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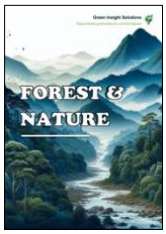

RESEARCH ARTICLE

Seed Quality Description of Kilemo (*Litsea cubeba* (Lour.) Pers.)

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ABSTRACT

Kilemo (*Litsea cubeba* (Lour.) Pers.), a forest tree species of the Lauraceae family, is naturally distributed in China, Taiwan, and Southeast Asia, including Indonesia. This species is valued for its high-quality essential oils and its potential applications in the biopharmaceutical and chemical industries. However, the semi-recalcitrant nature of kilemo seeds presents challenges in storage and germination, necessitating research to optimize seed quality and propagation methods. This study aims to evaluate the physical and physiological qualities of kilemo seeds sourced from highland regions in West Java and North Sumatra and to determine the best pretreatment methods to enhance germination performance. Seed samples were collected from Ciwidey, Mount Papandayan (West Java), and Aek Nauli (North Sumatra). The study assessed seed moisture content, purity, 1,000-seed weight, and seed viability. Different soaking treatments (plain water, boron solutions, KNO_3 solutions, and coconut water) were applied, followed by germination tests under two sowing conditions: open seedbeds and plastic-covered seedbeds. The results indicate that kilemo seeds exhibit moisture content ranging from 13.01% to 14.68%, purity above 96.77%, and a weight of 1,000 seeds varying from 21.36 to 27.86 g. Germination trials revealed that seeds soaked in 100% coconut water for 3 or 6 hours exhibited the highest germination percentages and vigor, particularly in an open seedbed condition. These findings suggest that coconut water pretreatment enhances seed germination and viability, offering an effective method for improving the propagation success of kilemo. The study provides valuable insights into optimizing seed handling techniques to support the conservation and commercial cultivation of this species.

1. Introduction

Kilemo (*Litsea cubeba* (Lour.) Pers.) is a forest tree species that grows well in upland areas, usually at an altitude of 500–2,700 meters above sea level (m asl) (Shi et al., 2023; Sylviani and Yosefi, 2010; Wang et al., 2023). It belongs to Lauraceae and is distributed naturally in China, Taiwan, and some Southeast Asian countries, including Indonesia (Java, Sumatra, and Kalimantan) (Heryati et al., 2022). Twenty-nine prospective plus trees of kilemo have been identified in Mount Lemo, Cianjur district, with its phenotypic appearance, i.e., total tree height reached out between 20 to 36 m, with the largest diameter of 32 cm and the branch-free height which was relatively low (Darliana and Nurmawanti, 2021).

This species produces high-quality essential oils (Kurniaty et al., 2014). It contains chemical compounds including alkaloids, flavonoids, saponins, tannins, glycosides, and steroids, which preferentially essential properties for anticancer, antioxidant, antibacterial, anti-inflammatory, and repellent (Fan et al., 2023; Wijaya and Safrina, 2021). Kilemo oil is used as raw material for biopharmaceuticals and chemical industry (Kamle et al., 2019). The oil can be extracted from various plant parts, mostly from the leaves and bark (Kurniaty et al., 2014).

Kilemo seeds are semi-recalcitrant, meaning their germination capacity quickly decreases and cannot be stored for long. Storage research of kilemo seed reported that the highest germination capacity (52%) is put in a container of calico cloth and kept in an ambient room. In the subsequent storage period, the germination capacity continued to decrease so that no more seeds were found in the eighth week. Storing kilemo seeds in a plastic container in a refrigerator showed that the seeds can still germinate after storage for 16 weeks (Suita, 2014).

Replanting kilemo plants in their natural distribution areas or developing them in other areas requires the availability of quality seeds to produce seedlings ready for planting in the field. Good quality kilemo seeds are obtained from seeds with high germination capacity and germination speed. Germination capacity and germination speed are closely related to the vigor of the produced seedlings (Syamsuwida et al., 2020). The success of kilemo planting is influenced not only by the availability of ready-to-plant seeds but also by the seed origin or the seed source. Seeds originating from the highlands of West Java and North Sumatra should be planted in areas near the seed source, considering altitude compatibility. Locations near the seed source are ideal for planting this species because the environmental conditions, such as soil type, rainfall, and altitude, align with the species' growth requirements (Rudawska et al., 2017).

Seed morphology, including shape, size, color, and specific traits, is closely related to seed viability in forest plants. Based on these characteristics, researchers can apply a deductive approach to establish a correlation between seed morphological traits and viability, particularly for kilemo seeds. Understanding this relationship is crucial for identifying high-quality seeds capable of producing healthy and productive seedlings. This study aims to describe the physical and physiological qualities of kilemo seeds originating from the highlands of West Java and North Sumatra. The results of this research are expected to provide important information for optimizing the germination of kilemo seeds through appropriate pretreatment methods.

2. Materials and Methods

2.1. Research Materials and Location

The collection of kilemo seeds was carried out in the highlands of Ciwidey (West Java), Mount Papandayan (West Java), and Aek Nauli (North Sumatera). Ciwidey is geographically located at 107°24'48"–107°26'24" East longitude and 07°07'12"–07°10'48" South latitude. The temperature varies from 15–22°C with rainfall of 3,556 mm annually. Topographic conditions with an altitude of 1,600–1,700 m asl (Prodjo, 2016). Mount Papandayan has an average elevation of 2,665 m asl. According to the Schmidt and Ferguson classification, this mountain belongs to climate type B with an average rainfall of 3,000 mm/year, humidity of 70–80%, and temperature of 10°C (Zulkarnain, 2022). The collection of kilemo seeds in Aek Nauli was at 43°25' East longitude and 40°89' North latitude, altitude between 1,164–1,218 m asl, under slope conditions 2–15%, yellowish brown podzolic soil type, and air temperature varies 17–29°C (KLHK, 2020). Seed quality testing was conducted in laboratories and greenhouses of the Bogor LHK Standards and Instrument Institute.

2.2. Research Stages

2.2.1. Fruit collection

Physiological ripe fruit is characterized by brown-black fruit skin (Kurniaty et al., 2014). The fruit was collected during physiological ripe in June by picking directly from the tree or using a hook to reach the fruit-bearing branches. After being collected, the fruits were put in a gunny sack or porous container and transported for further processing in the Bogor LHK Standards and Instruments laboratory. To maintain the quality of the seed, after arriving at the laboratory, the seeds were extracted and then stored in the refrigerator for seven days before preliminary treatment testing.

2.2.2. Extraction

Kilemo fruits were wet extracted by separating the seeds from the skin, and fleshy fruit was rubbed and then washed clean under running water, then air dried for about 24 hours (Kurniaty et al., 2014). The

dried seeds are then mixed perfectly and taken proportionally using a random part to test the quality of the seeds.

2.2.3. Seed quality testing

Seed quality testing was carried out on the moisture content, purity, and weight of 1,000-grain parameters on seeds originating from Ciwidey, Mount Papandayan, and Aek Nauli. Preliminary treatment was only done to the seeds originating from Aek Nauli.

2.2.3.1. Seed moisture content

Measurement of seed moisture content using dry furnace method, with a low temperature of 103 ± 2°C for 17±1 hour (ISTA, 2012). Lost water of seeds, reflecting the value of seed moisture content. The samples for seed water content were 5 g, repeated by three replications. Moisture content is expressed in percent (ISTA, 2012).

$$Moisture\ content = \frac{(M2-M3)}{(M2-M1)} \times 100\% \quad (1)$$

where *M1* is the weight of the container and cover (g), *M2* is the weight of the container, cover, and seeds before drying, and *M3* is the weight of the container, cover, and seeds after drying.

2.2.3.2. Purity of seeds

Purity reflects the percentage of pure seeds in the seed group (seed lot). The seed lot's purity is in the form of the proportion of pure seeds and the amount of dirt and other seeds (ISTA, 2012). Purity testing requires the weight of seed samples equivalent to 2,500 seeds. The purity of the seeds separates the pure seeds, other seeds, and dirt, then weighed and calculated the percentage of each component using Equations 2–4:

$$Pure\ seeds = \frac{K1}{K1+K2+K3} \times 100\% \quad (2)$$

$$Other\ seeds = \frac{K2}{K1+K2+K3} \times 100\% \quad (3)$$

$$Non\ seeds = \frac{K2}{K1+K2+K3} \times 100\% \quad (4)$$

where *K1* is pure seeds, *K2* is other seeds, and K3 is non seeds.

2.2.3.3. Weight of 1,000 seeds

The weight of 1,000 grains can be used to predict the number of seeds/kg. The weight of 1,000 grains was calculated randomly from 100 seeds with eight repetitions. To get the weight of 1,000 seeds, the average weight of 100 seeds is multiplied by 10 (ISTA, 2012). Calculation of the number of seeds per kg from the weight of 1,000 seeds (DPTH, 2002) is as follows:

$$Quantity\ of\ seeds\ per\ kg = \frac{1{,}000}{weight\ of\ 1000\ grains} \times 1{,}000 \quad (5)$$

The weight of 1,000 seeds and the quantity of seeds/kg are important to know as basic information for procuring seeds for planting.

2.2.4. Germination test

Kilemo seeds from Aek Nauli were used for preliminary treatment and germination test methods. Preliminary treatment used a factorial experimental design in a completely randomized design, with pretreatment factors and germination method factors. The soaking treatment for kilemo seeds to increase their viability uses boron solution (B), referring to the treatment of sandalwood seeds (Supriyanto et al., 2012), KNO_3, and coconut water, referring to papaya seeds (Ardi et al., 2018). KNO_3 solutions of 200 ppm and 2,000 ppm were prepared by dissolving 200 mg and 2,000 mg of KNO_3, respectively, in 1,000 ml of water.

The preliminary treatment factor of soaking (A) consists of 7 levels, namely: A1 = soaked in plain water for 24 hours (control), A2 = soaked in 200 ppm boron solution for 24 hours, A3 = soaked in 2,000 ppm boron solution for 24 hours, A4 = soaked in 200 ppm KNO_3 solution for 24 hours, A5 = soaked in 2,000 ppm KNO_3 solution for 24 hours, A6 = soaked in 100% coconut water for 3 hours, and A7 = soaked in 100% coconut water for 6 hours.

The germination test method factor (B) in the greenhouse follows Suita and Bustomi (2014), consisting of B1 = soil sand media (1:1, v/v) without covering the seed bed, and B2 = soil sand media (1:1, v/v) covering the seed bed with transparent plastic for two weeks.

Each treatment combination was repeated with four replications, and each experimental unit contained 50 seeds. The parameters observed were water content, purity percentage, the weight of 1,000 grains, seed germination (germination capacity and speed), daily germination, and germination value. Germination capacity indicates the rate of the number of normal germinations from the number of seeds shown (Nurhafidah et al., 2021) as follows:

$$DB = \frac{\Sigma KN}{N} \times 100\% \quad (6)$$

where DB is the germination percentage, ΣKN is the number of seeds that become normal seedlings, and N is the number of seeds sown.

Germination rate is the regular sprouts in observations from the first day to the last day divided by etmal (1 etmal = 24 hours). The germination rate also describes the vigor parameter (Widajati, 2013).

$$Germination\ rate = \frac{\Sigma_{i=0}^{n}\ Percentage\ of\ seeds\ germinated\ from\ day\ one}{etmal} \times 100\% \quad (7)$$

where i is observation day, and $etmal$ is 24 hours.

Mean daily germination is determined by calculating the number of days required for germination (Sutopo, 2002) using Equation 8:

$$Average\ days\ to\ germination = \frac{N1T1+N2T2+\cdots\ldots+N\times T}{Total\ number\ of\ germinating\ seeds} \quad (8)$$

where N is the number of seeds germinating at a specific time, and T is the initial number of germinations until the end of observation.

The germination value is the percentage of germination and the average daily germination (Sutopo, 2002) and is calculated using Equations 9–11:

$$Peak\ values = \frac{Percent\ germination\ at\ time\ T}{Number\ of\ days\ required\ to\ achieve\ it} \quad (9)$$

$$Mean\ daily\ germination = \frac{Percent\ germination\ at\ time\ G}{Overall\ number\ of\ test\ days} \quad (10)$$

$$Germination\ value = peak\ value \times mean\ daily\ germination \quad (11)$$

where T is the point at which the germination rate starts to decrease, and G is the point at which seed germination ends.

2.3. Data Analysis

All observed parameters, i.e. (the average seed moisture content, the weight of 1,000 grains and the number of seeds/kg) were analyzed based on the percentage of the average in its samples. Meanwhile, the average seed germination was tested using the Tukey Test to compare interactions among the treatments. Data analysis was carried out with the help of Minitab 17 software.

3. Results and Discussion

3.1. Water Content, Purity, Weight of 1,000 Grains, and Number of Kilemo Seeds per kg

Before the seeds are treated according to the research design, tests are carried out on the seed water content, seed purity, weight of 1,000 seeds, and number of seeds per kg to determine the quality condition of the seeds used in the research (**Table 1**).

Table 1. The average seed moisture content, the weight of 1,000 grains and the number of seeds/kg

Seed origin	Moisture content (%)	Seed purity (%)	Weight of 1,000 grains (g)	Number of seeds/kg (grains)
Ciwidey (West Java)	13.44	96.77	27.60	36.230
Mt. Papandayan (West Java)	13.01	98.26	27.86	35.890
Aek Nauli (North Sumatera)	14.68	99.11	21.36	46.821

Table 1 shows that the moisture content of kilemo seeds varies from 13.01–14.68%, the purity of the seeds is 96.77–99.11%, the weight of 1,000 grains is 21.36–27.86 g, and the number of seeds per kg is 35.890–46.821 grains.

3.2. Seed Germination

The analysis of variance showed that the single factor of the preliminary treatment of kilemo seeds had a significant effect on germination percentage, germination rate, and germination value. In contrast, the average daily germination had no significant effect (**Table 2**). The sowing test method factor showed that germination rate, mean daily germination and germination value have a significant impact. Despite this, the germination percentage of kilemo seeds did not have a significant effect. The analysis of variance showed a significant interaction between the sowing test method factor and the preliminary treatment on germination percentage, germination rate, and germination value of kilemo seeds. Although, there was no significant interaction on the mean daily germination of kilemo seeds (**Table 2**).

Table 2. Analysis of variance on pretreatments and testing methods to the germination percentage, germination rate, mean daily germination and germination value of kilemo seed

Sources	Germination percentage (%)	Germination rate (%/etmal)	Mean daily germination (%/days)	Germination value (%/days)
Pretreatments (A)	20,64**	20,07**	0,96 ^{ns}	1,10*
Testing method (B)	0.86 ^{ns}	13,08**	36,46**	14,39**
Interaction (A)*(B)	9,61**	10,13**	1,28^{ns}	2,91*

Notes: ** = significantly different at the real level of 5%, ns = not significantly different at the level of 5%, A = treatment by soaking the seeds; B= sowing test methods.

The results of the Tukey test showed that the average of the preliminary treatment factors A6 (soaked in 100% coconut water for 3 hours, and A7 (soaked in coconut water for 6 hours) had produced germination power, germination speed that was not significantly different, but substantially different from other preliminary treatments. The single factor of the sowing test method showed that the average daily germination speed germinated by the open sowing test method produced the highest value and significantly differed from the closed sowing test method (**Table 3**). However, the sowing test method in a closed tub produced the best germination value and was significantly different (**Table 4**).

Table 3. The effect of single-factor pretreatment on germination percentage, germination rate, mean daily germination, and germination value from Aek Nauli

Pre-treatment	Germination percentage (%)			Germination rate (%)			Mean daily germination (%/days)			Germination value (%/day)		
	Mean		StDev	Mean		StDev	Mean		StDev	Mean		StDev
A1	32.00	BC	4.00	50.01	BC	0.10	52.61	A	3.88	0.35	A	0.06
A2	21.67	C	10.23	47.38	C	0.19	49.22	A	8.38	0.49	A	0.28
A3	26.67	C	12.24	49.22	C	0.21	47.38	A	6.20	0.54	A	0.27
A4	28.33	C	11.34	49.59	BC	0.33	51.67	A	9.53	0.50	A	0.26
A5	29.00	C	4.86	49.79	BC	0.10	49.59	A	2.56	0.47	A	0.13
A6	46.67	AB	5.89	51.67	AB	0.19	50.01	A	4.06	0.47	A	0.11
A7	51.67	A	12.74	52.61	A	0.35	49.79	A	4.75	0.40	A	0.17

Notes: Means values followed by the same letter are not significantly different. A1= Soaked in plain water for 24 hours/control, A2= Soaked in 200 ppm boron solution for 24 hours, A3= Soaked in 2,000 ppm boron solution for 24 hours, A4= Soaked in 200 ppm KNO_3 solution for 24 hours, A5= Soaked in 2,000 ppm KNO_3 solution for 24 hours, A6 = Soaked in 100% coconut water for 3 hours, and A7= Soaked in coconut water for 6 hours.

The results of the interaction test showed that the method of sowing kilemo seeds in an open tub produced the best germination power and germination speed given the A7 preliminary treatment (soaked in coconut water for 6 hours) and was significantly different from other preliminary treatments.

The values were not significantly different for the average daily germination speed and germination value. In the closed sowing test method, the germination power and speed were equally excellent and insignificant between the preliminary treatments A1, A2, A3, A5, A6, and A7 but significantly different from the A4 preliminary treatment. The average values were insignificant for the parameters of the average daily germination and germination values between the initial treatments. Thus, if using the sowing test method in an open tub, the best combination of treatments is if the kilo seeds are soaked in coconut water for 6 hours (A7), while if using a closed plastic tub, the best treatment is soaked in coconut water for 3 hours (A6) or soaked in coconut water for 6 hours (A7). The results of the interaction test showed that the method of sowing kilemo seeds in an open tub produced the best germination power and germination speed if given the A7 preliminary treatment (soaked in coconut water for 6 hours) and was significantly different from other preliminary treatments. The values were not significantly different for the average daily germination speed and germination value. In the closed sowing test method, the germination power and speed were equally excellent and insignificant between the preliminary treatments A1, A2, A3, A5, A6, and A7 but significantly different from the A4 preliminary treatment. The average values were insignificant for the parameters of the average daily germination and germination values between the initial treatments. Thus, if using the sowing test method in an open tub, the best combination of treatments is if the kilo seeds are soaked in coconut water for 6 hours (A7), while if using a closed plastic tub, the best treatment is soaked in coconut water for 3 hours (A6) or soaked in coconut water for 6 hours (A7).

Table 4. The influence of single-factor treatment of sowing test method on germination power, germination speed, average daily germination, germination value

Germination test method	Germination			Germination Rate			Average daily germination			Germination value		
	Mean		StDev	Mean		StDev	Mean		StDev	Mean		StDev
B1	34.57	A	16.08	0.78	A	0.36	46.08	B	3.69	0.55	A	0.20
B2	32.86	A	10.80	0.63	A	0.23	54.00	A	4.87	0.37	B	0.15

Notes: Means values followed by the same letter are not significantly different. B1 = The sowing test method was used in an open seedbed condition, and B2 = The sowing test method was used in a seedbed covered with a plastic sheet.

3.3. Discussion

Decreasing seed viability is a natural characteristic of living things that will experience decline. Likewise, the seeds of a plant continue to experience a decline in viability, whether in a short period or over a long period. The water content influences the seed's decline or decrease in seed viability. Within a specific water content limit, the lower the water content, the longer the seed's viability, but water content that is too low can cause damage to the embryo. The higher the water content, the more seeds can germinate before being planted (Sutopo, 2002). The water content of kilemo seeds varies from 13.01%–14.68%. The water content of the seeds is not too high, below 15%, but the viability of these seeds decreases very quickly, so kilemo seeds can only be stored for a short time. Kilemo seeds can still be stored for two weeks with a germination rate of 52% (Suita, 2014).

Kilemo seeds originating from West Java and North Sumatera have a reasonably high purity, ranging from 96.77%–99.11% (**Table 1**). This shows that the studied kilemo seeds are pretty clean with little dirt because purity reflects how much pure seed content is in the seed group. The purity of the seed group shows the proportion of pure seeds of a type and the amount of dirt and other seeds contained in it (ISTA, 2012). Based on the results of the calculation of the weight of 1,000 kilo seeds, the average range is 21.36–27.86 g. Determining the weight of 1,000 seeds is used to predict the number of seeds in 1 kg, which is very useful in planning, especially in determining the number of seeds needed for nurseries to meet the target of ready-to-plant seedlings. From the calculation of 1000 seeds, the weight of 1 kg of kilemo seeds ranges from 35,890–46,821 seeds. The number of kilemo seeds/kg, which comes from Aek Nauli (North Sumatera), is higher because the weight of 1000 seeds is lighter. The type of kilemo tree in Aek Nauli is at an altitude of 1,164–1,218 m asl. The daily temperature varies from 17–29°C and the soil type is yellowish-brown podzolic. The location of Aek Nauli when compared to Ciwidey, Bandung district, with an altitude varying from 1,600–1,700 m asl, air temperature varying from 15–22°C, annual rainfall of 3,556 mm, and Mount Papandayan, Garut district, with an altitude of 2,665 m asl, an average air temperature of 10°C, annual rainfall reaching 3,000 mm. Growing

conditions can influence the growth of kilemo trees, so the size of kilemo seeds also varies. Variations in seed weight and size are influenced by hereditary (genetic) and environmental factors (Suita et al., 2013). Looking at the growth of the kilemo tree from the perspective of environmental influences, environmental factors play a role in the adaptation and growth of this species, both when growing naturally or when planted in the field. The conditions of the place where the Aek Nauli seeds grow, and the height of the place where they grow are lower than the place where the Ciwidey and Mount Papandayan seeds grow. Thus, the height of the place where they grow can affect the size of the seeds in addition to the influence of genetic factors. Meanwhile, when viewed from the temperature and rainfall aspects, the places where the kilemo species grow are from the three various locations.

Table 5. The results of the interaction test of preliminary treatment and sowing test method on germination power, germination speed, daily germination, and germination value of kilemo seeds

Pre-treatment_B1	Germination percentage (%)			Germination rate (%/etmal)			Average daily germination (%/days)			Germination value (%/days)		
	Mean	StDev		Mean	StDev		Mean	StDev		Mean	StDev	
In condition B1:												
A1	34.67	1.16	C	0.72	0.04	C	50.73	1.36	A	0.36	0.14	A
A2	14.00	4.00	D	0.35	0.09	E	42.68	2.29	A	0.69	0.16	A
A3	16.67	3.06	D	0.40	0.10	DE	42.73	4.94	A	0.76	0.09	A
A4	38.67	1.16	C	0.88	0.06	BC	45.79	4.57	A	0.61	0.15	A
A5	28.67	6.11	C	0.63	0.13	CD	48.43	1.16	A	0.44	0.10	A
A6	49.33	1.16	B	1.12	0.04	AB	46.41	1.36	A	0.45	0.17	A
A7	60.00	5.29	A	1.38	0.14	A	45.83	2.37	A	0.53	0.28	A
In condition B2:												
A1	29.33	4.16	AB	0.55	0.03	AB	54.50	5.02	A	0.34	0.04	A
A2	29.33	8.33	AB	0.56	0.22	AB	55.77	6.47	A	0.29	0.23	A
A3	36.67	8.08	AB	0.73	0.15	AB	52.03	2.60	A	0.32	0.09	A
A4	18.00	10.00	B	0.29	0.04	B	57.56	10.11	A	0.38	0.20	A
A5	29.33	4.62	AB	0.59	0.07	AB	50.75	3.31	A	0.50	0.09	A
A6	44.00	8.00	A	0.85	0.17	A	53.62	0.62	A	0.50	0.14	A
A7	43.33	13.01	A	0.86	0.28	A	53.74	1.95	A	0.26	0.01	A

Notes: Means values followed by the same letter are not significantly different. A1= Soaked in plain water for 24 hours/control, A2= Soaked in 200 ppm boron solution for 24 hours, A3= Soaked in 2,000 ppm boron solution for 24 hours, A4= Soaked in 200 ppm KNO_3 solution for 24 hours, A5= Soaked in 2,000 ppm KNO_3 solution for 24 hours, A6 = Soaked in 100% coconut water for 3 hours, and A7= Soaked in coconut water for 6 hours, B1=Sowing test method in an open seedbed condition and B2 = Sowing test method in a seedbed covered with plastic

Germination testing that produces the highest germination power and germination speed is in the open germination tank treatment with treatment soaked in coconut water for 6 hours, resulting in germination power of 60% and germination speed of 1.38%/etmal. Treatment carried out before sowing can increase the speed and uniformity of seed germination. Kilemo seeds soaked in coconut water for 6 hours can increase the germination speed. Nutrients, growth regulators, and organic compounds such as vitamin C, vitamin B, auxin hormones, gibberellins, and cytokinins 5.8 mg/l, contained in coconut water, are needed for plant development and growth. In addition, coconut water contains water, protein, carbohydrates, minerals, vitamins, a little fat, Ca, and P (Ardi et al., 2018; Yunita, 2011). These substances and organic compounds in coconut water are thought to help germinate kilemo seeds. This also occurs in nutmeg (*Myristica fragrans*) and red rosella (*Hibiscus sabdariffa* var. sabdariffa) (Dharma et al., 2015; Wati, 2013).

The interaction between preliminary treatment and germination test method on germination power parameters, germination rate, average daily germination, and germination value shows that if kilo seeds are germinated in an open tub, it will be better if soaked in coconut water for 6 hours, while if sown in a closed tub, it will be soaked in coconut water for 3 hours or 6 hours. Regarding the time length of soaking for 6 hours, other studies have shown coconut water can increase soybean yield by 64%, peanuts by 15% and vegetables by 20–30% (Siahaan, 2024). Working with Arabica coffee seed soaking for 6 hours, Sari et al. (2022) mentioned that coconut water significantly increased germination percentage, vigor index and dry weight.

External factors affecting seed germination include temperature and light (Murniati, 2013). Germination of kilemo seeds gives equally good results in open or closed plastic germination tubs; this indicates that kilemo seeds do not require high temperatures and humidity but require more light for germination. Not all types of forest plants are the same as kilemo in terms of light, temperature, and humidity requirements for germination; several types of plants require higher temperatures for germination, such as the were type which requires high humidity and temperature for the best germination (90%), which is sown in a plastic-covered seedling tray (Suita and Nurhasybi, 2014), and the saga tree type which is soaked in plain water for three days which is sown in a plastic-covered seedling tray with a germination rate of 81.33% (Suita, 2012); likewise with the *Leucaena leucocepha* type which requires relatively high temperature and humidity to achieve the best germination (Suita, 2019).

4. Conclusion

Kilemo seeds originating from West Java and North Sumatra have quality with seed water content varying from 13.01–14.68%, purity above 96.77%, average weight of 1,000 seeds varying from 21.36–27.86 g, and seed/kg varying from 35,890–46,821 seeds/kg. To obtain good germination power, germination speed, average daily germination, and germination value, kilemo seeds sown in an open tub should be soaked in coconut water for 6 hours. If sown in a plastic closed germination tub, kilemo seeds should be soaked in coconut water for 3 or 6 hours.

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