

Conference Paper

Fruit Description and Evaluation of Five Treatments to Break Seed Dormancy of *Brownlowia peltata* Benth

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Abstract

Brownlowia peltata Benth. is a native tree from Borneo, in its germination problem was physical dormancy due to the hard pericarp of the fruit. The study aimed to evaluate five treatments for breaking the seed physical dormancy and the fruit description. The experiment was using Randomized Complete Block Design (RCBD) with four different temperatures of water immersion, a scarification, and control. The fruit of *B. peltata* was a woody follicle; belong to yellow green group 148 A in color; 29.64 mm in long; 21.62 mm in thickness; 29.86 mm in wide, with an average weight of 12.05 g. Hot water immersion treatment of 40°C for 60 s; 60°C for 60 s and 80 °C for 30 s could raise the fruit moisture content of 0.92% to 1.04%. There was a significant difference on germination rate coefficient and coefficient of uniformity of germination among treatments. The mature seed does not have a physical dormancy once the carpel splits and create a slit (fruit opening).

Keywords: *Brownlowia peltata* Benth; dormancy; fruit; seed; viability.

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1. Introduction

Here *Brownlowia* belongs to Tiliaceae family and currently according to APG III, along with Bombacaceae, Malvaceae and Sterculiaceae merge into Malvaceae. *Brownlowia peltata* Benth. of the subfamily Brownlowioideae, is a small tree which is native to Borneo. The wood has been used for furniture and housewares. The fruit or seed is eaten as fresh fruit and used as a source of oil for perfumery by locals [1].

Brownlowia peltata is mainly propagated by seed since it produces a lot of fruit in recemes. *Brownlowia*'s fruit is woody follicle with rough hard pericarp. However, hard seed pericarp of the fruit may cause slow and erratic germination and emergence. We expected this hard pericarp was water-impermeable which causing physical dormancy (PY) in the seed germination. Physical dormancy occurs due to the cover of fruit and seed with hard water permeability. It may well be, due to the presence of woody walls of fruits or seeds [2]. Fabaceae, Malvaceae s. lat. (including Bombacaceae s. str., Sterculiaceae s. str. and Tiliaceae s. str.), and Rhamnaceae has been confirmed as

families of PY [3]. They mentioned seeds of *Luehea speciosa*, *Luehea seemannii*, *Apeiba aspera*, *Apeiba tibourbou* (Tiliaceae s. str.) were assigned to dormancy class PY.

Mechanical scarification, chemical (acid) and immersion in hot water/ heat treatment are two popular treatments to open the seed wall or break physical dormancy. The result of a study by Bien & Lan [4] recommended that seeds of *B. tubularis* need sowing immediately after harvest and was treated with 60°C water immersion for an hour before sowing. It indicated that *B. tubularis* possibly had a physical dormancy that needs to break before sowing.

Two specimens of *B. peltata* which are cultivated in Bogor Botanic Garden are flowering twice a year and produce abundant of fruits. The seedlings that are growing naturally from seed have never been observed related to the seed characters and dormancy. The germination character of *B. peltata* is also poor known. Therefore, the aim of this study was to evaluate five treatments to break the physical dormancy of the seed along with the fruit description.

2. Materials and Methods

2.1. Materials and methods

More than 240 fruits of *Brownlowia peltata* Benth. were collected from a collection specimen of Bogor Botanic Garden at May 4th, 2015. The fruit age or maturity was unknown and indehiscent (not split yet). The fruit and seed examination were conducted in Treub Laboratory and Seed Bank Unit of Bogor BG. The observation of germination conducted in trial nursery of Bank Seed Unit from May to June 2015. In fruit and seed description examination, we used 30 fruits that were chosen randomly. The variables included weight of 1000 units, fruit color (using RHS color chart), dimension size of fruit and seed.

For germination test, we used a Randomized Complete Block Design (RCBD) with total six treatments for breaking physical dormancy: four different temperatures of water immersion, a scarification treatment, and a control. Each treatment had four replicates and each replication contained 10 fruit. The water temperatures were 40°C for 60 min; 60°C for 60 min; 80°C for 30 min; and 93°C for 1 min. After the fruit had got treatments, all of the seed were immersed in room temperature water for 24 h to encourage imbibition. Sowing of the seeds conducted in boxes of sand media under tree shade with regular watering. Environment data was also collected throughout the observation including temperature, relative humidity, and light intensity.

2.2. Data analysis

Calculation of the seeds moisture contents on fruit was using formulas below:

$$\begin{aligned} &\text{Seeds Moisture Content (\%)} \\ &= \frac{\text{Weight of fruit} \times \text{day}}{\text{Weight of fruit} (\times \text{day} - 1)} \\ &\quad \times \% \text{ moisture content (beginning)} \end{aligned} \quad (1)$$

Calculation of germinating rate was using formulas as follows [5]:

$$\text{Germination rate} = \frac{\text{number of seeds germinated}}{\text{number of seeds on tray}} \times 100\% \quad (2)$$

$$\text{Germination Rate Coefficient} = \frac{\sum n}{n \times t} \quad (3)$$

$$T = \frac{\sum (t \times n)}{\sum n} \quad (4)$$

$$\text{Coefficient of uniformity of germination} = \frac{\sum n}{\sum \{(T - t)^2 \times n\}} \quad (5)$$

Descriptions: t : \times day; n : number of seed; T : Total number of days of germination.

Data analysis used Fisher Test (F-test) at a real level 0.05, followed with Duncan Multiple Range Test at a real level 0.05, when the F-test showed significant different.

3. Results and Discussion

3.1. Fruit and seed descriptions

Based on the examination, the fruit of *B. peltata* belongs to follicle type, oval, slightly flattened, sometimes irregular, woody with a line of dehiscence dividing the carpel into two parts. It contained a single seed that at maturity the fruits dry and dehisces on the line of dehiscence into two carpels [6], but in this case, the seed did not release and was separated from carpel. The carpel was persistent until the seed germinating.

The seed husk (pericarp) consists of three layers, the outer layer (exocarp) was hard woody layer with gray-brown pubescent hair/scales; brownish green (yellow-green group-148 A-B) in color. The mesocarp was a thick woody fibrous layer. The endocarp represented the seed coat; thin and water-impermeable [7]. It had length of 2.96 cm \pm 0.27 cm; width of 2.99 cm \pm 0.25 cm; thickness of 2.16 cm \pm 0.22 cm. The weight of 1 000 seeds was 11 342.39 g. The seed was off-white (ivory); flattened heart-shaped with the embryo was on the tip; 1.93 \times 1.81 cm. Cotyledon was 0.49 cm \times 0.22 cm (see Figure 1).

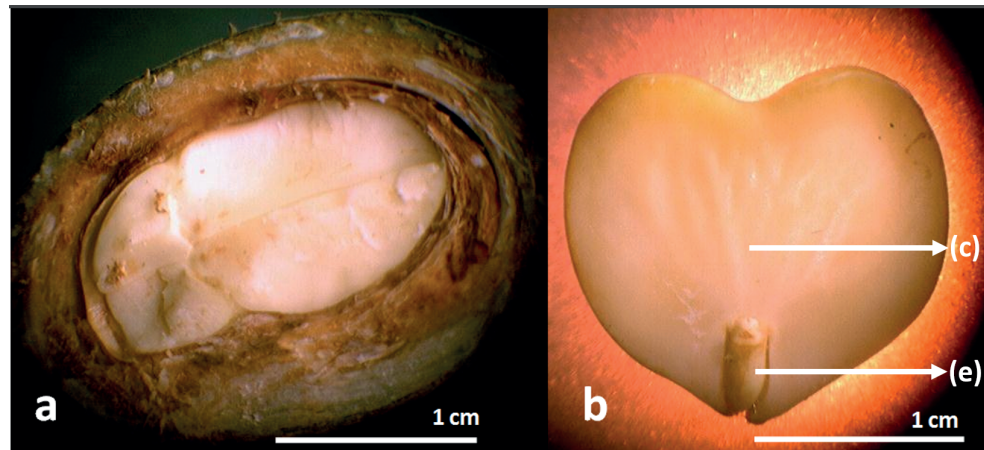


Figure 1: (a) Cross section slice of *B. peltata* fruit; (b) *Bronlowia peltata* seed: cotyledon (c) and embryo (e).

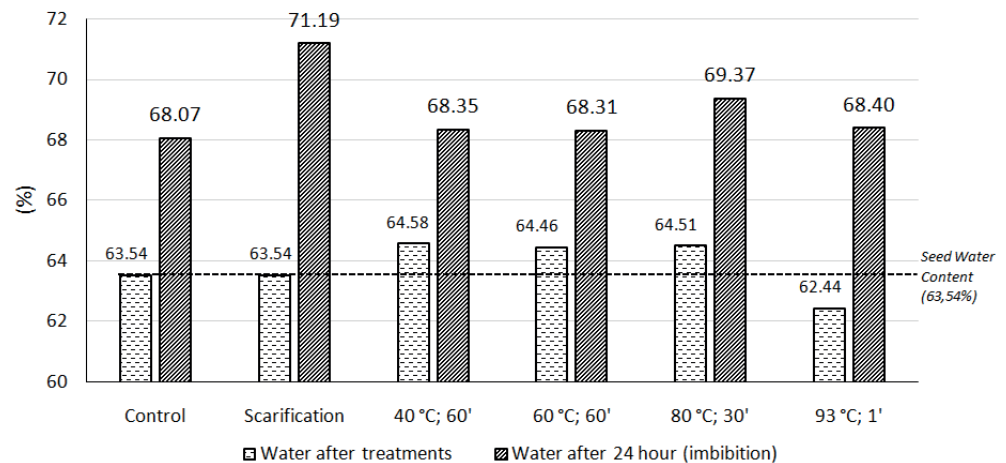


Figure 2: Imbibition rate of *B. peltata* fruit after treatments and 24 hours imbibition.

3.2. Imbibition rate

Germination starts with imbibition, a process of water uptake of seed, caused by different water concentration gradient between seed and the environment. It changes the metabolic process of the seed and induces cell differentiation of the embryo. The more water that goes into the seed, the colloidal materials such as proteins are likely inflated and causing the split of seed husk.

The fruit weight was 11.74 g when collected with moisture content of 63.54%. Volume of fruit changed after the treatments and 24 h imbibition. Figure 2 shows percentage of the change of fruit weight before-after treatment and after 24 h imbibition.

B. peltata fruit was floating at the beginning of water immersion due to its fibrous seed husk. After imbibition, some of the fruits were still floating and some of them were sunk. Hot water immersion treatment of 40°C for 60 s; 60°C for 60 s and 80 C for 30 s raised the fruit moisture content of 0.92% to 1.04% which is similar each other,

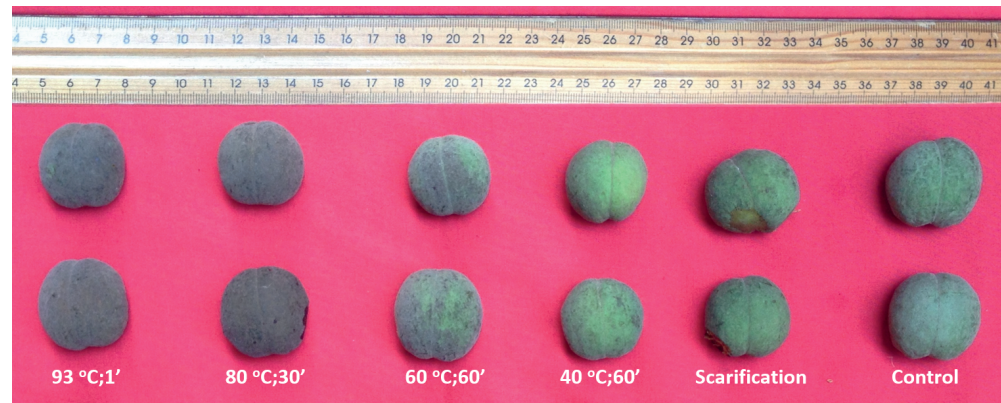


Figure 3: The discoloration of *Brownlowia peltata* fruit after hot water immersion treatments.

otherwise, another hot water immersion treatment of 93°C for one minute lowered the fruit moisture content up to 1.56% became 62.44%. A decreasing percentage of fruit weight possibly caused by plasmolysis of pericarp cell were damaged due to high temperature. The higher the temperature of the water led discoloration of the outer husk became more brownish and blackened. Figure 3 shows the discoloration of the outer husk after hot water immersion treatments.

After 24 h imbibitions, the highest imbibitions rate occurred to the scarification treatment (71.19%) and the lowest imbibitions rate occurred to control (68.07%). Comparing among hot water immersion treatments, the treatment of 80°C for 30 led the highest imbibition rate of 69.37% while the other treatments of 40°C for 60 s, 60°C for 60 s and 93°C for 1 s led relatively similar imbibition rate. They are 68.35%, 68.31% and 68.40%. Scarification treatment affected the water uptake of the seed before sowing. It indicated that the outer pericarp was impermeable. High temperature (up to 93°C) was not effective enough to break the permeability of the pericarp.

3.3. Seed germination

Germination is influenced by some of the factors, either internal or external. The main external factor are water, oxygen, and temperature [8]. Outdoor temperature at the location of germination test was 23°C to 31.7°C in the morning and 31.4°C to 34.8°C in the afternoon. The containers was placed under canopy shade of *Durio zibethinus*, *Cinnamomum burmannii*, and a palm to imitate natural condition in forest. Humidity of germination media was maintenance by regular watering.

Germination type of *B. peltata* seed was epigeal. Primary root or radicle was the first part growing from the seed, followed by elongation of hypocotyl that lifted up the cotyledon and plumule. Sometimes the carpel persisted to the cotyledon and lifted up along with it [9]. Splitting of the carpel was a sign that cotyledon and embryo cell were swollen and developing because of sustainable water uptake. It happened



Figure 4: Stages of *Brownlowia peltata* germination.

Treatments	Germination Rate	Germination Rate Coefficient	Coefficient of uniformity of germination
Control	60.00b	0.1014bc	0.0562bc
Scarification	52.50b	0.1582c	0.0513b
Temp. 40°C	60.00b	0.0762b	0.0845c
Temp. 60°C	10.00a	0.1147bc	0.0425b
Temp. 80°C	0.00a	0.0000a	0.0000a
Temp. 93°	0.00a	0.0000a	0.0000a

Numbers followed by the same letter in the same column are not significantly different at $p < 0.05$ using DMRT.

TABLE 1: Germination rate, germination rate coefficient and coefficient of uniformity of germination for each treatment.

mostly on the day 12 after sowing. After hypocotyl had stopped growing, the plumule was growing bigger became two opposite leaves along with epicotyl. The cotyledon shrank gradually after the plumule reaches the maximum size and started a new shoot. After the plumule reaches this maximum condition, we assumed that the germination was complete. It happened on the day 35 after sowing. Figure 4 shows the germination stage of *B. peltata*.

Either scarification or low-temperature treatment (40°C) did not raises germination rate significantly compared to control. The high temperature of water immersion treatment (80°C or more) had a tendency of damaging the seed instead of breaking the dormancy. According to germination rate coefficient, it showed that scarification treatment had the highest value (0.1558) compared to other treatment, but Duncan Multiple Range Test (DMRT) 0.05 results (Table 1) showed that scarification treatment and 60°C water immersion treatment was insignificant compared to control. Analysis of coefficient of uniformity of germination led to different result. The highest value was obtained by scarification treatment which means the treatment produced the most uniform germination of the seed among others. However, since it was not significantly different to control and 60°C treatment, we believe that those five treatments did not raise the uniformity of germination of the seed.

Even though, the highest imbibition rate happened on the scarification treatment. It did not affect the germination rate but slightly affected to germination rate coefficient and coefficient of uniformity of germination. Germination rate was not influenced by any treatment of physical dormancy breaking, either high temperature or scarification. Therefore, we believed the seed of *B. peltata* did not have a physical dormancy like the early supposition, and it normally germinates once they reach maturity with or without carpel splitting.

Dehiscent habit of the mature fruit of *B. peltata* was not perfectly released the seed from the persistent carpel, but it obviously created a slit in order to let the seed directly exposed to water faster. This was a possibly natural habit to break physical dormancy of the woody carpel. Baskin *et al.* [7] reported that Malvaceae (including Bombacaceae, Sterculiaceae, and Tiliaceae) contain species that produce non-dormant seeds, but they did not mention the species in detail. This result also contradicted with the study of Bien & Lan [4] which reported the germination rate of *B. tabularis* was positively affected by 60°C water immersion for an h and continued with cold water immersion for an hour. It increased germination rate by 85% while control's germination rate of 69%. The limitation of our study was unknown maturity or age of collected fruit. Study of Bien & Lan [4] did not inform the condition of fruit carpel (whether splitted or not) and maturity of fruit as well.

4. Conclusion

Fruit of *B. peltata* is belong to follicle type with impermeable woody persistent carpel. The mature seed does not have a physical dormancy once carpel splits and creates a slit which exposes the seed to the open air. The seed can normally germinate (60%) with or without some of the physical dormancy breaking treatments. Some hot water immersion treatments (80°C and above) can damage the seed and cause failure to germinate. To raise germination rate of the seed, further study is needed to determine the maturity of fruit when it is collected and determine of type dormancy of the seed other than physical dormancy such as physiological dormancy or other dormancy.

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