Agro Bali : Agricultural Journal
Vol. 8 No. 1: 220-229, March 2025

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

Effectiveness of Various Scarification Methods on Breaking Seed Dormancy in Some Types of Palm (*Arecaceae*)

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Article history: submitted: August 10, 2024; accepted: March 23, 2025; available online: March 28, 2025

Abstract. The palm breeding and cultivation challenges are mainly related to the seed germination process. Various factors, including seed dormancy, often influence this process. Various scarification methods and several types of palms that can play a role in breaking dormancy need to be tried. This research aims to determine the best dormancy-breaking scarification method for various palm seeds. This research was carried out in Bakung Village, Sukasada District, Buleleng Regency, from January to March 2024, using a Nested Design comprising two factors. The first factor is that the type of palm seed consists of four levels: Putri palm, Pinang palm, Squirrel Tail palm, and Green palm. The second factor consists of six levels, namely control method (without peeling), peel scarification method, peel scarification method+warm water, peel scarification method+H2SO4, peel scarification method+KNO3, peel scarification method+GA3. The results of the research showed that the scarification method had a significant effect ($p<0,05$) on the percentage of sprouts and shoot length. Very significant effect ($p<0,01$) on the variables of germination, maximum growth potential, seed growth speed, and root length, had an not significant effect on the synchronization of seed growth. This research concludes that the scarification method affects breaking seed dormancy in several types of palm, except for the areca palm.

Keywords: dormancy; germination; scarification; palm seeds

INTRODUCTION

Palm (*Arecaceae*) is an interesting type of plant in terms of shape, diversity, benefits as well as in terms of plant science. Several types of palm plants such as the Christmas palm (*Veitchia merillii)*, Squirrel-tailed palm (*Wodyetia bifurcate*), red palm (*Cyrtostachys renda* Blume), bottle palm (*Hyophorbe lagenicaulis*) and Macarthur palm (*Ptychosperma macarthurii*) have high economic value as decorative plants. In some areas, such as Bali, there are types of palms that have important roles in cultural and religious activities, one of which is the areca palm. However, its population is starting to decline due to seed dormancy, which is difficult to break. Therefore, the palm plant nursery business has great potential to be developed (Olotu et al., 2024). Challenges in the breeding and cultivation of palm plants are mainly related to the seed germination process. This process is often influenced by various factors, one of which is seed dormancy (Suhendra et al., 2024). Seed dormancy is a significant constraint to achieving optimal germination rates, and dormancy-breaking techniques have been identified as an effective strategy to overcome this constraint (Utami et al., 2020). According to Srilaba et al. (2018), peeling the entire seed coat produces the highest germination power in the Germination of Badung Plant Seeds (Garcinia dulcis (Roxb.) Kurz.), namely 78.33%.

Some palm kernels have a hard endocarp that causes resistance and inhibits seed germination. This condition is called mechanical dormancy, so germinating takes 12-16 weeks. One of the efforts to accelerate the germination of palm kernels is to facilitate the entry of water and air into the embryo by damaging the impermeability of the seed shell by giving mechanical and chemical treatments to the seeds (Agurahe et al., 2019).

Furthermore, Baskin & Baskin, (2021) stated that seeds with a hard skin structure will be *impermeable* to water, so the immunization process cannot run properly. In addition, the seeds of the *genus Hibiscus* also have *seed trichomes* that are unevenly spread on the seed skin and *the hilum cap* that is tightly attached to cover the hilum as the

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

entrance of water. This causes the seeds to experience physical dormancy but can be broken, one of which is by the scarification technique (Melasari et al., 2018).

Some dormancy-breaking methods involve physical or chemical treatments on the seeds, such as temperature treatment, hot water treatment, immersion in a specific chemical solution, or mechanical treatment, such as seed shell breaking (Mousavi et al., 2014).

Using hot water is one of the methods that is often used in the breaking of seed dormancy caused by physical dormancy, while the use of chemicals in the form of growth hormones such as gibberellin is often used in the breaking of seed dormancy caused by physiological dormancy. On the other hand, it is also often done by combining dormancy-breaking methods in seeds, which combines mechanical treatment and chemical treatment, such as the use of hormones like GA_3 (Gomes & Grossi, 2016).

The results of the research of Salsabila et al. (2011) showed that the dormancy-breaking treatment of Squirrel-tailed palm (Wodyetia bifurcate) seeds by soaking in hot water at 70oC for 5 minutes had a significant effect on germination power, which was 60.42% compared to ordinary water immersion of 46.25%. Based on the research results, it is known that the combination of H2SO4 and the length time of soaking significantly affect the dormancy breaking of date palm seeds (Burhanuddin, 2022). The homogeneity test results showed that the germination speed and germination power parameters had a significance value of >0.05, namely with values of 0.32 and 0.11. The study results by Purba et al. (2019) showed the best treatment for E. zwageri seeds germination speed was soaked for 24 hours and by giving 0,3% sodium nitrophenolate concentration,

The results of the research of Sinaga et al. (2021) showed that the treatment of KNO_3 with a concentration of 0.6% was able to provide better oil palm seed germination results, namely in the variable of the *percentage of germination of the first count* of 12%, the maximum growth potential of 108%, the germination power of 58%, the growth rate of 3.86%/etmal and the dormancy intensity of 188%.

This study aims to determine the effect of the scarification method on the most effective seed dormancy breaking in several types of palms.

METHODS

This research was carried out in Bakung Village, Sukasada District, Buleleng Regency, from January to March 2024. The materials used in this study are seeds of Areca palm (*Areca catechu* L), Squirrel-tailed palm (*Wodyetia bifurcate*), Christmas palm (*Veitchia merillii)*, Macarthur palm (*Ptychosperma macarthurii*), H_2SO_4, KNO_3, Giberelin (GA_3), sand and aquadest. The tools used in this study are polybags with size 50 x 50 cm, label paper, hand-sprayers, sieves, plastic covers, knives, digital scales, buckets, measuring cups, thermometers, rulers and stationery.

This study was prepared using a *Nested Design* , which consists of two factors. The first factor: Types of palm seeds consist of 4 levels, namely:

Pa = Areca palm (*Areca catechu* L)
Pe = Squirrel-tailed palm (*Wodyetia bifurcate*)
Ph = Macarthur palm (*Ptychosperma macarthurii*)
Pi = Christmas palm (*Veitchia merillii)*

The second factor: The dormancy breaking method with six methods, namely:

Mt = control (without peeling)
Mp = peel
Ma = peel + warm water
Mh = peel + H_2SO_4
Mk = peel + KNO_3
Mg = peel + GA_3

There were 24 combinations of treatments. Each treatment was repeated three times, 72 treatment units were obtained. Each experimental unit used 25

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

seed samples, so that all types of seeds totaled 1,800 seed samples.

The main plot (independent factor) P consists of 4 levels (Pa, Pe, Ph and Pi). In P, there is M (dependent factor), which consists of 6 levels (Mt, Mp, Ma, Mh, Mk and Mg). The M factor is repeated 3 times.

The implementation of the experiment began by preparing the Areca palm (*Areca catechu* L), Squirrel-tailed palm (*Wodyetia bifurcate*), Christmas palm (*Veitchia merillii)*, Macarthur palm (*Ptychosperma macarthurii*) that had been harvested at the same time, with characteristics the seed colour are red. Seeds are taken from the same location in each variety, with orange or red characteristics and mushy flesh. Palm seeds are sown on sand media in polybags, which are ready to be adjusted to the experimental treatment layout and maintained daily.

All selected seeds were then adjusted to the physical treatment method between unpeeled (control) and peeled. Palm seeds were peeled by cleaning the fruit's flesh, taking the seeds, washing them until clean from mucus, and then air-dried. Furthermore, the seeds were soaked according to the type of method and concentration that had been determined. The treatments given consisted of soaking seeds in warm water at an initial temperature of 60°C for 24 hours, soaking seeds in a 3% concentration of H_2SO_4 solution for 24 hours, soaking seeds in a 2.5% concentration of KNO_3 solution for 24 hours and soaking seeds in a 50 ppm concentration Gibberellin (GA_3) solution for 24 hours. The observation variables in this study are:

1. Percentage of Sprout Break (%)

Calculate the percentage of germination by lifting all types of seeds each 30 days after sowing (DAS) age treatment plot. This observation is calculated using the formula:

$$PSB = \frac{\sum Seed\ that\ Sprout\ Break}{\sum Germinated\ Seed} x\ 100\% \text{ .... (1)}$$

2. Germination Power (%)

The calculation of germination power is observed at the age of 90 das; this observation is calculated using Equation 2.

$$GP = \frac{\sum Normal\ Sprout}{\sum Germinated\ Seed} x\ 100\% \text{ .... (2)}$$

3. Maximum Growth Potential (%)

Maximum Growth Potential (MGP) was observed at 90 das, this observation was calculated using the formula:

$$MGP = \frac{\sum Normal\ Sprout + \sum Abnormal\ Sprout}{\sum Germinated\ Seed} x\ 100\% \text{ .... (3)}$$

4. Seed Growth Rate (%/etmal)

The seed growth rate was calculated at the age of 10 das, 30 das, 50 das, 70 das and 90 das in normal growing seeds. The formula calculates the speed of seed growth according to Tefa (2017):

$$SGR = (\% \frac{kn}{etmal}) = \sum_0^n \frac{n}{t} \text{ .... (4)}$$

5. Seed Growing Simultaneity (%)

Seed germination simultaneity was calculated using the percentage of strong normal germination at the last observation:

$$SGS = \frac{\sum Numbers\ of\ Strong\ Sprouts}{\sum Germinated\ Seed} x\ 100\% \text{ ...... (5)}$$

The data from this study was statistically analyzed with *Analysis of Variance* (ANOVA) to see the effect of the treatment tested on both treatments. If one factor has a significant and very significant impact on the observed variables, then the Tukey HSD test of 5% is carried out on both factors (Pradita & Koesriharti, 2019).

RESULTS AND DISCUSSION

The results of the analysis showed that the scarification method had a significant effect on the percentage of sprouts and shoot length, had a very significant effect on the variables of germination power, maximum growth potential, seed growth speed, and root length and had an insignificant effect on the simultaneity of seed growth. Some types of palms show a very real influence on all the variables observed.

The effectiveness of various methods of scarification of dormant breaking of Christmas palm (*Veitchia merillii)* seeds

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

provided the highest percentage of germination in the peeling and GA_3 soaking scarification method, which was 78.67%, compared to the peeling scarification method without soaking, which gave the lowest percentage of germination breaking, which was 48.00% (Table 1).

The dormancy breaking of Areca palm (*Areca catechu* L) seeds gave the highest percentage of germination in the peeling and GA_3 soaking scarification method, which was 44,00%, compared to the unpeeled scarification method, which gave the lowest percentage of germination breaking, which was 33.33% (Table 1). The dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) seeds gave the highest percentage of germination in the peel scarification method without soaking, which was 53.33%, compared to the scarification method without peeling, which gave the lowest percentage of germination breaking, which was 22.67% (Table 1). Dormancy breaking of Macarthur palm (*Ptychosperma macarthurii*) seeds gave the highest percentage of germination in the peel scarification and GA_3 soaking method, which was 56.00%, compared to the peeled scarification and H_2SO_4 soaking method gave the lowest percentage of germination breaking of 17.33% (Table 1). The percentage of sprout break (%) parameter showed the same result with Chaerani et al. (2023) that explained, with the scarification of the seed skin, the thickness and hardness of the seed skin can be reduced. This makes the water imbibition process easier and the seeds can germinate quickly.

Table 1. The effectiveness of various scarification methods on several types of palm seeds on the percentage of germination breaking.

Parameters	Percentage of Sprout Break (%)			
Treatments	Pa	Pe	Ph	Pi
Mt	33.33b	22.67c	21.67c	52.00a
Mp	36.00b	53.33a	22.00c	48.00a
Ma	38.67bc	45.33b	30.67c	62.67a
Mh	38.67b	26.67c	17.33c	62.67a
Mk	37.33b	34.67bc	25.33c	77.33a
Mg	44.00c	34.67c	56.00b	78.67a
Average	38.00B	36.22C	28.83D	63.56A

Remarks: Numbers followed by the same lowercase and uppercase letters in the same column indicate an insignificant difference, based on Tukey HSD 5% test.

The effectiveness of various methods of scarification of dormant breaking of Christmas palm (*Veitchia merillii)* seeds provided the highest germination power in the peeling and soaking scarification method GA_3, which is 84.00%, compared to the peeling scarification method without soaking, which gave the lowest germination power of 50.67% (Table 2). The dormancy breaking of Areca palm (*Areca catechu* L) seeds provided the highest germination power in the unpeeled scarification method, which was 56.00%, compared to the peeling scarification method of H_2SO_4 and KNO_3 soaking gave the lowest germination power, which was 40.00%. The dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) seeds provided the highest germination power in the unpeeled scarification method, which was 54.67%, compared to the unpeeled scarification method, which gave the lowest germination power, which was 22.67%. The dormancy breaking of Macarthur palm (*Ptychosperma macarthurii*) seeds provided the highest germination power in the GA_3 immersion peel scarification method, which was 80.00%, compared to the non-peel

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

scarification method, which gave the lowest germination power, which was 52.00% (Table 2). The scarification method with peeled skin seed and soaking with GA_3 had a significant effect on the sprout power. It caused the infiltration of the embryo growth stimulant solution in the scarified seeds to become easier so that the growth power of the seeds increased (Prabawa et al., 2020). The sprout power increased to 80.00% after soaking in GA3 solution, which might be due to its ability to make the cell wall plasticity and better water absorption (Lay et al., 2013).

Table 2. The effectiveness of various scarification methods on several types of palm seeds on germination.

Parameters	Sprout Power (%)			
Treatments	Pa	Pe	Ph	Pi
Mt	56.00a	22.67b	52.00a	57.33a
Mp	41.33c	54.67b	70.67a	50.67b
Ma	41.33b	48.00b	65.33a	62.67a
Mh	40.00c	46.67c	76.00a	65.33b
Mk	40.00c	54.67b	73.33a	80.00a
Mg	44.00b	38.67b	80.00a	84.00a
Rerata	43.78C	44.22B	69.56A	66.67A

Remarks: Numbers followed by the same lowercase and uppercase letters in the same column indicate an insignificant difference, based on Tukey HSD 5% test.

The effectiveness of various methods of scarification of dormant breaking of Christmas palm (*Veitchia merillii)* seeds provided the highest maximum growth potential in the peel scarification and GA_3 soaking method, which was 84.00%, compared to the peel scarification method without soaking gave the lowest maximum growth potential of 50.67% (Table 3). The dormancy breaking of Areca palm (*Areca catechu* L) provided the highest maximum growth potential in the unpeeled scarification method of 56.00%, compared to the H_2SO_4 and KNO_3 soaking scarification methods provided the lowest maximum growth potential of 40.00% (Table 3). Dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) seeds provided the highest maximum growth potential in the unpeeled scarification method of 57.33%, compared to the unpeeled scarification method, which provided the lowest maximum growth potential of 22.67% (Table 3). The dormancy breaking of Macarthur palm (*Ptychosperma macarthurii*) seeds provided the highest maximum growth potential in the GA_3 immersion peel scarification method, which was 80.00%, compared to the non-peel scarification method, which gave the lowest maximum growth potential 52.00% (Table 3).

The scarification method with peeled seed skin and GA3 immersion showed a significant effect from all types of areca plants that were used in the plant sample on the growth potential parameter. The result might be caused by the GA_3 and peeled seed skin can make water absorption better and activated the cytological enzymes (Lay et al., 2013).

The effectiveness of various methods of scarification of dormancy breaking of Christmas palm (*Veitchia merillii)* seeds provided the highest seed growth rate in the peel scarification method and immersion in GA_3 solution, which was 8.00%/etmal, compared to the peel scarification method without soaking gave the lowest seed growth rate of 4.89%/etmal (Table 4). The dormancy breaking of Areca palm (*Areca catechu* L) seeds provided the highest seed growth rate in the unpeeled scarification method, which was 4.76%/etmal, compared to the KNO_3 solution soaking scarification method,

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

which provided the lowest seed growth rate, which was 3.91%/etmal (Table 4). Dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) seeds provided the highest seed growth rate in the peel scarification method without soaking, which was 5.29 %/etmal, compared to the peelless scarification method which gave the lowest seed growth rate of 1.64 %/etmal.

Table 3. The effectiveness of various scarification methods on several types of palm seeds on maximum growth potential.

Parameters	Maximum Growth Potential (%)			
Treatments	Pa	Pe	Ph	Pi
Mt	56.00a	22.67b	52.00a	57.33a
Mp	41.33c	57.33b	70.67a	50.67b
Ma	41.33c	50.67b	65.33a	64.00a
Mh	40.00c	46.67c	76.00a	65.33b
Mk	40.00c	57.33b	73.33a	80.00a
Mg	44.00b	38.67b	80.00a	84.00a
Rerata	43.78C	45.56BC	69.56A	66.89A

Remarks: Numbers followed by the same lowercase and uppercase letters in the same column indicate an insignificant difference, based on Tukey HSD 5% test.

The dormancy breaking of Macarthur palm (*Ptychosperma macarthurii*) seeds provided the highest seed growth rate in the GA_3 solution immersion peel scarification method, which was 6.67 %/etmal, compared to the peelless scarification method, which gave the lowest seed growth rate of 2.49 %/etmal (Table 4). Combination peel scarification and immersion GA3 solution for dormancy break gave significant result on Christmas palm (*Veitchia merillii)* and Macarthur palm (*Ptychosperma macarthurii*) its might be caused the combination GA_3 and peeled method can removed the enveloping layer seed and increased activity of α-amylase and protease enzyme necessary for germination (Utami, 2010).

Table 4. The effectiveness of various scarification methods on several types of palm seeds on the growth rate of seeds.

Parameters	Speed Growth Rate (%)			
Treatments	Pa	Pe	Ph	Pi
Mt	4.67a	1.64b	2.49a	5.56a
Mp	3.91b	5.29a	4.62ab	4.89a
Ma	3.96c	4.89b	4.49bc	6.31a
Mh	3.96c	3.91c	4.98b	6.36a
Mk	3.91c	5.07b	4.89b	7.73a
Mg	4.40b	3.69b	6.67a	8.00a
Rerata	4.15C	4.08D	4.69B	6.47A

Remarks: Numbers followed by the same lowercase and uppercase letters in the same column indicate an insignificant difference, based on Tukey HSD 5% test.

The effectiveness of various methods of scarification of dormant breaking of Christmas palm (*Veitchia merillii)* seeds provided the highest growth simultaneity in the KNO_3 solution immersion peel scarification method, which was 21.97%, compared to the non-peel scarification method, which provided the lowest growth simultaneity, which was 19.71% (Table 5). The dormancy breaking of Areca palm

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

(*Areca catechu* L) provided the highest growth simultaneity in the GA_3 solution soaking peel scarification method of 21.74%, compared to the peel scarification method without soaking gave the lowest growth simultaneity of 18.53% (Table 5). The dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) seeds provided the highest growth uniformity in the GA_3 solution immersion peel scarification method, which was 18.07%, compared to the peelless scarification method, which gave the lowest growth uniformity, which was 14.60% (Table 5). The dormancy breaking of Macarthur palm (*Ptychosperma macarthurii*) seeds provided the highest growth simultaneity in the GA_3 solution soaking peel scarification method, which was 24.20%, compared to the peel scarification method without soaking, which gave the lowest growth simultaneity, which was 17.59% (Table 5).

Table 5. Several types of palm seeds against the simultaneity of growing seeds.

Parameters	Seeds Growth Simultaneity (%)			
Treatments	Pa	Pe	Ph	Pi
Mt	33.33b	22.67c	21.67c	52.00a
Mp	36.00a	37.33a	22.00b	44.00a
Ma	34.67bc	43.67b	30.67c	56.00a
Mh	38.67b	26.67c	17.33c	62.67a
Mk	37.33b	34.67bc	25.33c	77.33a
Mg	44.00c	34.67c	56.00b	78.67a
Rerata	37.33B	33.28C	28.83D	61.78A

Remarks: Numbers followed by the same lowercase and uppercase letters in the same column indicate an insignificant difference, based on Tukey HSD 5% test.

The dormancy breaking of Christmas palm (*Veitchia merillii)* by peeling scarification method and soaking in GA_3 solution affected the variables of germination power, maximum growth potential and growth rate of the seeds that obtained the highest percentage, compared to the unpeeled (controlled) which obtained the lowest percentage of several variables observed. This is because the use of GA_3 as a result of dormancy breaking activates the metabolic process so that cell elongation runs faster with cell activation, and the coleoptile will be longer. The dormancy that occurs in palm seeds is caused by the thick seed skin, so it *is impermeable* to water and gas (Rumahorbo et al., 2020).

The dormancy breaking of Areca palm (*Areca catechu* L) was most effective in the treatment of the dominant unpeeled scarification method, obtaining the highest percentage of germination power variables, maximum growth potential, seed growth rate and root length, compared to the treatment of peeling scarification method and soaking of various chemical solutions. This is likely due to the seed shell (epicarp) which is a protector of the seed from moisture, with environmental conditions of lack of sunlight and low temperature, because at the seedbed location at that time, it was still in rainy season conditions, so that some embryos in Areca palm (*Areca catechu* L) seeds that used the peel scarification method treatment were easily rotted before germination.

The method of dormancy breaking of Squirrel-tailed palm (*Wodyetia bifurcate*) showed the highest percentage on the variables of germination percentage breaking, germination power, maximum growth potential and seed growth rate at various peel scarification methods without soaking, compared with the treatment of peel scarification combine with chemical solution immersion method. However, it has an effect on the growth of high shoots and root length on the KNO_3 and GA_3 immersion combined with the peel scarification method. This is likely because the seed endocarp is hard and impermeable, making it difficult for water

e-ISSN 2655-853X
https://doi.org/10.37637/ab.v8i1.1995

and oxygen to enter, causing the seeds to stagnate, which is a condition where seeds are slow to germinate even though the environmental conditions are ideal (Wijayanti, 2023). Furthermore, (Akbar et al., 2017) stated that based on the mechanism in seeds, dormancy is divided into physiological dormancy and physical dormancy. Physiological dormancy is a dormancy caused by the occurrence of obstacles in physiological processes such as rudimentary embryos.

The use of the peeling and soaking scarification method GA_3 obtained the longest root length in the sprouts of the Squirrel-tailed palm (*Wodyetia bifurcate*). This happens because GA_3 can affect the vegetative growth of plants, in this case, the development of plumula and root growth. Asyi'ah et al. (2019) state that the growth rate of plants is directly proportional to the vegetative growth of plants. Where the rapid growth of plants causes the structure of plant vegetative organs to also quickly form which is helped by environmental factors such as temperature, light and humidity (Tefa, 2017).

Mature, freshly shed seeds of palms typically display a combination of underdeveloped embryos (morphological dormancy) and the inability of developing embryos to rupture covering structures (physiological dormancy). Removal of embryo-covering structures and incubation under moist, warm conditions promotes rapid and complete germination on Loulo Palm (Pritchardia remote) (Pérez, 2009). Furthermore, Setyaningsih (2018) stated that enzymes will begin to digest the materials stored in the cotyledon and the nutrients are transferred to the embryo that has grown. Enzymes that play a role in the digestion of food reserves are amylase enzymes, beta-amylase and proteases. The GA_3 hormone plays an important role in triggering and regulating the activation and formation of these enzymes.

The most effective dormancy of Macarthur palm (*Ptychosperma macarthurii*) was found in the peel scarification method and the dominant GA_3 soaking method provided the highest percentage of germination breaking percentage, germination power, maximum growth potential, seed growth speed and longest root length, compared to other scarification methods. It happens that the scarification method can break the dormancy in seeds that are impermeable to water and gas because it can increase seed imbibiability. Asra (2014) stated that GA_3 can affect the germination process of seeds because it is able to stimulate the formation of amylase enzymes. Amylase enzyme is an enzyme that has a role in breaking down amylum compounds in plant endosperm (food reserves).

CONCLUSION

Based on the results and discussion, it can be concluded as follows: the scarification method has an effect on the dormancy breaking of seeds in several types of palms, except Areca palm (*Areca catechu* L). The germination power variable showed the most effective seed dormancy breaking method that in the Christmas palm (*Veitchia merillii)* is the peeling and gibberellin soaking (GA_3) method, the effective method for Areca palm (*Areca catechu* L) is the scarification method without peeling, for the Squirrel-tailed palm (*Wodyetia bifurcate*) the effective method is peeling scarification method without soaking and the Macarthur palm (*Ptychosperma macarthurii*) the effective method is the peeling and soaking GA_3 scarification method.

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