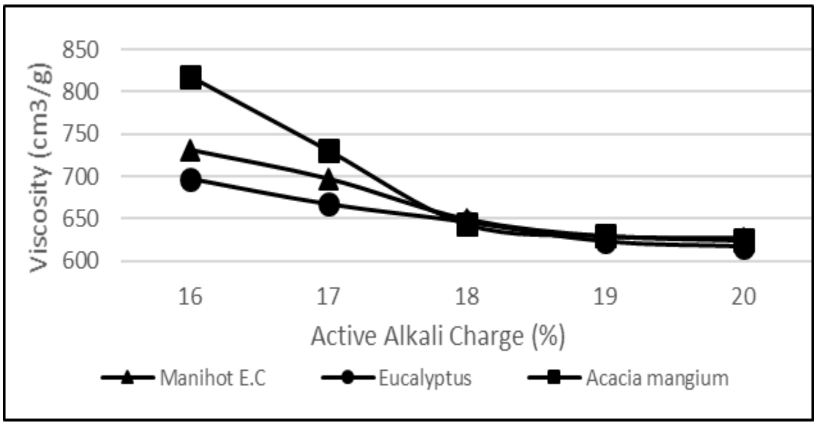

Figure 11. Effect of AA charge on the pulp viscosity in cooking process of *manihot esculenta crantz, eucalyptus* and *acacia mangium*

Figure 11, shows that the viscosity value of cooking result with variation of active alkali charge between 16% to 20% with 1% range. The active alkali charge range 16% and 17% showed viscosity significantly different when compared with AA charge 18%, 19% and 20%. The pulp viscosity value of *manihot esculenta crantz* wood was higher than *eucalyptus*. At AA charge 16%, 17%, 18%, 19% and 20% viscosity differences were 4.65%, 4.30%, 0.46%, 0.95% and 1.56% respectively. The large viscosity differences between *manihot esculenta crantz* and *eucalyptus* pulp occurred on 16% and 17% AA charges with average was 4.475%. The viscosity value of the *manihot esculenta crantz* pulp was lower than *acacia mangium* at 16% and 17% AA charge. At AA charge 16%, 17%, 18%, 19% and 20% viscosity differences were 11.9%, 4.88%, 0.77%, 0.16% and 0.32% respectively. The large viscosity difference between the *manihot esculenta crantz* and *acacia mangium* occurred of 16% and 17% AA charges was 8.39%.

For *manihot esculenta crantz*, an AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% can decrease viscosity were 4.65%, 6.89%, 3.08% and 0.18% respectively. Every 1% AA charge increase in *manihot esculenta crantz* may result the reduction of the viscosity value was 3.70% averagely. For *eucalyptus*, an AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% can decrease the viscosity value were 4.30%, 3.15%, 3.56%, and 0.963% respectively. Every 1% AA charge increase may result the reduction of the viscosity value was 2.99% averagely. For *acacia mangium*, AA charge increase of 16% to 17%, 17% to 18%, 18% to 19% and 19% to 20% can decrease the viscosity value 10.64%, 11.90%, 2.17% and 0.974% respectively. Eevery 1% AA charge increase may decrease viscosity value was 6.42%.

4. Conclusion

Manihot esculenta crantz is one of the raw materials that can be used for the process pulping. The proportion of wood and non-wood that on trees with a distance of 22 cm above the surface of the earth wood component is greater than 87%. Wood basic density of *manihot esculenta crantz* equivalent with *eucalyptus* wood and *acacia mangium* were for 0.480 g/cm^3, 0.483 g/cm^3 and 0.499 g/cm^3 respectively. *Manihot esculenta crants*, *eucalyptus* and *acacia mangium* have the same dominant functional groups were carboxylic acid, CH group, alkuna, carboxylic groups, alkene groups, CH_3 groups, and compounds aromatic. The total yield and screen yield of *manihot esculenta crantz* wood cooking process was lower than *eucalyptus* and *acacia mangium*.

The difference of total yield between *manihot esculenta crantz* with *eucalyptus* and *acacia mangium* was 12.42% and 24.92% respectively, while the difference of screen yield was 13.68% and 26.85% respectively. Lignin content was influential components in the cooking process.
The KaNo of *manihot esculenta crantz* pulp was higher than *eucalyptus* or *acacia mangium.* KaNo differences between *manihot esculenta crantz* with *eucalyptus* and *acacia mangium* were 7.038 and 5.236 respectively. However, the delignification process of *manihot esculenta crantz* more maximal than *eucalyptus* and *acacia mangium* wood. Every 1% increase of AA charge of *manihot esculenta crantz, eucalyptus* and *acacia mangium* were 7.693%, 3.778% and 6.628% respectively. Differences of pulp viscosity values between *manihot esculenta crantz* and *eucalyptus* occurred at AAcharge 16% and 17% were 4.65% and 4.30% respectively. The viscosity value of *manihot esculenta crantz* was higher than *eucalyptus*, with an average difference of 4.475%. The difference of viscosity value of *manihot esculenta crantz* with *acacia mangium* at AA charge 16% and 17% were 11.9% and 4.88% respectively. The viscosity of *manihot esculenta crantz* was lower than *acacia mangium* with an average difference 8.39%. Every 1% AA charge increase in cooking process of *manihot esculenta crantz*, *eucalyptus* and *acacia mangium* can decrease viscosity value were 3.70%, 2.99% and 6.42% respectively. Based on the total yield and screen yield value, indicates that the cellulose content of *manihot esculenta crantz* was lower than *eucalyptus* and *acacia mangium*. Base on the viscosity value, indicates the fiber strength of *manihot esculenta crantz* was better than *eucalyptus*. Cooking conditions, such as AA charge , maximum temperature, H-factor and liquid ratio (LR) value, were needed to increase total yield, screen yield, viscosity and to lower KaNo of *manihot esculenta crantz* pulp.

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