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Effect of NaOH Concentration and Immersion of Ice Water on Physical and Mechanical Characteristics of Candlenut Seeds (*Aleurites moluccana* L Willd)

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Abstract

The breakdown of candlenut seeds from the shell is very important to note due to the increasing consumption needs of candlenut seeds in the market has not been able to be balanced with the quality of the breakdown of good candlenut seeds. The purposed of this research was to identified the physical and mechanical properties of candlenut, analyzed the strength of the candlenut seeds that was in the treatment, analyzed the mass of the candlenut seeds which stick to the shell, analyzed the level of integrity of the candlenut seeds. This research was conducted using factorial randomized block design (RAKF) method with 2 factors. The first factor was the variation of NaOH concentration, while the second factor was the time of immersion ice water. Pressed load testing of candlenut shell used brazillian test, from this research was obtained the result of press load candlenut seeds with variations of NaOH immersion and the immersion time of ice water 10 and 45 minutes on average were 31.28 N and 22.30 N, while the load control was 44.692 N. Mass the seed core that was still sticky to the shell with the treatment given was an average value of 0.114 gr (3.8%) and 0.033 gr (1.2%), while the control is 1,753 gr (63%). The whole candlenut seeds core results with the given treatment were 7 grains (31.8%) and 15 grains (64%), whereas the control did not get the whole candlenut seeds core. The results of research is shows that the parameters of the increase in NaOH concentration does not have a significant effects but when compare with the control of NaOH it is very significant for the breakdown of candlenut, while the time parameters have a very significant effects.

Keywords: The process of breaking candlenut, NaOH, ice water immersion.

INTRODUCTION

Candlenut seeds can grow in tropical countries, one of which is Indonesia, besides that the consumption of core candlenut seeds is very large [1], this is proven that the core candlenut production was widely used for local consumption and export [2]. Every year the area and production of candlenut plants in Indonesia tends to increase. That was supported by the potential of land area and the production of candlenut plants in Indonesia since 2004, the area of hazelnut land is 206,321 ha with yields of 94,005 tons, until 2009 the estimated area of land is 210,198 ha increased production result by 111,058 tons [3]. However, along with the development of modern agriculture today the processed of handling post-harvest candlenut seeds is very important, it must be known both from the physical and mechanical properties of the candlenut seeds. The function was to provide engineering data needed in carrying out handling actions in post-harvest processing. Candlenut seed data was needed in analyzing, evaluating and maintaining the quality of the products [4].

Candlenut seeds was classified as a type of stone fruit because they have physical characteristics of hard skin and shell shape, then the outer surface was roughly curved. Candlenut seed shells ± 3 to 5 mm thick, have a color that is brown and black. Candlenut from an area had a compressive load that was different from candlenut from other regions [5]. Postharvest handling of candlenut (candlenut) at the level of farmers mostly still used traditional methods where the method of breakdown candlenut seeds still used simple breakers. This method was considered to be less effective and efficient because one worker in one day can only

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break candlenuts 9 to 10 kg, that was causes high exhausted work, besides that the other disadvantages were many broken and crushed candlenut seeds with a percentage of whole seed core only 40 to 60% which causes candlenut prices to be cheaper [6]. Meanwhile, to obtain the core results of the whole candlenut seeds must be accompanied by appropriate postharvest handling, by maintaining the quality of the candlenut seeds, and reducing the carelessness in the breakdown of candlenut seeds which can cause the core of broken candlenut seeds to collapse so that was easily contaminated with fungus. To avoid undesirable things, when handling postharvest results it must be done well, especially in the case of the breakdown of candlenut seeds.

This research aims to discuss the physical and mechanical properties of the primary treatment of candlenut seed shells before breaking down process, with the final results of the candlenut shell easily solved with the candlenut core not sticky with the shell and expected to be intact.

RESEARCH METHODS

Tools and Materials

The tools used in this research are: oven UN 260, wheeling period (Prohex), footbath, spoon, clamp, digital scales, glass cylinder, and Brazilian test.
The materials used in this study are: seeds of candlenut NaOH, water, and ice water.

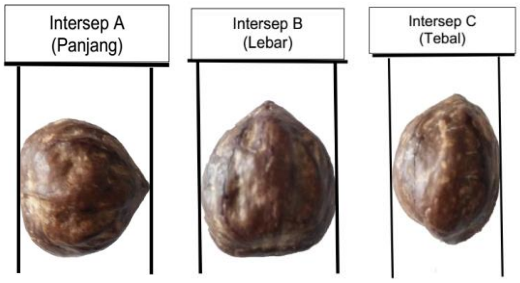

Figure 1. Dimension of candlenut on each of intercepts A, B, C

$$\%\text{Water Content} = \frac{M2-M3}{M2-M1} x100\% \quad \text{.....[7]}$$

Explanation:
M1: container weight
M2: container weight + seed weight before oven
M3: container weight + seed weight after oven

$$\text{Sphericity} = \frac{(A \times B \times C)^{1/3}}{A} \quad \text{.....[8]}$$

$$\text{Elipsoidal (V)} = \frac{2}{9}\pi + A\ x\ B\ x\ C \quad \text{.....[9]}$$

Explanation:
A: seed length from A intercept
B: seed width from B intercept
C: seed thickness from C intercept

$$\text{Roundness} = \frac{\text{The area of the field with smallest intercept}}{\text{Largest area of interception}} \quad [4]$$

Preparation

Cleansing of candlenut from dirt and candlenut fibers that are still attached, then measuring (length, width, thickness) of candlenut seeds. Then analysis by testing the moisture content, roundness, ellipsoidal, and elasticity using the formula in equations 1-4. And the sample material used in this study came from the area of Blitar City, East Java, Indonesia. And can be seen in at the figure 1.

Immersion NaOH

This step was carried out to have an impact on candlenut seeds so that it was easily broken down with less energy with a variation of 10%, 15%, 20% 25%, and 30% NaOH concentrations. Then reconstituted with water up to 1 liter, then the candlenut seeds were immersed for 24 hours and the slicing process for 3 hours, then oven was done for 24 hours. The application of NaOH to the peculiarity of candlenut shell is based on the study from Pugersari [10]. To soften the coconut shell by using NaOH [11]. Mendong fiber strength [12]. Softening coconut fibers so that the texture is soft. Each of the literature is composed of the same composition in the hazelnut shell so that the authors applied NaOH as a shell brushing material.

Oven Treatment

This step was done to provide controlled heat treatment with temperature 70^{o}C for 24 hours and then immediately done immersion the ice water so that the membrane binding between the shells with the seed core can be detached, it is based on the source [6]. Stating that the seeds of candlenuts are dried first for 3 to 11 days depending on the scorching heat of the sun before solving to get the nucleus of candlenut seed, but it can be added by immersion the ice water to Increase the number of core results of the whole seeds obtained.

Immersion of Ice Water

This step was carried out when the candlenut seeds was released from the oven which heated for 24 hours then the hot candlenut seeds was inserted into the ice water immersion briefly with a

temperature of 3±1°C for 10 minutes, and 45 minutes for immersion ice water. There is a supporting literature in the journal about the breakdown of candlenut seeds with immersion ice water based on previous research [13]. The cooler water immersion temperature of the immersion water, so that the result of breakdown candlenut shell higher intact [14].

Step of Giving Pressurization on Candlenut Seeds Using Intercept C

In this research was applied to candlenut seeds using Intercept C based on the results of research by Sinaga [5] from the press load on intercept A because needed of a greater force to cut in parallel directions along the direction of the shell fiber [15], whereas Intercept B seed emphasis and kernel of the distance in vertical positions indicate the strength of faults with the greatest value [16]. Can be seen in Figure 2.

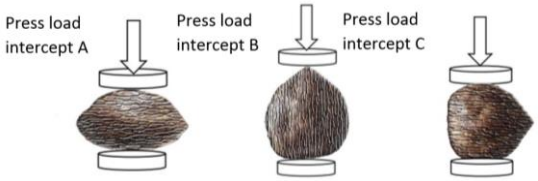

Figure 2. Press Load on Different Intercepts

The principle of intercept compressive load C is the candlenut seeds are placed in a slanted position, with a grooves of horizontal shell fibers. It aims to easy the compressive load to break the hazelnut shell, so that the compressive load required in the solving process tends to be small.

Research Design

The research design of this research was used RAKF, with two factors namely NaOH concentration and immersion time. The concentration level used is 10%, 15%, 20%, 25%, 30%. While the immersion time used is 10 and 45 minutes. So that from the two factors above, there were 10 combinations of treatments, each of which was repeated 3 times. After that, if there were significant differences, further testing is carried out using the BNT Test (Smallest Significant Difference).

Phase Determination of the Criteria for the Rendement of Candlenut Seed Core

To determining the yield value of candlenut seed core there are three criteria. The first criteria is the core of the whole candlenut seeds, where the criteria the core of the candlenut seeds is rounded intact without any defects caused by the impact and the force given at the time of solving. The second criterion is the core of candlenut seeds broken into two equal parts. The third criteria is the broken core of candlenut seeds, where the results of the breakdown of the candlenut seeds obtained is irregular shapes and more than two.

Figure 3. Criteria for Rendering of candlenut Seed Core. A. Core intact, B. Core breaks two, C. Core breaks broken

Core Mass of Sticky Candlenut Seeds in Shell

This measurement is very important because it is used to find out what percentage of the candlenut seed core mass is still sticky to the shell.

$$\%\ \text{Mass of the sticky candlenut seed core} = \frac{\text{Amount of sticky candlenut core mass (gr)}}{\text{Total mass of candlenut core (gr)}} \text{ x } 100\%$$

Explanation:

Amount of sticky candlenut core mass: The candlenut seed core is still sticky to the shell after (gr).

Total mass of candlenut core: The amount of sticky candlenut seed core mass is added to the amount of loose candlenut seed core mass (gr).

Intact Seed Core

This measurement was carried out to determine how much percentage of whole candlenut seed core results after treatment and compared with candlenut which was not treated (non-treatment).

$$\%\ \text{Whole candelnut core} = \frac{\text{Whole candelnut core}}{\text{Total Seeds}} \text{ x } 100\%$$

Explanation:

Whole candlenut core: The total number of whole candlenut seeds obtained in the breaking process

Total seeds: Total number of seeds as a sample (25 seeds)

RESULTS AND DISCUSSION

Identification of the physical and mechanical properties of candlenut,

Table 1. Identification of Physical and Mechanical Properties of Candlenut Seeds

Identification of candlenut physical properties						
Mass measurement	Unit	Number of sample	Value			SD
			min	mean	max	
a. Mass of shell and core seeds of candlenut	gr	100	5.024	8.216	9.932	0.792
b. Mass of shell	gr	100	2.643	5.409	7.088	0.632
c. Mass of core seeds candlenut	gr	100	0	2.697	6.384	0.576
Identification of candlenut mechanical properties						
Dimension measurement	Unit	Number of sample	Value			SD
			min	mean	max	
a. Length	(mm)	100	25.000	27.885	30.550	1.145
b. Width	(mm)	100	24.000	26.362	28.600	0.841
c. Thickness	(mm)	100	17.750	20.113	23.600	1.105
Identification of candlenut physical properties						
Dimension measurement	Unit	Number of sample	Value			SD
			min	mean	max	
a. Sphericity	(mm)	100	148.155	176.814	176.814	12.223
b. Ellipsoidal	(mm^3)	100	11 220.700	14 816.220	18 811.370	14 60.212
c. Roundness	(mm)	100	0.637	0.721	0.827	0.040
Identification of candlenut mechanical properties						
Force press intercept C	Unit	Number of sample	Value			SD
			min	mean	max	
a. Intercept C	(N)	25	32.00	44.692	57.300	6.331

it was necessary to do this as a basis for knowing the parts of the physical and mechanical properties of candlenut seeds which can be seen in Table 1.

Identification of the physical and mechanical properties of candlenut seeds was carried out 3 times with the aim to determine the accuracy of the data obtained by using a sample of 100 candlenut seeds in each replication, the value of which was used as a result of identification of physical and mechanical properties in candlenut seeds.

That was proven the physical properties of candlenut seeds have a diversity value from the measurement values of masses such as shell mass and candlenut seed core obtained an average value of 8.216 gr, shell mass of 5.409 gr, the core mass of candlenut seeds which is 0.802 gr, the core mass of candlenut seeds sticky 1,895 gr, while for dimensions such as length the average value is 27,885 mm, width is 26,362 mm, and thickness is 20.113 mm. And there were dimensions such as roundness measured by an average value of 176. 814 mm, ellipsoidal 14 816,220 mm^3, backwardness of 0.721 mm. At the mechanical properties with emphasis on intercept C, the average load press is obtained at 44.692 N. At the study Sinaga [5], the average value diameter of candlenut seeds was 32.55 mm long, 29.05 mm wide and 23.23 mm thick, the average value of candlenut baldness was 0.65, the average value of candlenut volume was 15,365 mm, candlenut mass 11.26 g. Based on the data on physical properties there were differences in the measurement values of physical properties, this can be influenced by the area harvested by candlenut seeds and the conditions of their growth environment.

Water content of candlenut seeds

Water content needs to be included in a study as supporting data to compare the differences in water content between treated and untreated samples, so that the differences water content between the treated and untreated samples can be known. This can be seen in figure 4.

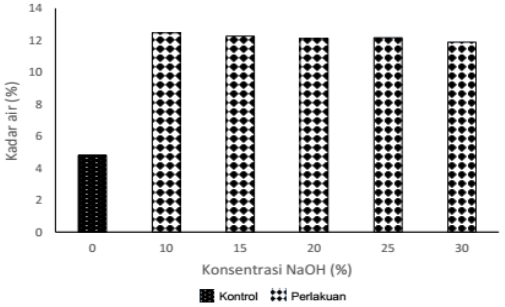

Figure 4. Water content at various levels of NaOH concentration

The moisture content of the sample material needs to be measured as a reference for the ability of the material to release the water content in it. Testing of moisture content between samples treated with un-treated ones needs to be done in order to find out how much difference in water content possessed by the sample whether treated or not, it is used to complement supporting data in a study. From these data samples that were treated with water content obtained an average value of 12%. Whereas in samples without treatment of water content in candlenut seeds 5%, it was influenced by the treatments given to the treatment sample so that the water content between the two samples had a considerable difference. From the research results of Tarigan [17] stated that the level of water content that is most suitable for the process of breaking candlenut is 4-6% bk (dry basis). In samples with water levels lower than 3% BC, candlenut seeds were found to be damaged. In the study of Sinaga [5] stated the value of the initial moisture content of candlenut before drying was 12.05% bk and after drying for 20 hours the value of candlenut water content became 4.96% bk.

Value of press load on the candlenut Shell Power

Press load given to the candlenut shell was carried out to determine the amount of compressive load required by the candlenut shell when solving with a combination of concentration and length of immersion so that it can be seen that the need for pressurized candlenut seeds required at 10 minutes of ice water immersion is 31.28 N while for 45 minutes of immersion ice water the required compressive load is 22.30 N. when compared to the required compressive load control was very large 44.692 N. While the research of Sinaga [5] Modulus of elasticity value of candlenut seed 31.43 Mpa and that was influenced of the physical and mechanical properties of candlenut seeds, conditions of that growth environment even that given treatment before the breakdown of candlenut. So that way influenced the strength of shells at the breakdown process.

The press load of the treatment based on the time of immersion water for 10 minute it was different than pressed of immersion water for 45 minute. While the concentration was not influenced against pressed of candlenut seeds because the changed of pressed value between concentration one with other less concentration.

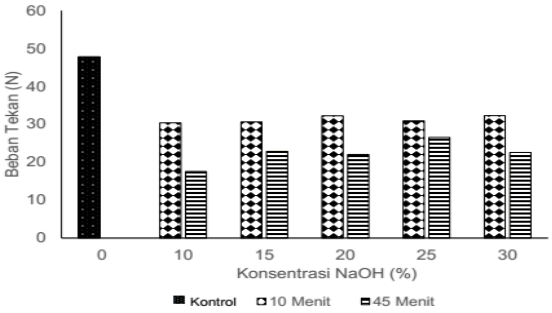

Figure 5. Load Needs Press on the candlenut Shell with Various NaOH Concentrations and the time of immersion ice water.

Core mass of candlenut seeds sticky on shell

The method of releasing adhesive bonds between the candlenut core and the shell was very necessary because it was one of the factors that caused the quality of the candlenut seeds to be poor so that the solution to overcome can help to increase the core yield of the whole candlenut without or very little stick to the shell when the solution done.

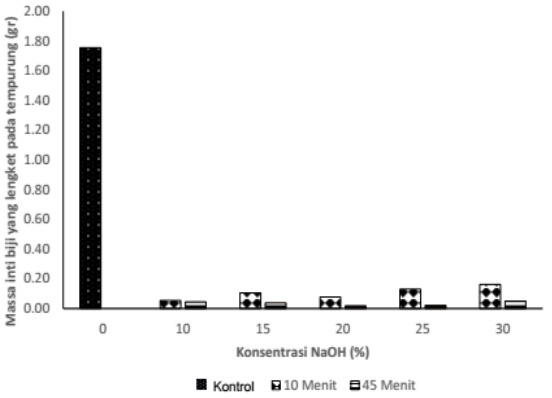

Figure 6. Mass of Stickiness of candlenut Seed Core in Every Concentration Treatment and Length of Time of Immersion Water Ice

In this research that has been done, the results of the candlenut core mass were still attached to the treatment that has been carried out with variations concentration and length of time of immersion ice water which is the result of immersion ice water for 10 minutes with a variation of NaOH concentration. on the shell 0.114 (gr), while the 45 minute ice water immersion obtained an average value of 0.033 (gr), when compared with the control value of the mass

of candlenut seeds sticky to the shell 1,753 (gr). Based on Siallagan study [13], S2 (with immersion temperature of 6^{o}C) and treatment of S3 (with a temperature of 3^{o}C) differed very significantly from treatment S1 (with a temperature of 9^{o}C) based on the research It can be seen that the temperature of 3^{o}C has the lowest amount of candlenut seed stickiness. This is the same as Suparlan study [14], state that the cooler the temperature of the immersion water, so that the result of breakdown candlenut seeds whole was getting higher intact.

Percentage of the core mass of candlenut seeds sticky at the shell

It should be noted that the value of the percentage of candlenut seeds on the release of the candlenut seed core was very influential on the value of success in a method of research conducted. The calculation results obtained by the percentage value of stickiness that still exists with the method treatment carried out but there was significant differences in each treatment where stickiness occurs if the material without treatment was very large 63%, while if treated with ice water immersion for 10 minutes has decreased adhesiveness with an average value of 3.8% from here it has begun to show a noticeable difference between the material treated with the non-one, and the long treatment of immersion ice water for 45 minutes shows very small adhesion results with an average 1.2%. In the Siallagan study [13], the highest percentage of sticky core was obtained from S1 treatment (with 9^{o}C immersion temperature) that were equal to 7.05% while the lowest was obtained in S3 treatment (with immersion temperature 3^{o}C) that is equal to 2.74%. The combination of NaOH treatment with immersion ice water can affect the stickiness value of candlenut seed core in the shell with the smallest value compared to immersion ice water only.

Based on the results print analyzed shows the core mass of candlenut seeds sticky in the shell was given the treatment of water immersion time for 10 minutes obtained a distinct result was evident with the core mass of candlenuts sticky on ice water immersion for 45 minutes, while the concentration has no effect Noticeable to the core glutinous seeds of candlenut because of the change in the value of the nucleus between the concentration of one and another only slightly.

Integrity of Candlenut Seed Core

Determining the integrity of the candlenut seed core the results of solving with whole round form were obtained without any slight defects due to compressive and impact loads during the breaking process. The integrity of the candlenut seed core is the most important thing in this research because the end result desired was an increase in the results of the breakdown of candlenut seeds with more intact conditions than the first treatment without treatment.

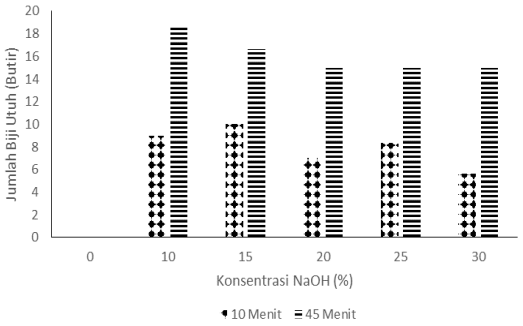

Figure 7. Integrity of the candlenut seed core

Percentage of Integrity of candlenut Seed Core

Measurements form of percentages to state the results of the candlenut seed core integrity need to be done as a measure of success candlenut solving, and was interpreted in the form of percent. If the candlenut seeds were not treated in this research the results of 0% seed integrity, whereas those given treatment for 10 minutes immersion ice water showed an increase in the percentage of whole seed core with an average of 31.8%, at the time of immersion 45 minutes of ice water the results of the percentage of candlenut seeds is more than the immersion of ice water for 10 minutes was half the difference of 64%. In the Siallagan research [13], the highest percentage of intact core was obtained at 3^{o}C immersion temperature of 38.83% and the lowest at 9^{o}C immersion temperature of 26.56%. In this research, it was shown that the combination of NaOH variations with immersion ice water had quite a lot of candlenut seeds integrity values [18]. The results of the breakdown of candlenut by roasting using sand obtained a core of 35% whole candlenut seeds [6].

Table 2. Results of Percentage of Percentage of Core Candlenut Seeds

Immersion time (minute)	Concentration (%)	Number of sample (unit)	Whole seed core (%)	Core broke two (%)	Broken core destroyed (%)
10	10	25	36	40	22
	15	25	40	36	26
	20	25	28	34	37
	25	25	33	28	38
	30	25	22	41	36
Average			31.8	35.8	31.8
45	10	25	74	18	6
	15	25	66	21	8
	20	25	60	28	12
	25	25	60	30	9
	30	25	60	26	13
Average			64	24.6	9.6

The results of the breakdown of candlenut seeds by drying under the sun for 3 to 11 days and obtained the core of whole candlenut seeds 40% to 60%.

The integrity of the candlenut seed core by treatment of water immersion time for 10 minutes was significantly different from the integrity of the immersion for 45 minutes, while the concentration did not significantly affect the integrity of the candlenut seeds because there was only a small change in the integrity of the concentration of one.

Percentage of candlenut seed core yield

From the results of the breakdown of candlenut seeds the quality classification based on the condition of the nuts of the candlenut released from the shell which classified into three categories, namely whole seed core, two broken core, and broken core. The results of the classification can be seen in table 2.

The result of the core yield candlenut of seed after the discharge was necessary to be observed because from the results can be known that a method can be said successful if the yield is higher than the previous method, it was achieved as the benchmark value of the success rate of the increased yield. In the calculation of the percentage of the broken of the candlenut nuclei were classified into 3 kinds, namely the whole seed core, two broken nuclei, and broken nuclei. in this research the amount of whole seed nuclei with varying concentrations of NaOH and immersion ice water 10 minute whole seed core 31.8%, broken core two 35.8%, broken nuclei were crushed 31.8%. While with varying concentrations of NaOH and immersion ice water 45 minute Whole seed core 64%, nuclei broke two 24.6%, breken nuclei were destroyed 9.6%. When compared with Siallagan research, (2012). The full core percentage of 3^{o}C immersion temperature was 38.83%. The core percentage broke out two by 39.65%. The core percentage was destroyed by 21.52%. In this comparison shows that the variation of NaOH with the immersion of ice water affects the high value of candlenut seed yield if compared only to the immersion of ice water only.

CONCLUSION

Based on the results of the research that have been conducted, can be drawn conclusions as follows:

1. The analysis of the physical properties of candlenut obtained the results of mass measurement such as shell and candlenut of seeds obtained an average value of 8.216 gr, mass shell average value of 5.409 gr, density of the seed of candlenut that loose an average value of 2.697 gr, While for dimensions such as average value length of 27.885 mm, the average value width is 26.362 mm, and the thickness of the average value is 20.113 mm. As well as there is dimension measurements such as the shape of the circle obtained an average value of 176. 814 mm, spores ellipsoidal obtained an average value of 14 816.220 mm^2, the roundness obtained an average value of 0.721 mm. In mechanical properties with the emphasis of

important C is obtained the average value of the press load 47.558.

2. Moisture content that is given average treatment of candlenuts is 12% while the moisture content of hazelnut without treatment is 5%.
3. Lowest load of press is obtained at 45 minutes ice water immersion treatment with press load value 22,300 N.
4. The best time to get the lowest glutinous grades and a lot of whole-grain seeds are immersion the ice water 45 minutes.

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