STUDY OF RECALCITRANT BEHAVIOUR OF *Arthocarpus integer*

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ABSTRACT

Arthocarpus integer or *cempedak* is an indigenous fruit with a distinctive taste and smell. Cutting seeds on water content observations need to be considered because the seeds contain sap that can affect the observation results. A. integer seeds are classified as recalcitrant seeds, so the handlers must be careful. This research aims to study the recalcitrant properties of A. integer seeds. The study consisted of 2 treatments i.e., drying length (0, 2, 3, 4, 5, 6 hours) and seed colour (yellow, orange, white). The results showed that the length of drying had an effect on the height of the seedlings, the wet weight of the sprouts, and the maximum growing potential, while the colour of the fruit had an effect on the maximum growing potential and wet weight of the seedling.

Keywords: *Chempedak, Nangka, Recalcitrant, Seed, Storage*

1. INTRODUCTION

Arthocarpus integer or "*cempedak*" is a forest and a fruit tree. *Cempedak* wood used in the construction of homes and ships. *Cempedak* is classify as a strong class II wood according to this classification [1]. Under air-dry conditions, *cempedak* wood has a flexural strength at the proportional limit of 602.77 kg/cm2 and flexural strength at the fracture limit (maximum flexure) of 989.63 kg/cm2, a modulus of elasticity of 60479.97 kg/cm2, and parallel compressive strength of 602.77 kg/cm2. Fibre 431.50 kg/cm2, 197.69 kg/cm2, 120.45 kg/cm2, 34.39 kg/dm3 strength Specific gravity, flexural strength at fracture limit (maximum flexural strength), and compressive strength parallel to wood fibres under air-dry conditions are used in Indonesia to classify wood strength.

Grafting is the most common method of propagating *cempedak* plants. Grafting is the process of attaching the scion to the existing rootstock. As a result, the rootstock is required to ensure the success of grafting. Planting *cempedak* seeds, prepare the rootstock. *Cempedak* seeds, on the other hand, are recalcitrant. Hence, seed viability does not last long. The viability of seeds stored at room temperature will continue declining until they reach 0% in the fourth week. If the seed is stored at 20°C, the viability could last up to 41 weeks. However, the viability decreased once more when the temperature was reduced in the second week of storage [2].

Recalcitrant seeds do not dry out as they mature, remaining hydrated and metabolically active. They are shed at a relatively high moisture content and are typically poise for continued development or germination after being shed [3,4]. Unlike orthodox seed, the storage method of recalcitrant seed is complicated. Recalcitrant seeds will die if dried below a relatively high critical value, which is typically between 12 and 35 per cent moisture content [5], and they are also sensitive to low temperature [6]. These seeds must be kept moist and relatively warm. The seed longevity is measured in weeks [4].

Another factor influencing seed quality is fruit maturity. Color indicates the maturity level of seeds. Fruit viability in *cempedak* fruit is affected by fruit at harvest. Seed size, in addition to fruit color, influences seed viability because larger seeds have more food reserves. Besides, drying method also give strong effect to seed viability of recalcitrant seed. Flash drying to sub-lethal water contents achieves this goal not only by reducing the time, but also the intensity of the

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dehydration stress to which most germinative cells are exposed. This research aims to study the recalcitrant properties of *A. integer* seeds.

2. METHOD

The study was a factorial completely randomized design. The main ingredients used are *cempedak* seeds from fruit purchased at the market. The study consisted of 2 treatments, namely drying time and seed color. The drying time treatment consisted of 6 levels, namely 0 (T0), 2 (T1), 3 (T2), 4 (T3), 5 (T4), and 6 (T5) hours. Seed color treatment consisted of 3 levels: yellow, orange, and white. *Cempedak* seeds extracted manually until the seeds were clean from the arils. The seeds then separated into three according to their color. Seed drying was carried out using a fan and at room temperature. Observations were made on water content, maximum growth potential, germination, growth speed, seedling height, and wet weight of seedlings. Seedling height was measured at eight weeks after planting.

3. RESULT AND DISCUSSION

The results of the analysis of variance showed that the treatments did not interact. The drying time treatment affected the maximum growth potential, seedling height, and wet seedling weight (Table 1). Seed color treatment affected the maximum growth potential and wet seedling weight (Table 2).

Drying time is very influential on the maximum growth potential. The longer the drying time, the lower the maximum growth potential. *Cempedak* seeds that were not dried had the highest maximum growth potential (92%) compared to dried seeds. Undried seeds had the highest seedling height (27.6 cm) (Table 3).

Table 1. ANOVA drying treatment result for all parameters

Parameters	F Value	Pr > F	Coefficient of variance
Water content (%)	0.43^{ns}	0.8170	25.59
Maximum growth potential (%)	3.98^{*}	0.0301	39.74
Germination Percentage (%)	1.97^{ns}	0.1696	37.66
Growth Speed (%KN/etmal)	0.81^{ns}	0.5662	40.65
Seedling height (cm)	6.62^{*}	0.0057	18.29
Wet height (g)	4.04^{*}	0.0288	57.89

Table 1. ANOVA seed color result for all parameters

Parameters	F Value	Pr > F	Coefficient of variance
Water content (%)	1.87^{ns}	0.2048	25.59
Maximum growth potential (%)	4.47^{*}	0.0411	39.74
Germination Percentage (%)	2.77^{ns}	0.1103	37.66
Growth Speed (%KN/etmal)	1.71^{ns}	0.2292	40.65
Seedling height (cm)	1.40^{ns}	0.2902	18.29
Seedling wet (g)	4.69^{*}	0.0366	57.89

The colour of the seed also affects the maximum growth potential and the wet weight of the sprouts. Seeds with yellow color have the maximum growth potential and wet weight of germination compared to white and orange seeds (Table 4).

Table 2. Effect of drying time in parameters

Drying time (hour)	Water Content (%)	Seedling height (cm)	Wet Seedling (g)	Maximum Growth Potential (%)
0	53.91	27.60 a	117.47 a	92.00 a
2	63.78	17.75 b	40.99 b	36.00 bc
3	64.20	14.83 b	32.65 b	26.67 c
4	63.70	17.75 b	39.94 b	58.67 abc
5	51.54	13.87 b	28.73 b	40.00 bc
6	64.08	16.91 b	39.22 b	73.33 ab

Numbers followed by letters in the same column are not significantly different

Table 3. Effect of seed color on maximum growth potential and wet seedling weight

Seed Color	Maximum Growth Potential (%)	Wet Seedling Weight (g)
1 *(Yellow)*	76.00 a	58.77 a
2 *(Orange)*	43.33 b	69.68 a
3 *(White)*	44.00 b	21.06 b

Numbers followed by letter in the same column are not significantly different

The results of the analysis of variance showed that seed color had a very significant effect on viability of *cempedak* seeds on the percentage of growth potential and wet weight of sprouts. If you look at the two seed colors, namely yellow and orange, it does not show a significant effect. Quantitatively, the value of the highest viability of *cempedak* seeds was in white. It is suspect that the white color was a stadia or phase of seed development. In this case, the translocation of food substances in the seed probably was still ongoing. Meanwhile, seeds with yellow and orange colors are morphological and physiological ripe stages where the growth potential and wet weight of germination slowly reach the point of cessation of food translocation or seed deterioration [7] .

Seed that passed the physiological maturity stage will experience a decrease in the value of seed viability due to ongoing catabolic changes. A decrease in the ability of seeds to germinate can occur in past physiologically ripe fruits due to catabolic changes in the seeds. The use of white seeds expected to produce high-quality and high-quality *cempedak* seeds. The same phenomenon occurs in coffee seed. The viability of Arabica coffee seeds of Gayo 1 variety was influenced by fruit color and seed size on the benchmarks of germination, growth speed, and growth simultaneously. The highest seed viability was found in seeds derived from bright red fruit with small seed sizes, except for the dry weight of normal sprouts [8].

A decrease in viability of *cempedak* seeds was an indication of desiccation injury. The critical moisture content is a marker of the lowest water content that can be applied to *cempedak* seeds in the drying process. Fruit ripeness also affects the rate of desiccation injury. Recalcitrant seeds, including *cempedak*, are metabolically active seeds. The embryonic cell ultrastructure is fully hydrated, metabolically active tissue [5]. Recalcitrant seeds do not have an easily identifiable mode of transition from developmental metabolism to germination metabolism [6].

The drying method is also very influential on the decrease in seed liability. In general, fast-dried recalcitrant seeds have a higher viability than slowly-dried recalcitrant seeds [6]. When drying occurs, there are 5 levels of hydration in the seed tissue based on the thermodynamic properties of water as measured using DSC (Differential scanning calorimetry). At the first and second levels of hydration, there were no metabolic changes that lead to seed damage, however, at the third level of hydration, it began to show the possibility of changing water to crystals. It is at this level that signs of deterioration begin to show after drying [5].

Cell damage in the slow drying method occurs due to ongoing metabolic activity in the dried material to level 3 hydration, which is oxidative damage. If the material is dried for a long time, then there is enough time for this damage to build up to lethal levels and even seeds with high moisture content will die [4].

There are two types of water in seeds: free water and bound water. The current hypothesis indicates that the degree of seed drying tolerance is related to the amount of water bound. Dry-resistant seeds have the ability to replace starch with water in membranes and other structural elements by providing the hydrophilic interactions necessary for structural stability While seeds that are sensitive to drying have a high level of subcellular structure and metabolism that can be maintained only at a relatively high water content, in other words, the bound water content is high. Seeds that are not resistant to drying cannot bind water tightly, so they will experience cell damage when dried [5]. From this research, we aimed that *A. integer* was a recalcitrant seed. Its viability is influenced by drying methods. Its viability also depends on seed development, indicated by seed color. Even though, there is still more research about the recalcitrant behaviour of *A. integer*, such as seed development, which this part did not do in this research.

AUTHORS' CONTRIBUTIONS

Utami and Rustam did the research and analyzed data, meanwhile Ibrahim wrote the discussion part. Utami also templating the text, wrote the discussion part, and finalizing the article.

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