Ulin (*Eusideroxylon zwageri* T.et.B) seed cleavage, fast way of germination in Sambas Regency, West Kalimantan

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**Abstract.** Ulin (*Eusideroxylon zwageri* T.et.B) or Ironwood has never been cultivated by the people in Sambas, West Kalimantan. As the limited duration of the germination and growth of ironwood trees need to breakthrough propagation techniques. Forests in Sambas Regency are beginning to lose the ironwood trees because of the wood that is strong and durable (including the strong class I and durable class I), so that it is widely used for building houses and bridges. This study aims to propagating of ironwood seeds through propagation techniques. The seed coat treatments and cleavages used for this experiments in Sajingan Besar of Sambas Regency.

Sowing seeds regular of Ironwood takes 9 months and can accelerated to be 3 months but the seed coat must be peeled first. The characteristic of ironwood seed has a polyembryonic seed, so that used treatments of cutting the seeds to be 2 and 3 parts of seed. The results that the ironwood seeds can grow faster after 4 weeks planting if peeled the coat and cutting seeds into two part of seeds. The quantitative analysis explained and showed in this paper.

1. **Introduction**

Bulian or Ulin or Ironwood has the Latin name *Eusideroxylon zwageri* T. & B. (Family Lauraceae). Previously it could not be separated from the culture of traditional houses which resist of a termite and used for houses on the banks of long-lasting rivers in Sumatra and Kalimantan. But now it is a type of wood whose scarcity is categorized as vulnerable (Vulnerable = VU1d), even this status in 2010 became Vulnerable A1cd + 2cd ver 2.3 [1]. *Eusideroxylon zwageri* growth is very slow even an average of 0.5 cm per year making it difficult to make as a plantation. Ironwood is one of the types of wood that is widely used, so that its population in nature decreases because it is not cultivated by replanting efforts. Ironwood has a very high commercial value because of wood that is very strong and durable, with strength class I and durability class I, the trunk is upright, height reaches 50 m, diameter 50-200 cm [2]. According to Heyne [3], ironwood has the potential to be a construction material for buildings, bridges, and railroad bearings. This plant distributed in Indonesia, namely on the islands of eastern and southern Sumatra, Bangka, Belitung and Kalimantan. Excessive logging without rejuvenation or replanting efforts can cause natural populations to be vulnerable [4]. This situation is very worrying if no conservation efforts are made. Ironwood can be propagated through seeds, grafts, or tissue culture [5]. Propagation through tissue culture requires high costs and still fails because of high polyphenols. While graft can damage the parent plant and hard to climb. For this reason, propagation in a simple and precise way through seed germination is expected to facilitate for farmers
and help to preserve this type of wood with high economic value. However, seed propagation naturally takes 6 - 12 months to germinate [2]. In addition, seeds can germinate if they get 3 conditions, namely the seeds must be alive, the seeds are not in a dormant state, and environmental requirements for seed germination can be reached. This study aims to determine and study the treatment of ironwood seeds which propagating of ironwood seeds through propagation techniques.

2. Method

2.1. Location and Time
This research was carried out in the Sambas Botanic Gardens and Ironwood Nursery in Kaliau Village, Sajingan Besar District, Sambas Regency, West Kalimantan Province for one year (January-December 2017) but seed of ironwood collected since November 2016.

2.2. Materials
The research materials used were ironwood seeds where collected in the garden of Kaliau Village, Sajingan Besar District, Sambas Regency, Province of West Kalimantan. There are two parent trees in the field. Seedling media used consists of soil and compost. Ironwood seeds are planted into a 30 cm diameter polybag in each treatments. The nursery is done in the polybag that is given a paranet roof by 60 % in mesh of paranet. Provision of paranet is intended to shade ironwood seedlings from the sun. This research was conducted under paranet, so the factors that influence it are thought to be homogeneous. The treatment of seed consists of shelled out of coat on seeds, seeds cut into 2 and into 3 pieces (Figure 1A).

![Figure 1](image)

Figure 1. Seed of ironwood cut into 2 and 3 (A), part or seedling i.e coat or exocarp (B), endosperm (C), shoots (D) and roots (E); polyembryonic seed of ironwood (F) and seedling after 14 weeks planted in nursery of this study (G).

2.3 Parameters and data analysis
Observation of Ironwood parents height and diameter of bark, then seed size (length and diameter) and shape. Germination of seed in each treatments were observed. Parameters of seedling are height, diameter, number of shoots in each seeds, number of leaves, and height in every weeks. Habitat conditions i.e. pH soil, soil humidity (Rh%), air humidity (Rh%) and temperature at noon (˚C) were also observed. Analyze of seedling growth data using the Excel Windows program.
3. Result and discussion

3.1. Ironwood parent trees characters and seed size

The two parent trees used in this study showed variations in their height and diameter of stems that parent of variants B (26.2 m high and 69.6 cm in diameter) higher than variants A (25.5 m high and 45.8 cm in diameter). The shape of seed of two parents also different, namely seed of parent trees A (hereafter A) and seed of parent trees B (hereafter B). Variants A has a larger seed size (76.87 cm²) or longer in average compared to variants B (50.01 cm²), while the diameter is not so different (A = 5.5 cm; B = 5.6 cm). So that is why variant A called long seeds (oblong) and variant B called round seed (ovate). In addition, differences in the two variants were also shown in stem diameter, leaf area, and height of shoots produced. In var B, ironwood seedlings were higher (74.36 cm) than var A (63.94 cm) as well as leaf area (B = 398.88 cm²; A = 293.45 cm²), although the stem diameter was smaller (B = 0.69 cm; A = 0.77 cm). Likewise, the characteristics of growing sites also show similarities between the two variants (presented in Table 1).

Table 1. Comparison of parent trees size and environmental factors of the two ironwood variants

| Parent trees | Variants A | Variants B |
|--------------|------------|------------|
| Height (m)   | 25.50      | 26.20      |
| Diameter (cm)| 45.80      | 69.60      |
| Seed size    |            |            |
| Average of seed size (cm²) | 76.87 | 50.01 |
| Average of seed diameter (cm) | 5.5 | 5.6 |
| Seed shape   | oblong     | rounded    |
| Seedlings    |            |            |
| Average of heights (cm) | 63.94 | 74.36 |
| Average of stem diameter (cm) | 0.77 | 0.69 |
| Average of leaf area (cm²) | 293.45 | 398.88 |
| Habitat conditions |            |            |
| pH soil      | 6.0        | 5.9-6.1    |
| Rh soil (%)  | 55-75%     | 65-70%     |
| Temperature (°C) | 33   | 33         |
| Rh air (%)   | 68%        | 68%        |

3.2. Ironwood seed, seed germination and treatments

Ironwood seeds grow many shoots and these are known as polyembrionic seeds (Figure 1F). The seed scheme in ironwood seeds consists of the outside as an exocarp, the shell or the middle as a coat or mesocarp (Figure 1B) and the inside endosperm and some embryos (Figure 1C). After 3 months of observation (Figure 1D), showed that the shoot height in each variants also showed differences. Ironwood seeds variety A, showed that treatment by cutting into 2 (A2) had the highest average shoot height (62.5 cm) compared to other treatments. Unlike the case with round seeds, where treatments cut 2, cut 3 and peel showed quite high results compared to whole (with exocarp) (Table 2). This also corresponds to the height of the shoots in the whole observation sample (Figure 2) which shows the cutting of the seeds and opening the seed coat produces the best seedling height compared to the exocarped seeds. Early seed germination can be accelerated by injuring or cutting the seeds so that water enters. Consequently, seed germination tends to produce higher shoots, although the availability of food reserves and root readiness in absorbing nutrients in the soil are very influential.
Table 2. Comparison of leaves number and branches number in both ironwood variants and among treatments

| Sample Code* | Number of samples | Number of growing seeds (%) | Number of leaf shoots |
|--------------|------------------|-----------------------------|-----------------------|
| A1 (peeled or uncoat) | 13 | 8 (61.5) | 24 | 7 |
| A2 (cutting 2) | 10 | 10 (100) | 5 | 3 |
| A3 (cutting 3) | 14 | 5 (35.7) | 33 | 7 |
| **Total** | **37** | **23 (62)** | **62** | **17** |
| B1 (peeled or uncoat) | 27 | 8 (29.6) | 13 | 3 |
| B2 (cutting 2) | 39 | 5 (12.8) | 8 | 3 |
| B3 (cutting 3) | 37 | 1 (2.7) | 12 | 4 |
| **Total** | **103** | **14 (13.6)** | **33** | **10** |

*A=Ironwood seed with variant oblongate; B=Ironwood seed with variant ovate or rounded

In other parameters, the number of leaves and number of branches showed differences in both variants and treatments. In the long seed variants (A), the number of leaves and the number of branches produced higher in percentage of seed growing (62 %) than variant in the treatment is cut 2 smaller than round seed variants (B). So that they produce seedlings which tend to have more sparse leaves (62 leaves) and shoots (17 shoots) than Variant B (33 leaves and 10 shoots). In long seeds (B), even cutting seed into 2 shows growing 100 %, but in B variant cutting into 3 only 2.7 % grown. Furthermore, the comparison of germination of the two variants (Table 2) shows that the rounded seeds (var B) that are cut tend to produce smaller germination compared to the long seed variants (var A). This is related to the size of the seeds, that the type of round seeds is relatively smaller (var B = 50.02 cm²) compared to long seeds (var A= 76.87 cm²) see in Table 1. So the bigger the seed size, the higher the percentage of the germination. Another tendency is that improper division of seeds, especially at smaller sizes, can damage the seed embryos themselves so that the germination is disrupted.

Seeds that germinated in each treatment showed differences in the number of seeds that germinated. Seeds that are peeled (endosperm) show the highest percentage of growth (40%) compared to other treatments, namely whole seeds (coat / without peeling, only 9%), seeds cut into 2 (by 15%) and seeds cut into 3 (as much as 11.8%) (Figure 2). Referring to [5], seedling of ironwood by peeling the entire seed coat gives the best results from all treatments that are tried, such as sun-dried, soaked in water, cracked the coat, soaked in water or stored at a temperature of 20°C. Fruit with a hard seed coat type, as in the type of ironwood is one of the factors blocking the entry of water for the imbibition process. The entry of water into the seeds can activate the hydrolytic enzymes that play a role during the process of seed germination so that the seed dormancy can be removed [7, 8].

The seeds that are cut are even higher than the seeds which are whole or even which are in a peeled coat seed (Figure 3). In the split seeds will be more effective in the growth of the roots so that the roots appear more and the growth becomes faster. Seeds that are cut, both into 2 and 3 show better results when compared to whole-exocarpned seeds (which have coat).
Figure 2. Percentage of the number of seeds germinated in each treatment.

Figure 3. The height average (cm) of shoots in each treatment.

3.3. Ironwood growth
The graph of ironwood germination growth during 18 weeks of observation showed that almost every week there was an increase in the number of ironwood sprouts (Figure 4). The endosperm content is an internal factor of the seeds which influences the germination. Seeds that come from the same variety, but with different sizes, the larger size will be able to grow relatively quickly [9].
Figure 4. The growth of Ironwood seedlings from seed germination for 18 weeks of observation

The effect of seed treatment on ironwood seed germination is presented in Figure 4. This figure shows that every week there is an increase in the number of ironwood seed sprouts. Starting at the age of 14 weeks after planting (Figure 1G), peeled seeds germinate more than 50%. The highest percentage of germination occurs in seeds that are coated or discarded. While the lowest occurs in seeds that are injured. Low germination caused by seeds damaged when cutting the tip of the seed. Peeled seeds get faster of water and light as well as in the process of growing roots and shoots are not obstructed by the coat. The natural treatment occurring in the forest was revealed by [10], that the regeneration of Ironwood trees in protected forests in Sabah Malaysia is highly dependent on the adequacy of the spread and nursery of Borneo ironwood seeds (Eusideroxylon zwageri). Here, a decline in the abundance of ironwood seeds is exacerbated by local aggregation and the contribution of ironwood seed-eating and young leaf-eating animals (deer and apes). In addition Ironwood seedlings that are less than 3 years old are sometimes more sensitive to sunlight and dry weather conditions than older seeds (aged 3 years or more) and Ironwood will hold fire after becoming large [11]. Ironwood is a valuable tree species that is associated with forests and old forests slow tree species found in mixed dipterocarp forests. When clear felling of forests, the consequences are long-term for East Kalimantan forests destroyed [12]. Although Dipterocarpaceae trees are considered resilient, however, they will need 50 to 100 years to grow back. Ironwood is one of them most ancient living organisms, with a life span of 1,200 years or more, however, have very low regeneration rates.

The treatment of ironwood seeds by traditional handling has been found to be able to increase its growth rather than naturally in the forest. Even the occurrence of real differences due to the effect of treatment of seeds that are peeled with seeds that are injured and intact. The seeds shell produced the highest sprouts compared to other treatments.

4. Conclusion

Seeds for variant B with rounder shape grow higher (74.36 cm) than variant A with oblong shaped seeds (63.94 cm), but percentage of growing (62 %) higher in var A than var B (13.6 %). Ironwood seeds that are peeled intact have a higher percentage of growth (40%) than those halved 2 (15%), halved 3 (11.8%) and whole (with coat; 9%). In addition, coat peeled are better than whole seeds. Seed growing fast since 14 week after planting for 18 weeks observation under the paranet nursery.
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