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ANALYZE BREAKING PALM OIL DORMANCY THROUGH CHEMICAL PROCESSES USING MULTIVARIATE ANALYSIS OF VARIANCE

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Abstract: Palm oil is a dormant plant. The main cause of oil palm seed dormancy is the hard and thick seed coat or shell, inhibiting the effective absorption of water and gases. The presence of a seed coat barrier causes the germination process of oil palm seeds to be hampered. This study aims to determine the effect of chemical treatment on breaking palm oil dormancy by immersion in a solution of strong acids, namely H_2SO_4, KNO_3, and HCl. This study used a completely random design (CRD) with three treatments, four observations, and five replications. The results of the following study were analyzed using MANOVA with the parameters observed were germination rate, germination rate, seedling height, and most extended root length. Based on the analysis results, it was found that immersion with a solution of a strong acid, namely H_2SO_4, KNO_3, and HCl, had different effects on breaking palm oil dormancy. The highest average germination rate was through immersion with HCl, which produced an average of 65.24. The highest average germination was through immersion in H_2SO_4 with an average of 8.52. In contrast, the average seedling height and most extended root length were soaked in HCl with an average of 35.28, and 15, respectively. Based on the results obtained, the best chemical treatment for breaking palm oil dormancy is through soaking with HCl.

Keywords: *Dormancy Breaking, Chemical Process, Palm Oil, MANOVA*

INTRODUCTION

Indonesia is the largest palm oil producer globally and Malaysia currently controls about 85% of the world's palm oil production. The development of the palm oil industry continues to increase from year to year. It can be seen from the increase in oil palm plantations in Indonesia in the last five years. Namely, in 2015 the area of oil palm plantations was 11,260,277 ha, and in 2019 it had reached 14,677,560 ha [1]. As the area increases, it will lead to an increase in demand for superior oil palm seeds.

Demand for oil palm seeds per year reaches 100-120 million sprouts, but seed producers in Indonesia can only provide 60-70 million sprouts per year. The shortage of seed supply has not met consumer demand because the demand for seeds continues to increase due to the high interest of entrepreneurs and the community in cultivating oil palm [2].

The availability of superior oil palm seeds is one of the important components in the oil palm industry. Generally, many superior seeds are produced by large plantations. The demand for superior seeds has increased every year, namely 302,000, 626,509, 1,651,103, 1,124,371 seeds respectively from 2015 to 2018 [1]. In this case, seed production must be in line with demand. If at any time the demand is higher than the availability of seeds, it is feared that fake seeds will circulate to cover the shortfall in demand for these seeds. Suppose fake seeds are circulated into the hands of farmers. In that case, this will be very detrimental to farmers because seeds are one of the determining factors for oil palm cultivation which is the first step that will determine the success of planting in the field. Therefore, it is necessary to increase the amount of seed production, which does not ignore the quality of the seed.

The germination of oil palm seeds is quite difficult because it has a hard skin that is dormant. Farhana stated that the main cause of oil palm seed dormancy is the hard and thick seed coat or shell, which inhibits the effectiveness of water and gas absorption [2]. Naturally, it takes several months, and the growth percentage is low. Specific treatments need to be carried out, such as scarification or chemicals to make it easier for water and gas to enter the seeds [3]. Chemical breaking of dormancy can be done by immersing chemical solutions, namely strong acid groups such as H_2SO_4 and KNO_3, making the seed coat softer so that water can pass easily [4].

This study added one chemical treatment, namely HCl, to break palm oil dormancy. This study aims to determine the effect of chemical treatment on oil palm seed germination, including germination rate, germination speed, seedling height, and roots the longest. In addition, this study will analyze to determine the best chemical treatment in the germination process of the best oil palm.

The results of this study are expected to provide information and alternative ways for the community to break the dormancy of oil palm seeds that facilitate oil palm germination to help farmers provide oil palm seeds independently.

RESEARCH METHODS

The tools used in this research are a knife, sandpaper, measuring cup, ruler, plastic bucket, and hand sprayer. The materials used in this study were oil palm seeds, sulfuric acid solution (H_2SO_4), potassium nitrate (KNO_3) solution, HCl, soil, sand, germination

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tray, 7.5 cm diameter pot, labels, writing instruments, documentation tools, and aquadest.

The research design used in this study was a Completely Randomized Design (CRD) with three chemical treatments, four observations, and five replications. The treatment tried to dissolve 255 ml of H_2SO_4 into 1000 ml of distilled water, dissolve 5 grams of KNO_3 into 1 liter of water, and dissolve 2.5 ml of HCl into 997.5 ml of distilled water. The variables observed were germination rate, speed, seedling height, and most extended root length.

The analysis used to determine the effect of chemical treatment on palm oil dormancy breaking is using MANOVA. MANOVA is a diversity analysis for tests whether the population means vectors are the same or different [5]. The formula for determining the treatment variance matrix estimator is stated [6].

$$S_i = \frac{1}{r_i - 1}\sum_{j=1}^{r_i}(y_{ij} - \bar{y}_{i.})(y_{ij} - \bar{y}_{i.})'$$

$$i = 1,2,\ldots,t \ dan \ j = 1,2,\ldots,r$$

The hypothesis in this study is formulated as follows:

$H_0: \boldsymbol{\tau_i} = \boldsymbol{\tau_j}$

$H_1: there\ is\ at\ least\ \boldsymbol{\tau_i} \neq \boldsymbol{\tau_j}\ \ where\ i \neq j$

The above hypothesis suggests that there are *t* treatments that will be examined for their effect on *p* observation variables. One vector indicates one treatment. There is an effect of treatment. It is necessary to calculate the test statistic on MANOVA, the Wilks' lambda test.

$$\Lambda = \frac{|JK(G)|}{|JK(G) + JK(P)|}$$

The results of the Wilks' lambda test calculation will be substituted into the Bartlett test formula according to the number of observations and treatments. In this study, there were four observations and three treatments, so the Bartlett test equation is:

$$\left[\frac{\sum_{i=1}^{t} r_i - p - 2}{p}\right]\left[\frac{1-\sqrt{\Lambda}}{\sqrt{\Lambda}}\right] \sim F_{2p,2(\sum_{i=1}^{t} r_i - p - 2)}$$

The results are compared with F_{table} with degrees of freedom according to the test used in the Bartlett Table. Hypothesis testing is based on F value and F_{table} with degrees of freedom (v1) and (v2). If the value of $F > F_{table}$, then H0 is rejected, and if F value < Ftable, then H_0 is accepted. The significant level (α) used is = 5% [7].

RESULTS AND DISCUSSION

The results of the research on breaking the dormancy of oil palm seeds through a chemical process using immersion with H_2SO_4, KNO_3, dan HCl with five replications are as follows:

Table 1. Average Observed Variables Based on Chemical Treatment

Observed variables	Chemical treatment	Average
Germination speed	H_2SO_4	39.50
	KNO_3	43.88
	HCl	65.24
Germination rate	H_2SO_4	8.52
	KNO_3	6.89
	HCl	2.98
Seedling height	H_2SO_4	24.83
	KNO_3	31.24
	HCl	35.28
Roots the longest	H_2SO_4	10.92
	KNO_3	13.70
	HCl	15.85

The research results on the germination rate of oil palm through a chemical process showed that the highest average germination rate of oil palm was soaked with HCl with an average of 65.24, and the lowest was using H_2SO_4 which was 39.50. The results obtained to follow the research results by Imansari & Haryanti, which state that the higher the concentration of acid used to soak the seeds will significantly accelerate the rupture of the seed coat [8].

The highest average speed of oil palm germination was obtained through immersion in H_2SO_4 with an average speed of 8.52, and the lowest average speed was obtained by using HCl of 2.98. The results of this study are supported by research [9]. States that concentrated sulfuric acid (H_2SO_4) causes the seed coat to become soft. The length of immersion in the H_2SO_4 solution must be taken into account. Because if it is too long, it can cause the germination speed to decrease [10].

The height of oil palm seedlings through a chemical process showed that the highest average height of oil palm seedlings was those using the HCl immersion method, with an average seedling height of 35.28. The lowest average was those using the H_2SO_4 immersion method, with 24.83. soaking with HCl produced oil palm roots with the longest average of 15.85, and the shortest average was using H_2SO_4 which was 10.92.

The results of this study showed three variables. They are germination rates, seedling height and longest root. The highest average value was obtained through immersion using HCl. While the lowest average was obtained through immersion using H_2SO_4. Following the research of Aryani and Eka,

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which stated that breaking oil palm dormancy by chemical scarification treatment of HCl had a very significant effect on germination [11]. Germination value and growth speed of oil palm seeds. The effect of the independent variable can be seen in Table 2.

Based on Table 2, it can be seen the effect of chemical treatment on each dependent variable, namely germination speed, germination rate, Seedling height and Roots the longest. From these results, the effect of chemical treatment can be seen based on the value in the Sig column. Chemical treatment is said to have a significant effect if the value of sig. < 0.05. From the analysis results, it can be seen that the four values indicate the value of sig. <0.05, so it can be said that the chemical treatment used in this study had a significant effect on breaking palm oil dormancy based on germination speed, germination rate, seedling height and roots the longest.

The analysis results showed that chemical treatment significantly affected germination speed, germination rate, Seedling height, and Roots the longest. It can be said that there were differences in the dependent variable based on the independent variable. Further tests were carried out using the Bonferroni test.

Table 2. Effect Of Chemical Treatment On The Dependent Variable

Treatment	Type III Sum of Squares	n	F	Sig.
Chemical treatment	Germination speed	2	76.252	0.000
	Germination rate	2	69.598	0.000
	Seedling height	2	6.379	0.013
	Roots the longest	2	28.002	0.000

Table 3. Differences In The Effect Of Each Chemical Treatment on The Dependent Variable

Dependent Variable	(I) Chemical treatment	(J) Chemical treatment	Mean Difference (I-J)
Germination speed	H_2SO_4	KNO_3	-4.3800
		HCl	-25.7400*
	KNO_3	H_2SO_4	4.3800
		HCl	-21.3600*
	HCl	H_2SO_4	25.7400*
		KNO_3	21.3600*
Germination rate	H_2SO_4	KNO_3	1.6360*
		HCl	5.5440*
	KNO_3	H_2SO_4	-1.6360*
		HCl	3.9080*
	HCl	H_2SO_4	-5.5440*
		KNO_3	-3.9080*
Seedling height	H_2SO_4	KNO_3	-6.4140
		HCl	-10.4500*
	KNO_3	H_2SO_4	6.4140
		HCl	-4.0360
	HCl	H_2SO_4	10.4500*
		KNO_3	4.0360
Roots the longest	H_2SO_4	KNO_3	-2.7840*
		HCl	-4.9280*
	KNO_3	H_2SO_4	2.7840*
		HCl	-2.1440*
	HCl	H_2SO_4	4.9280*
		KNO_3	2.1440*

Table 3 shows the significant difference in each dependent variable's value based on the treatment. Differences between treatments for each dependent variable are marked with an asterisk in the Mean Difference column. The germination speed with immersion using H_2SO_4 and HCl has an average difference of -25.74. The negative sign indicates that soaking with HCl resulted in a higher average germination speed than soaking with H_2SO_4. The germination speed using KNO_3 and HCl immersion had an average difference of -21.36. The negative sign indicates that soaking with HCl resulted in a higher average germination speed than soaking with KNO_3.

Germination rate immersion with H_2SO_4 and KNO_3 has an average difference of 1,636. The positive sign indicates that immersion with H_2SO_4 resulted in

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a higher average germination rate than immersion using KNO_3. The immersion method with H_2SO_4 and HCl has an average difference of 5.544. A positive sign indicates that immersion with H_2SO_4 resulted in a higher average germination rate than immersion with HCl. Immersion with KNO_3 and HCl has an average difference of 3.908. The positive sign indicated that soaking with KNO_3 resulted in a higher average germination rate than HCl.

Seedling height through immersion with H_2SO_4 and HCl has an average difference of -10.45. The negative sign indicated that soaking with HCl resulted in a higher average seedling height than H_2SO_4. The longest roots through immersion with H_2SO_4 and HCl had an average difference of -4.928. The negative sign indicates that soaking with HCl resulted in a longer average root length than soaking with H_2SO_4. Soaking with KNO_3 and HCl had an average difference in root length of -2.144. The negative sign indicates that the immersion with HCl resulted in a longer average root length than KNO_3. Root length through immersion with H_2SO_4 and KNO_3 has an average difference of -2,784. The negative sign indicated that soaking with KNO_3 resulted in a longer average root length than soaking with H_2SO_4.

The results of this study are in line with several previous studies on the effect of chemicals on germination, both using H_2SO_4, KNO_3, and HCl. Research on breaking the dormancy of mucuna seeds showed that H_2SO_4 and KNO_3 could break the dormancy of Mucuna seeds with germination > 80% [12-14]. Nengsih's research on using chemical solutions in breaking the dormancy of liberica coffee seeds showed that H_2SO_4 and KNO_3 could break the dormancy of liberica coffee seeds by softening the seed coat [15]. Based on these studies, no one has investigated the use of H_2SO_4, KNO_3, and HCl breaking palm oil dormancy.

Based on the soaking results using H_2SO_4, KNO_3, and HCl, soaking using HCl was the best result in breaking the dormancy of oil palm. Soaking using HCl obtained germination, the height of seedlings, and long roots with the maximum average. Strong acid solutions such as HCl are often used with varying concentrations depending on the seed needed, making the coat soft [16-18]. The administration of HCl given to sugar palm seeds caused a speedy increase in the percentage of germination growth [19-20].

CONCLUSION

The chemical process, which includes immersion with H_2SO_4, KNO_3, and HCl, has a significant effect on breaking palm oil dormancy, as seen by the difference in the average germination speed and germination rate seedling height and longest root length. Based on the average difference in germination speed, chemical processes that gave different results were soaking with H_2SO_4 and KNO_3, soaking with H_2SO_4 and HCl, and soaking with KNO_3 and HCl. Based on the average difference in germination rate, the chemical processes that gave different results were soaking with H_2SO_4 and KNO_3, soaking with H_2SO_4 and HCl, and soaking with KNO_3 and HCl. Based on the average difference in seedling height, the chemical process that gave different results was soaking with H_2SO_4 and HCl. Based on the average difference in root length, the chemical processes that gave different results were soaking with H_2SO_4 and KNO_3, soaking with H_2SO_4 and HCl, and soaking with KNO_3 and HCl.

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