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The Effect of Seed Location in Cempedak Fruit (*Artocarpus chempeden)* on the Germination Percentage and Growth Rate

Hasanudin[1]; Emi Malaysia[2]; Noorhamsyah[3]; Dwinita Aquastini[4]; Rudi Djatmiko[5]; Suwarto[6]

[1,2,3,4,5,6] Forest Management, State Agricultural Polytechnic of Samarinda,75131 East Kalimantan, Indonesia

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Abstract: This study aimed to determine the effect of seed position within cempedak (*Artocarpus chempeden*) fruit on germination percentage and germination rate. The experiment was conducted using a Completely Randomized Design (CRD) with three treatments, namely basal (base), middle, and apical (tip) seed positions, each with three replications. The observed parameters included germination percentage and growth rate expressed in days. Data were analyzed using analysis of variance (ANOVA) followed by the Least Significant Difference (LSD) test at a 5% significance level.

The results showed that seed position significantly affected both germination percentage and growth rate. Seeds from the basal part produced the highest germination percentage (88.89%) and were significantly different from those of the middle (73.33%) and tip (68.89) parts. In addition, basal seeds exhibited the fastest growth rate (4.83 days), followed by middle seeds (5.88 days), while tip seeds showed the slowest growth rate (6.78 days).

In conclusion, seeds obtained from the basal part of cempedak fruit have higher viability and vigor compared to seeds from other positions. Therefore, basal seeds are recommended as a superior seed source to improve germination success.

***Keywords**: Cempedak, Seed Position, Germination Percentage, Growth Rate, Seed Vigor.*

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I. INTRODUCTION

➢ *Background*

Cempedak (*Artocarpus chempeden*) is a tropical fruit plant belonging to the Moraceae family and is widely distributed across Southeast Asia, particularly in Indonesia, Malaysia, and Brunei Darussalam. This plant holds significant economic value as a local consumption fruit and has the potential for development within agroforestry systems (Lim, T. K. 2012). Beyond the utilization of its fruit pulp, cempedak seeds can also be consumed or used as plant propagation material.

Generative propagation through seeds is the most common method used in tropical fruit nurseries. The success of this method is heavily determined by seed viability and vigor. Seed viability is reflected in the germination percentage, while seed vigor relates to the germination rate and the growth strength of the seedling (Bewley et al., 2013). The higher the percentage and the faster the germination rate, the better the physiological quality of the seed.

Germination is a physiological process initiated by water imbibition, followed by enzyme activation, respiration, and embryo growth until the emergence of the radicle (Taiz et al., 2015). This process is influenced by external factors such as temperature, humidity, oxygen, and light, as well as internal factors like embryo maturity, food reserves, and the physiological condition of the seed (ISTA, 2018).

Within a single cempedak fruit, seeds are arranged along the fruit axis and enclosed by the aril (fruit pulp). Physiologically, it is possible that seeds located at the basal (base), middle, and apical (tip) sections of the fruit experience differences in nutrient supply during fruit development. Variations in the distribution of photosynthates and growth hormones within the fruit can affect embryo development and

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the accumulation of food reserves in each seed (Marcos-Filho, 2015).

In several fruit plants, variations in seed position within the fruit have been reported to affect seed size, weight, and viability. This is caused by a nutrient distribution gradient during the seed-filling process. Seeds that develop earlier or receive a more optimal nutrient supply tend to have larger food reserves, potentially resulting in higher vigor (Bewley et al., 2013).

However, scientific information regarding the influence of seed position within the fruit on the germination percentage and rate of cempedak is still limited. Given the importance of seed quality in fruit plant nurseries, research on this aspect is highly relevant. The results of this study are expected to provide a scientific basis for selecting higher-quality seed sources to improve the success of cempedak propagation.

➢ *Research Objectives*

This study aims to:

- Analyze the effect of seed position within the fruit on the germination percentage of cempedak.
- Analyze the effect of seed position within the fruit on the germination rate of cempedak.

➢ *Research Benefits*

- Theoretical Benefits
- To provide a scientific contribution regarding the internal factors that influence the germination percentage and growth rate of cempedak seeds.
- Practical Benefits

To provide information for nursery workers and farmers regarding the selection of cempedak seeds with the best germination potential to increase nursery efficiency.

II. RESEARCH METHODOLOGY

A. Location and Time of Research

This research was conducted at the Nursery Laboratory, Forest Management Study Program, Department of Forest Management, State Agricultural Polytechnic of Samarinda. The study spanned over 30 (thirty) days, encompassing tool and material preparation, data collection, and data processing.

B. Tools and Materials

➢ *Tools*

- Trays: Used for sowing the seeds.
- Hand Sprayer: Used to water the germination media.
- Camera: Used for research documentation and photography.
- Stationery: Used to record observation data.
- Plastic Jars: Used as water containers for seed selection.
- Labels: Used for numbering the seeds.
- Bowls: Used for soaking the seeds in plain water.

➢ *Materials*

- Cempedak seeds (*Artocarpus integer*)
- Sand and soil as planting media.
- Water for soaking.

C. Research Procedures

➢ *Seed Preparation*

- *Determining Seed Position in Cempedak Fruit*
  - ✓ The length of the fruit used as the research object was measured.
  - ✓ The measurement results were divided into three sections:
    - Base Section (A)
    - Middle Section (B)
    - Tip Section (C)

- *Seed Selection*

Seed selection was performed for each fruit section to obtain high-quality seeds by submerging them in water. The steps were:

- ✓ Prepare the seeds.
- ✓ Prepare a bowl filled with water.
- ✓ Submerge the seeds in the water.
- ✓ Select the seeds that sink.
- ✓ Let the seeds cool/rest for 1 minute.

- *Seed Samples*

For each treatment, 10 seeds were used, with each part taken from 3 different fruits

- *Seed Scarification*

The cempedak seeds were treated by soaking them in cold water for 24 hours.

➢ *Sowing the Seeds*

The selected and scarified seeds were sown into the prepared media.

➢ *Maintenance and Watering*

- Watering was conducted daily at 08:00 AM using a hand sprayer until the germination media was "moist/wet."
- Watering continued until the seeds germinated.
- Maintenance/watering was stopped if no further germination occurred within 10 (ten) days after the last germinated seed.

➢ *Data Collection*

- Collected data consisted of the number of seeds germinated each day.
- Germinated seeds were counted and marked on the media to avoid double counting.

D. Data Processing

Daily germination data were processed to determine germination values, including: germination percentage, growth rate, and seed germination capacity. These were calculated to find the germination viability using the following formulas:

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- *Germination Percentage (GP)*

Germination percentage is used to determine the proportion of seeds that successfully germinate out of the total seeds sown. This parameter is a basic indicator of seed viability in seed physiology research. (Sutopo,2004)

- *Germination Percentage Formula*

$$GP = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds sown}} x\ 100\ \%$$

Where :

- GP = Germination Percentage
- Number of germinated seeds = total seeds that germinated during the germination period
- Total number of seeds sown = total seeds prepared for the experiment

- *Growth Rate (GR)*

According to Sutopo in the book *Seed Technology* (2004), the germination rate is used to determine the speed at which seeds germinate during an observation period. The calculation is performed by comparing the number of germinated seeds against the observation time.

- *Growth Rate Formula*

The growth rate (GR) can be expressed as:

$$GR = \sum \frac{N}{T}$$

Or it can be written as:

$$GR = \frac{N_1}{T_1} + \frac{N_2}{T_2} + \frac{N_3}{T_3} + \cdots + \frac{N_n}{T_n}$$

Where:

- GR = Growth rate
- N = Number of seeds germinated at a certain observation time
- T = Observation time (days after sowing)

E. Statistical Analysis (ANOVA)

ANOVA is used to determine whether the treatments have a significant effect on the observed variable. The analysis is presented in an ANOVA table consisting of sources of variation, degrees of freedom, sum of squares, mean squares, and the calculated F value.

The Mathematical Model:

$$Yij = \mu + \tau i + \epsilon ij$$

- Y_{ij} :The response or observed value from the i-th treatment and the j-th replication.
- μ : The grand mean (overall average).
- τi : The effect of the i-th treatment.
- ϵ_{ij} : The experimental error effect from the i-th treatment and the j-th replication.

Table 1. Anova

Source of Variation	df	SS	MS	F
Treatment	t − 1	SST	MST	MST/MSE
Error	t(r − 1)	SSE	MSE	
Total	tr − 1	SSTotal		

- If $F_{calc} < F_{table}$} : The seed position has no significant effect on germination.
- If $F_{calc} > F_{table}$: The seed position significantly affects germination.

The data obtained from the experiment were analyzed using Analysis of Variance (ANOVA) based on a Completely Randomized Design (CRD) to determine the effect of treatments on the observed variables. The ANOVA was conducted at a 5% significance level. If the results of the ANOVA indicated a significant effect among treatments, the differences between treatment means were further tested using the Least Significant Difference (LSD) test at the 5% significance level to identify which treatments were significantly different from each other.

To calculate the LSD value (the minimum threshold for a difference to be considered "real"), use the following formula:

$$LSD = t_\alpha \sqrt{\frac{2xMSE}{r}}$$

Where:

- t_α: The critical value from the t-student table at significance level alpha (usually 0.05) with Error Degrees of Freedom (df).
- MSE: Mean Square Error obtained from your ANOVA table.
- r: Number of replications (reps)

III. RESULTS

Based on the testing of seed viability and germination rate of cempedak seeds from three different positions within the fruit, the following data were obtained:

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Table 1. Germination Percentage and Growth Rate Based on Seed Position in Cempedak Fruit

No.	**Seed Position**	**Germination Percentage (%)**			**Growth Rate (Days)**		
		1	**2**	**3**	**1**	**2**	**3**
1	A (base)	93,33	86,67	86,67	4,86	5,50	7,10
2	B (middle)	80,00	73,33	66,67	5,00	5,73	6,64
3	C (tip)	66,67	73,33	66,67	4,62	6,40	6,60

Table 2. Analysis of Variance (ANOVA) of Cempedak Seed Germination Percentage at Different Positions

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	661,73	2	330,86	13,40	0,01	5,14
Within Groups	148,15	6	24,69			
Total	809,88	8				

Table 3. Analysis of Variance (ANOVA) of Growth Rate of Cempedak Seeds at Different Positions

Source of Variation	***SS***	***df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	5,74	2	2,87	25,74	0,0011	5,14
Within Groups	0,67	6	0,11			
Total	6,41	8				

The results of the analysis of variance indicated that the treatment of planting material sections (Base, Middle, and Tip) had a significant effect on both survival percentage and growth rate. The calculated F-values for both parameters were higher than the F-table values at the 5% significance level, indicating that the applied treatments significantly affected plant growth.

The mean values and the results of the Least Significant Difference (LSD) test are presented in Table 4.

Table 4. Mean Germinations Percentage and Growth Rate

Treatment	**Survival Percentage (%)**	**Notation**	**Growth Rate (days)**	**Notation**
Base	88.89	a	4.83	a
Middle	73.33	b	5.88	b
Tip	68.89	b	6.78	c

Note: Values followed by the same letter in the same column are not significantly different according to the LSD test at the 5% level.

IV. DISCUSSION

For the survival percentage parameter, the Base treatment showed the highest value and was significantly different from the Middle and Tip treatments. This indicates that the basal part of the planting material has higher viability in supporting successful establishment. The higher survival percentage in this section is presumably related to greater food reserve content and more mature and stable tissue conditions. Adequate food reserves play an important role in supporting germination and early plant growth (Salisbury & Ross, 1995).

In contrast, for the growth rate parameter, the interpretation differs because the unit of measurement is time (days). A lower value indicates a faster growth rate. The results showed that the Base treatment had the lowest growth rate value (4.83 days), indicating faster growth compared to the other treatments. Conversely, the Tip treatment had the highest value (6.78 days), indicating the slowest growth.

The LSD test results revealed that all treatments were significantly different from each other in terms of growth rate, with the order of growth speed being Base, followed by Middle, and then Tip. This suggests that, in addition to improving survival percentage, the basal section also accelerates early plant growth.

Physiologically, the basal part of the plant generally contains higher carbohydrate reserves and more stable concentrations of growth hormones such as auxin, which play an important role in root formation and early plant development. Auxin is known to regulate cell elongation and tissue differentiation (Taiz & Zeiger, 2010). This condition makes the basal section more responsive to the growing environment compared to the middle and tip sections. On the other hand, the tip section tends to consist of younger, meristematically active tissues, but lacks sufficient food reserves, resulting in slower initial growth. According to Hartmann et al. (2011), the success of plant propagation is

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strongly influenced by the balance between food reserves and physiological activity of the tissues.

The middle section showed an intermediate response, reflecting physiological conditions that are not as optimal as the basal section but better than the tip section.

V. CONCLUSION

The treatment of planting material sections significantly affected both germination percentage and growth rate. The Base treatment produced the best results, with the highest survival percentage and the fastest growth rate, and is therefore recommended as the most optimal source of planting material

RECOMMENDATIONS

It is recommended to evaluate additional growth parameters, such as plant height, stem diameter, and root development, in order to strengthen the research findings and obtain a more comprehensive understanding of plant growth.

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