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Nutmeg (*Myristica fragrans* Houtt.) Dormancy Breaking Rate by Potassium Nitrate and Sulfuric Acid

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ABSTRACT

Nutmeg is an agricultural commodity which has a high economic value. Seeding can be problematic when cultivating nutmeg because its skin is impermeable to water which means that nutmeg hard skin does not allow water pass through it. Chemical treatments have been proven able to break the nutmeg seed dormancy. This research attempted to use KNO_3 and H_2SO_4 to accelerate the nutmeg dormancy breaking rate. Appropriate concentration of the chemicals allows the absorption of water by nutmeg seeds during the imbibition process. To investigate kinds and concentration of chemicals that can be used to speed up the nutmeg dormancy breaking rate, the present experimental study employed a completely randomized design with 9 treatments and 3 repetitions. This experiment made use of KNO_3 and H_2SO_4 with concentration of 1,0, 1,5, 2,0, and 2,5% for each. Nutmeg without chemicals soaking was made as the control subject. Research findings show that KNO_3 could improve the percentage of nutmeg dormancy breaking rate (33-100%). In addition to that, the use of KNO_3 with concentration of 2% was able to speed up the rate (22 days/seed). The use of H_2SO_4 with low concentration was unable to soften the nutmeg skin; on the other hand, the use of H_2SO_4 with high concentration resulted in the nutmeg seeds damage.

INTRODUCTION

Nutmeg with scientific name *Myristica fragrans* Houtt. is a spice plant which has high economic value. Its seeds and mace (arillus) can produce an essential oil and special fat. Market demand for nutmeg keeps increasing from year to year, and no less than 60% of nutmeg found in the world is imported from Indonesia. To increase foreign exchange through non oil and gas export and to expand employment, it is necessary to pay a careful attention to the development of the nutmeg production Agritek Maluku Utara[1].

Three parts of nutmeg which contain a high economic value are nutmeg flesh, mace (arillus), and seed Drazat[5]. Local people of North Maluku find it hard to cultivate nutmeg seeds because the seeds are constructed by hard stone cells which result in slow water absorption (imbibition). Therefore, chemicals treatments need to be performed in order to soften the skin.

People in North Maluku normally use two ways to breed nutmeg. First, the seeds are sowed without giving any prior treatment. Through this way, however, the germination process takes more than a month. Second, before the seeds are sowed, they were cracked. This treatment can speed up the germination process (2 -3 weeks), but the cotyledon of the seeds is more vulnerable to damage if they were soaked in a considerable amount of water. Thus, an early stratification should be done to accelerate the imbibition process. One of which is by using chemicals.

Chemical treatments can be done to break nutmeg seeds dormancy. The main purpose of these treatments is to make the seeds skin easy to absorb water during the imbibition process. A strong acid solution can soften the skin so that water can pass through it Sahupala[9]. According to Gardner[6], exogenous chemical compounds in a medium are useful to encourage the germination process. However, people need to note that the chemical compounds can only be used as a trigger, not the required condition of a germination process. The aim of this research, thus, was to increase the nutmeg seeds breaking rate by using chemical compounds.

MATERIALS AND METHODS

Nutmeg seeds were collected from ripe nutmeg fruits taken from the tree. They should be in a good condition and a normal shape. The seeds were cleansed by water and air-dried for 2-3

days. In the meantime, 1000 ml of 5% potassium nitrate (KNO_3) and 1000 ml of 5% sulfuric acid were put in a storage. Soon after, KNO_3, H_2SO_4 compounds were prepared and divided into various concentrations (1, 1,5, 2, and 2,5%); 600 ml for each by using the following dilution Yazid [15].

$$V_1M_1 = V_2M_2$$

Note:

V_1 = volume of solution before dilution.

V_2 = volume of solution after dilution.

M_1 = concentration of solution before dilution.

M_2 = concentration of solution after dilution.

After that, 75 nutmeg seeds were selected and soaked in H_2SO_4 and KNO_3 solution with five different concentrations (1, 1,5, 2, and 2,5%) separately for 24 hours. Each treatment used five seeds and was repeated three times.

The seeds were sowed at the Green House of LPPM Universitas Khairun. The seeds were planted on sandy loam soils which were put in plastic containers sized 50 X 25 cm^2. Before the sands were poured into the plastic boxes, they were cleaned from any remaining roots of plants and dried under the sun for 1-2 days. The containers were lined up neatly. A small and narrow hole was made on each planting medium. One seed was planted into a 3-5 cm deep seeding hole and covered with thin ground. After the seeding process was over, the media were watered.

An observation was conducted a week after. The number of sprouts was recorded every two days within 29 days. The percentage and the rate of the nutmeg dormancy breaking were calculated using the following formula suggested by Sutopo[12].

$$\text{Percentage of dormancy breaks} = \frac{\text{The number of seeds that broke his dormant}}{\text{Number of seeds used}} \text{ x } 100\%$$

$$\text{The pace of dormancy compliance} = \frac{N_1T_1 + N_2T_2 + \ldots + N_xT_x}{\text{The number of seeds that broke his dormant}}$$

Note:

N = number of seeds whose dormancy is broken at a specified time

T = time needed to break the N-dormancy

Data gathered from the observation was analyzed using ANOVA test and advanced *Duncan's Multiple Range Test* (DMRT) using a significance level of $p < 0,05$.

RESULTS AND DISCUSSION

Nutmeg seeds skin contains compact lignin and starch. Experts have successfully proven that there are covalent bonds (ester, ether, and glycosidic bonds) found between those two compounds. Ester bonds are easily broken by alkali compounds while glycosidic bonds are easily broken by a strong acid Sjöström[11]. Because of that, pores of testa on seeds are open and water can easily pass through them during the imbibition process.

White fungi could be found on the nutmeg seeds skin after the seeds were soaked in KNO_3 and H_2SO_4. These fungi are categorized into white filth that can degrade lignin. According to Siagian et al. [10], besides degrading lignin, white filth can also damage other components of a cell wall. White filth simultaneously destruct the structure of the main polymer of xylem, such as lignin, hemicellulose, cellulose at the same time. It means that after the seeds were soaked in KNO_3 and H_2SO_4, the bonds between carbohydrate and lignin found on the seeds skin were broken. Then, these lignin and carbohydrate were degraded by white filth so that the water absorption could easily occur during the imbibition process. Followings are the pictures that show damages on the nutmeg seeds by white filth which made it easy for water to pass through the skin and as a result broke the seeds dormancy.

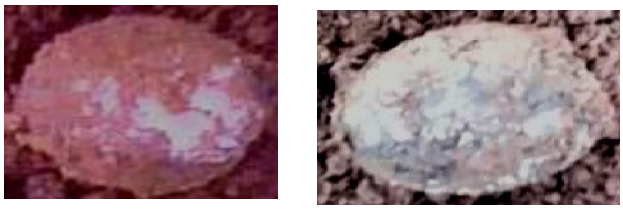

Figure 1. A damaged nutmeg seed after being soaked in H_2SO_4 2,5%.

a b c

Figure 2. The nutmeg seed experienced dormancy breaking which was marked by the appearance of radicula that penetrated the skin.

a) The control seed sprout (observation day-29);

b) A seed sprout soaked in KNO_3 2% (observation day-19);

c) A seed sprout soaked in KNO_3 2% (observation day-29).

Table 1. The percentage of nutmeg seeds dormancy breaking

Treatments	**Average (%)***
control	47±12 bc
KNO_3 1,0%	47±23 bc
KNO_3 1,5%	67±31 c
KNO_3 2,0%	100±00 d
KNO_3 2,5%	33±12 b
H_2SO_4 1,0%	00±00 a
H_2SO_4 1,5%	00±00 a
H_2SO_4 2,0%	33±12 b
H_2SO_4 2,5%	00±.00 a

Note: * number followed by the same letter is not significantly different according to DMRT test at $\alpha = 5\%$.

Table 2. The nutmeg seeds dormancy breaking rate

Treatments	Average (day/seed)*
control	28,44±0,51 c
KNO_3 1,0%	27,44±1,39 c
KNO_3 1,5%	24,93±1,79 c
KNO_3 2,0%	22,20±1,06 b
KNO_3 2,5%	27,33±1,53 c
H_2SO_4 1,0%	0,00±0,00 a
H_2SO_4 1,5%	0,00±0,00 a
H_2SO_4 2,0%	26,67±3,21 c
H_2SO_4 2,5%	0,00±0,00 a

Note: * number followed by the same letter is not significantly different according to DMRT test at $\alpha = 5\%$.

The results of the analysis on the breading of the seeds soaked in KNO_3 and H_2SO_4 solution with different concentrations (1, 1,5, 2, and 2,5%) for 29 days indicated that the solutions had an effect on the nutmeg seeds dormancy breaking. In line with Sahupala[9], chemicals can be used to break dormancy of seeds.

According to Asiedu *et al.* [2], the imbibition process is important because it allows an increase in seeds' water content that is needed to trigger the biochemical changes so that the seeds can produce sprouts quickly. The imbibition rate is not only affected by the seeds skin permeability, but also by its water content. The imbibition process occurs because the concentration of water in the seeds is lower than of the surroundings which as a result allows water diffusion.

Seeds soaked in KNO_3 with different concentrations also resulted in breaking the nutmeg seeds dormancy (33-100%). Candra *et al.* [4] reported that the dormancy breaking rate of pomegranate seeds could be improved by 86,66% by the use of potassium nitrate. Treatments used H_2SO_4 did not always result in the nutmeg seeds dormancy. Only seed soaked in H_2SO_4 2% had the dormancy broken. This could happen because H_2SO_4 with low concentration was not yet able to trigger seeds hydrolysis. Meanwhile, seed soaked in H_2SO_4 2,5% was damaged. As is reported by Sahupala[9], a strong acid solution can damage seed skin and soften it so that water can go through it. However, the use of a strong acid solution can also result in damaging the seed if the solution touches the embryo.

Sutopo[12] explains that treatments using chemicals such as KNO_3 and H_2SO_4 with an appropriate concentration can speed up the production of sprouts because water can go through the skin easily during the imbibition process. The percentage of the nutmeg seeds skin dormancy was higher at KNO_3 2% (100% in average) and followed by KNO_3 1,5% (Table 1). Widhityarini et al. [14] revealed that seeds soaked in KNO_3 0,4% without scarification produced more than 29% *Mimusops elengi* L. sprouts within 89 days. Hartawan [7] also reported that palm seeds that were soaked in KNO_3 1,5% could produce 58,50% more sprouts.

During the dormancy breaking process (the production of sprouts), a seed must contain enough water. According to Gardner [6] *in* Taha [13], the absolute requirement to start the process is the availability of water that can soften the seed skin and allow protoplasm hydration which deactivates the embryonic axis. Taha [13] argues that a great amount of water will be needed to accelerate the production of sprouts.

Cahyono [3] states that nothing happens in plants without water because all chemicals cells need liquid to react. To help accelerate the imbibition process in nutmeg, the seeds should be soaked in chemicals. The nutmeg seeds dormancy breaking is marked by the appearance of radicula.

The results of the analysis on the average rate of nutmeg sprouts production indicate that seed soaked in KNO_3 2% experienced faster dormancy breaking (22 days). Meanwhile, seeds soaked in H_2SO_4 1, 1,5 and 2,5% did not experience dormancy breaking at all. It might happen because KNO_3 could soften the seed skin and replace the sunlight function. Widhityarini *et al.* [14] reported that the use of KNO_3 0,5% could speed up the production of *Mimusops elengi* L. sprouts (47,75 days). Rodrigo *et al.* [8] also revealed that the use of KNO_3 0,5% for 30 minutes could results in accelerating the production of nutmeg sprouts.

CONCLUSION

Based on the results of the research, it can be concluded that:

1. KNO_3 could improve the percentage of nutmeg seeds dormancy breaking by 33-100%. KNO_3 2% is able to accelerate the process within 22 days/seed).

2. H_2SO_4 with low concentration cannot be used to soften the nutmeg seeds and H_2SO_4 with high concentration has been proven to damage the seeds.

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