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Seed storability of malapari (*Pongamia pinnata* Merrill)

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Abstract. Seed storage is carried out to secure the seed stock obtained from the harvest until they are planted. The appropriate techniques were used to maintain the seed viability during storage. The objective of the research is to evaluate the viability of malapari (*Pongamia pinnata*) seeds after being treated. The seeds are stored in a room in sealed plastic with no media, sealed plastic + coconut coir powder media, sealed plastic + husk charcoal. The other containers were calico fabric with no media, calico fabric + coconut coir powder media, and calico fabric + husk charcoal. The finding showed that the best storage was storing the seed in a plastic container plus husk charcoal media, and within five weeks, it can maintain the seed moisture content of 62.92%, germination percentage of 93.33%, and germination speed of 7.55% KN/et mal. The seed can also be stored in a plastic container without media at a moisture content of 60.69%, and a germination percentage of 91.00%.

1. Introduction

1.1. Background

Malapari (*P. pinnata* Merrill) is one of the most potent biofuel sources [1]. Its wood has a calorific value of 19,000-20,000 kJ/kg, and its seeds contain vegetable oil with an oil content of 27-39% based on dry seed weight, consisting of 70% Oleic Acid and 11% Linoleic Acid [2]. The development of this species as a source of biodiesel raw material requires the existence of a good and adequate amount of seeds when needed. Seed storage is one of the attempts to provide the inevitable seeds at the time of planting.

Several research results showed a decrease in seed viability along with increasing storage time, among others, seeds of kilemo [3] and campaka waisan [4]. Seed quality will decline naturally, as Siahaan [5] stated that seed quality will decrease linearly with time. Storage periods had also a real effect on the germination capacity of Sambiloto seeds [6]. Maintaining the viability of seeds during storage requires proper techniques so that their quality will not decrease drastically during the storage process.

Aminah and Syamsuwida [7] reported that the moisture content of malapari seeds reached 51.37%. Likewise, Putri and Jayusman [8] stated that the seed water content of the species was high, reaching 40-60%, and classified as recalcitrant seeds. Seeds that have a seed moisture content of 30-70% at maturity are recalcitrant [9]. Seeds with high moisture content will rapidly decrease their viability. One of the problems faced in developing plant species with recalcitrant (intermediate) seeds is that they rapidly decline.

The optimal recalcitrant seed storage requires conditions that favor a good storage environment.



According to Umarani *et al.* [10], three main features cause damage to recalcitrant seeds during storage, namely, non-optimal seed moisture content, fast drying rate, and high storage temperature. Therefore, supporting storage conditions are needed to regulate the stability of seed water content by providing an environment that may keep the humidity, such as giving moist media and storage containers that can maintain moist conditions during storage.

A suitable storage medium is to have a light density, and rough so that air circulation is high, has good porosity, low thermal conductivity, and low water absorption. Rice husk charcoal and coconut are the storage media that has the physical characteristics mentioned above [11].

Song *et al.* (1986) in Schmidt [9] found a suitable storage medium of moist coconut powder for *Hopea hainanensis*. Nurhayati and Wulandari [12] have reported rubbing ash, husk charcoal, and cocopeat as the media for storing ylang seeds and found that the best media was cocopeat.

The storage period of recalcitrant seeds needs to be considered for several days to several weeks recommended for recalcitrant seeds [13] in order not to cause a drastic decrease in viability.

Concerning the recalcitrant seed problems that support the maintenance of seed quality, a study on the viability of malapari seed has been carried out using several types of storage containers and media for several weeks periods to hold the physiological grade of the seeds during storage.

1.2. Purpose

The purpose of the study is to evaluate the viability of malapari (*Pongamia pinnata*) seeds after being treated with a variety of containers and media for several weeks of storage.

2. Materials and methods

2.1. Materials and Tools

The material used is malapari seeds collected from Carita - Banten. Other materials were cocopeat and husk charcoal for storing the seeds, and media of sand and soil for germinating the seed. The equipment used includes germination boxes, an oven, analytical balance, labels, etc.

2.2. Research Procedure

2.2.1. Provision of working samples. Pods that have been collected are extracted by hitting the pods with blunt object to open their pods, and then the seeds are separated from other parts of the pods manually. After extraction, the seeds are not dried in the sun but are left in the open air in the room.

2.2.2. Storage trial. The experimental design used was a Completely Randomized Design (CRD). Two factors of the experiment are storage containers and periods. Storage container factor consists of 6 levels, namely (1) sealed plastic bags; (2) sealed plastic bag + coconut coir powder medium; (3) sealed plastic bag + husk charcoal media with a ratio of media and water (5:1) ; (4) calico fabric; (5) calico fabric + coconut coir powder medium; and (6) calico fabric + husk charcoal media with a ratio of media and water (5:1). The storage period factor consists of 6 levels, namely (1) 0; (2) 1; (3) 2; (4) 3; (5) 4; and (6) 5 weeks. Each combination of treatments was repeated for four Replications. The seeds packaged in the storage containers according to the treatment given are then stored in a room (T: 27-30°C, RH: 70-80%).

Parameters measured/observed:

Each storage period is tested for moisture content and seed germination

2.2.2.1. Moisture Content. Water content was tested by the oven method [14] using a low temperature of (103 ± 2°C) for (17 ± 1 hour). The water capacity lost from this test reflects the seed water content. It is

calculated as follows:

Where:

$$\text{Moisture content} = \frac{(\text{WCBd} - \text{WCAd})}{(\text{WCBd} - \text{WL})} \times 100\%$$

WL: weight of the container and lid in grams

WCBd: weight of the container, cover, and seed before

drying
WCAd: weight of the container, cover, and seeds
after drying

2.2.2.2. Seed germination (germination percentage and germination rate). Germination is the number of normal germinated seeds, the formula of germination percentage (GP) is:

$$\text{GP} = \frac{\sum \text{KN}}{\text{N}} \times 100\%$$

Where: KN = number of germinating normal seeds; N= number of sowing seeds

The germination rate is calculated for the germinating seeds from the first day of observation up to the end of observation. By counting normal germination in each observation divided by et mal (1 et mal = 24 hours). According to Widajati [15], the rate of germination describes the vigor parameters with the formula as follows:

$$\text{GR} = \frac{\sum_{i=1}^n (\text{KN})_i}{\text{Wi}}$$

Where: i = the length of observation day; KN_i = the number of normal germination at day i (%); Wi = the total of time (et mal) at day i.

2.3. Data analysis

A randomized design organized with a factorial pattern which consists of 2 (two) factors was employed. - Duncan's distance test was used to compare the mean values between classes that were significantly different.

3. Results and discussion

The initial seed moisture content originating from Carita ranged from 57.05% to 63.39%. This range of value indicates a reasonably high water content of malapari seed, as reported by Aminah and Syamsuwida [7], that if the initial seed moisture content of malapari of 51.37%, then malapari seeds possess a characteristic of recalcitrant. Hartawan and Nengsih [16] stated that generally, the water content of recalcitrant seeds at harvest is more than 50%. Recalcitrant seeds are very sensitive to drying and will regress at low water content and temperature. Seeds of this type have characteristics, among others, only able to live in high water content (36-90%) [17].

Suhartanto [18] said that the viability of recalcitrant seeds would rapidly decrease if the seeds face a decrease in water content below the critical water content limit and generally have a short vitality that will cause many problems in storage because the fully recalcitrant seed is not tolerant to decreasing water content and is sensitive to low temperatures.

The analysis of variance (Table 1.) showed that the container and storage period had a significant effect on moisture content, germination, and germination rate, and its interaction significantly affected all observed responses.

Table 1. The summary of the analysis of variances for some parameters

Source of variances	The parameters		
	Water content	Germination percentage	Germination rate
Containers (A)	126,97*	100,69*	68,12*
Storage period (B)	19,83*	33,51*	84,53*
Interactions (A)*(B)	9,53*	9,57*	11,28*

* Level of 95% confidence is remarkable

Table 2. The interactions effect storage period and container treatments toward moisture content (%), germination percentage (GP), and germination rate (GR).

Storage periods	Containers	Moisture content (%)	GP	GR
0 week	P	58,49 ef	78,67 fghi	2,08 q
	P+AS	58,49 ef	78,67 fghi	2,08 q
	P+Ccpt	58,49 ef	78,67 fghi	2,08 q
	B	58,49 ef	78,67 fghi	2,08 q
	B+AS	58,49 ef	78,67 fghi	2,08 q
	B+Ccpt	58,49 ef	78,67 fghi	2,08 q
1 week	P	58,78 ef	98,67 ab	5,07 efghi
	P+AS	60,72 def	84,00 cdefg	3,78 lmno
	P+Ccpt	67,34 abcd	70,00 hi	3,05 nopq
	B	48,70 g	82,00 cdefg	4,19 ijklm
	B+AS	57,68 f	88,00 bcdefg	4,80 fghijk
	B+Ccpt	60,65 def	89,00 abcdef	4,72 hijkl
2 weeks	P	57,68 f	100 a	6,37 bcd
	P+AS	64,65 abcdef	92,00 abcd	4,10 jklm
	P+Ccpt	69,16 abc	57,33 jk	2,74 pq
	B	24,43 i	90,00 abcdef	3,94 klmn
	B+AS	38,55 h	91,00 abcde	4,63 hijkl
	B+Ccpt	46,53 g	93,33 abc	6,01 cde
3 weeks	P	56,65 f	97,00 ab	5,77 def
	P+AS	61,39 cdef	99,00 ab	7,15 ab
	P+Ccpt	69,59 ab	60,00 j	2,89 opq
	B	36,18 h	97,33 ab	5,18 efghi
	B+AS	36,65 h	96,00 ab	6,82 abc
	B+Ccpt	38,47 h	92,00 abcd	5,74 defg
4 weeks	P	59,67 def	77,00 ghi	3,00 nopq
	P+AS	62,40 bcdef	69,00 ij	5,20 efgh
	P+Ccpt	66,63 abcde	26,67 l	1,05 r
	B	35,74 h	83,00 cdefg	3,33 mnop
	B+AS	38,33 h	80,00 efghi	4,18 ijklm
5 weeks	B+Ccpt	42,44 gh	90,00 abcdef	5,17 efghi
	P	60,69 def	91,00 abcde	4,77 ghijkl
	P+AS	62,29 bcdef	93,33 abc	7,55 a
	P+Ccpt	72,20 a	18,67 l	0,74 r
	B	25,51 i	81,00 defgh	3,51 mnop
	B+AS	35,38h	80,00 efghi	4,29 hijklm
	B+Ccpt	43,23 gh	77,33 ghi	4,06 klm

Similar letters following the values indicate no differences effect significantly at the level of 95% confidence. P (Plastic), P+AS (Plastic + husk charcoal), P+Ccp (Plastic+ Cocopeat), B (calico fabric), B+AS (calico fabric + husk charcoal), B+Ccp (calico fabric + Cocopeat)

Seeds stored in the calico fabric containers caused a decrease in the moisture content of the seeds, thus affecting the moisture content of the seeds during storage. The more extended storage periods will make the seed moisture content decrease. This is due to the porous nature of the calico fabric creates a long time of humid air flowing out of the container. The use of calico fabric containers without storage media makes the lowest seed moisture content (25.51%).

Throughout the store, several factors would influence the viability of the seed; one of these is moisture content because this factor is the most essential effect in seed decline. The decreased water content during storage is a critical factor affecting seed viability [21]. Mahjabin and Abidi [22], explained that seed deterioration may occur during storage due to crucial factors such as non-optimal seed moisture content are not achieved. In the process of seed storage, the seed moisture content is a critical factor that affects the process of reducing seed quality [23]. Therefore, it is necessary to keep the level of seed water content along the storage by the character of the seeds. A high seed moisture content is necessary to maintain the viability of recalcitrant seed characteristics, while a low seed moisture content is suitable to maintain the viability of orthodox seeds characteristics.

Malapari seeds stored in plastic containers make the germination in the first-week increase by 20%; it can be estimated that there was an after-ripening process during seed storage. According to Sutopo [24], any changes in seed viability during storage are called after ripening. Storage with this plastic container can maintain seed germination for five weeks (Table 2.). The use of plastic storage containers is also able to maintain seed moisture during storage. According to Sari and Faisal [25], the best storage container is a storage container that can stop the movement of air and water between the outside atmosphere and the seeds. When added with husk charcoal media, it can also maintain germination for five weeks of storage. It is different if the seeds are stored in sealed plastic bags with the addition of coco-peat media; during the storage period, there was a decrease in germination, so that in five weeks period, the germination percentage was 18.67%. As seen in Table 2. the moisture content of seeds stored using sealed plastic bags can maintain moisture content and even increase up to the level of water of 72.20%, it is estimated that the seeds will have an increase in water content that exceeds their capacity because of storing in an airtight container and with coco-peat media where the nature of coco-peat can absorb water [26] so that makes the seeds rot due to excess water and cause the death of the seeds. In contrast to seeds stored in plastic containers with husk charcoal media, where the water content also increased while the germination percentage was still high, this is thought to be due to the nature of the husk charcoal media, which has large cavities [27] and also has a high carbon (C) content that might be able to increase soil porosity to make this planting medium loose [26] and the seeds can still germinate well. In this case, malapari seed is suitable to store in a plastic bag with such media, as this condition of the container can keep a high moisture content as required by the seeds.

The use of calico fabric containers in the storage of malapari seeds still maintains the viability of malapari seeds. In the third week, it performed the highest germination percentage. Giving husk charcoal or cocopeat media into a calico fabric container made the seeds even get a high germination percentage either in the third or fourth weeks of storage. But overall, the seeds stored with calico fabric alone or added with cocopeat media or husk charcoal until storage for five weeks still had a high enough germination percentage. When viewed from the grade of seed moisture capacity, stored in the calico fabric containers, both without media and with additional media, there was a decrease in moisture content during the storage, and the lowest moisture content (21.51 %) was found in the seed storage used only the calico fabric containers (Table 2.); however, the germination percentage still got a high value of 81.00% (Table 2.). The seed storage used in a calico fabric bag was also quite good in terms of seed viability. This is in line with the opinion of Tompsett (1992) in Schmidt [9], Whose mentioned that calico fabric was suitable for seeds with relatively low moisture content. A suitable air ventilation container such as a cotton bag or sack might be required for these seeds with high moisture content [9]. Lodong *et al.* [19] stated that efforts to maintain the viability

of recalcitrant seeds remain optimal, namely by storing seeds in non-tight containers and storage media with high humidity. According to Nurhasybi and Suita [28], using a nested container such as a calico fabric that was permeable so that air exchange continued to occur frequently to avoid excessive heat.

From the results of Table (2), the summary showed that husk charcoal should be added to the plastic containers to maintain the moisture content, and germination and if the storage used calico fabric, then a mixture of husk charcoal and cocopeat should be added.

A plastic container added by husk charcoal media resulted in the highest germination rate during storage for five weeks (7.55% KN/et mal), while plastic containers added by cocopeat media brought about the lowest germination rate after being stored for five weeks (0.74% KN/ et mal). Therefore, husk charcoal media might be able to maintain the viability of malapari seeds during storage.

4. Conclusion

The best storage of malapari seeds is the use of a plastic container added by husk charcoal storage media which were stored for five weeks to maintain a moisture content of 62.92%, germination capacity of 93.33%, and germination rate of 7.55% KN/et mal). The seed could also be stored in a plastic container without storage media for five weeks to get a moisture content of 60.69% and a germination percentage of 91.00%.

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