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Improving the Quality of Coconut Fruit (*Cocos nucifera* L.) by Adjusting Planting Age

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Abstract

Coconut (*Cocos nucifera* L.) is a strategic plantation crop in Indonesia, playing important roles in society, the economy, and industry. Indragiri Hilir Regency is the largest producer of coconut in Riau Province; however, productivity has declined as plantations have aged. This study aimed to analyze the quality of coconut fruit based on plant age. A non-experimental comparative observational design was employed with three plant age treatments (15, 20, and 25 years). Each treatment was replicated six times, yielding 18 experimental units. Each unit consisted of two sample plants, totaling 36 plants. The measured parameters included endosperm thickness (mm), oil yield (%), and oil moisture content (%). For oil yield and moisture analysis, two mature coconuts were collected from each plant and analyzed in the laboratory, resulting in 36 samples. Data were analyzed using one-way ANOVA, and significant results were further tested using Tukey's HSD at the 5% level. The results showed that plant age had a considerable effect on endosperm thickness, oil yield, and moisture content. These findings suggest that plant age affects coconut fruit quality, with 25-year-old trees producing the highest-quality fruits in the Tembilahan Hulu District, Indragiri Hilir Regency. This study offers recommendations for coconut farmers to optimize cultivation strategies, thereby enhancing production and fruit quality.

Keywords: Coconut Fruit, Crop Age, Endosperm Thickness, Productivity, Quality of Fruit

1. Introduction

Coconut (*Cocos nucifera* L.) is a strategic plantation crop in Indonesia with important socio-cultural, economic, and industrial roles. It contributes to foreign exchange earnings, provides a source of income for farmers, and generates substantial employment opportunities (Tarigans, 2005). All parts of the coconut plant are utilized, serving as sources of vegetable oil and raw materials for the food, construction, pharmaceutical, and allelochemical industries.

Indragiri Hilir Regency is the largest coconut-producing region in Riau Province, earning the designation "the world's coconut expanse." In 2022, the regency produced 313,527 tons of coconuts from 341,625 hectares of land (BPS Riau Province, 2022). Despite this high production, coconut farming in the area continues to face persistent challenges. Damanik (2007) identified key problems, including reliance on traditional farming systems, marketing coconuts primarily as raw grains or copra, low productivity, limited capital, and weak adoption of recommended technologies. One of the most critical constraints is the age of the plant. According to Khairizal et al. (2018), the peak productive age of coconuts is 10–15 years; yet, the average age of coconut plantations in Indragiri Hilir exceeds 20 years, leading to declining yields.

Research has highlighted factors influencing coconut productivity. Wulandari et al. (2018) reported that yields exceeding 80 coconuts per tree annually are considered high. In contrast, Winarti et al. (2022) found that productivity is influenced by factors such as tree age, land area, labor input, and fertilizer application. At the farm level, the low purchase price of coconuts—averaging IDR 1,199 compared with a selling price of IDR 1,489—has been linked to aging and damaged plantations (Wulandari et al., 2018).

Coconuts consist of approximately 33% husk, 15% shell, 22% water, and 30% flesh. The flesh contains the highest oil fraction: fresh coconuts contain 30–50% oil, and dried copra includes 63–65% fat. Coconut oil, composed primarily of triglycerides, contains about 90% saturated fatty acids and 10% unsaturated fatty acids (oleic and linoleic acids). Its high proportion of medium-chain fatty acids has led to its recognition as a healthy oil (Subagio,

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2011).

Fruit quality is determined by the physicochemical characteristics of its components, which are directly influenced by fruit type and plant age (Mahmud & Ferry, 2005). However, contrasting evidence has been reported in other crops: Puspita et al. (2023) found that oil palm fruit oil yield was not affected by plant age but rather by fruit ripeness and processing speed. This finding highlights the limited literature addressing the relationship between the age of coconut plants and fruit quality. Key indicators of coconut fruit quality include the number of bunches per tree, endosperm thickness, oil yield, and water content. Therefore, this study aimed to determine and analyze the effect of coconut (*Cocos nucifera* L.) plant age on fruit quality.

2. Material and Methods

The research was conducted from October 2024 to January 2025 in Tembilahan Hulu District, Indragiri Hilir Regency, Riau Province, which is located astronomically between 0° 36' North Latitude and 1° 07' South Latitude and between 104° 10' and 102° 32' East Longitude. The analysis of coconut fruit quality was carried out at the Chemical Engineering Laboratory, Faculty of Engineering, University of Riau, Binawidya campus, Jl. HR. Soebrantas km 12.5, Simpang Baru Village, Binawidya District, Pekanbaru.

The implementation of the research involves determining the research location, sampling, observation, and laboratory analysis of fruit quality. The materials used in this study were 15-year-old, 20-year-old, and 25-year-old coconut plants of the Dalam type, along with chemical materials for fruit quality analysis in the laboratory. The tools used in this study were binoculars, a spatula, a coconut pick, plastic, analog scales, knives, coconut graters, sieves, machetes, meters, measuring tapes, calipers, label paper, frying pans, stoves, documentation tools, and laboratory tools such as analytical scales, cups, dropper pipettes, ovens, and desiccators.

This study employs a non-experimental comparative observational approach, aiming to compare the quality of the Coconut fruit based on plant age. There are 3 categories of coconut plant age, namely: UT1 (Coconut plants aged 15 years), UT2 (Coconut plants aged 20 years), and UT3 (Coconut plants aged 25 years). Each plant age treatment was repeated 6 times to obtain 18 experimental units. Each experimental unit consists of two sample plants, resulting in a total of 36 sample plants used.

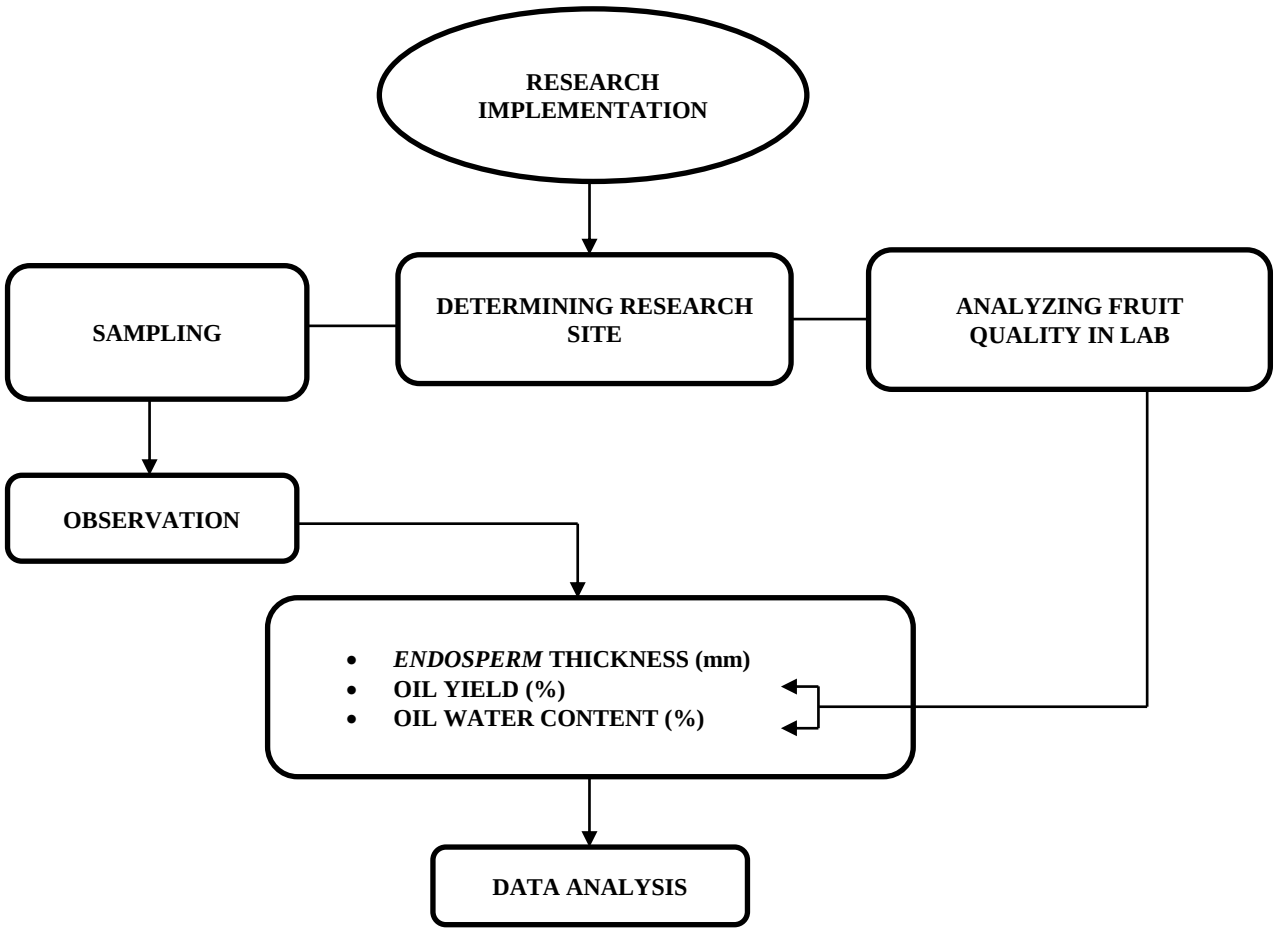

Figure 1. Research Flow Diagram

The parameters used in this study are:

1. *Endosperm* thickness (fruit flesh) is measured by measuring the fruit flesh from the outside to the inside.
2. Coconut oil yield: The oil produced from coconut milk is separated and then heated. The calculation of coconut oil yield uses the following formula:

$$\mathbf{Rendemen} = \frac{\boldsymbol{Oil\ volume\ formed\ (ml)}}{\boldsymbol{Coconut\ cream\ volume\ (ml)}} \times \mathbf{100\%}$$

3. The resulting oil is then oven-dried at 105 °C for 2 hours, and then cooled in a desiccator for 15 minutes. This process is repeated until a constant weight is achieved. The calculation of the water content of coconut oil uses the following formula:

$$\boldsymbol{Kadar\ air} = \frac{(\boldsymbol{BS} + \boldsymbol{BCK}) - (\boldsymbol{BC} + \mathbf{1})}{\boldsymbol{BS}} \times \mathbf{100\%}$$

Information:
BS : Total Weight of Oil Sample
BCK: Weight of Empty Cup (g)
BC : Weight of the cup after filling Oil

Sampling was conducted for the oil yield parameters and coconut water oil content using 2 old coconuts in healthy condition, which were brought to the laboratory. A total of 36 coconut samples were used. The data were analyzed using One-Way ANOVA (Analysis of Variance) to compare the averages of different groups and to determine significant differences between the group means. The results were further tested using the Honestly Significant Difference (HSD) test at the 5% level. Data were analyzed using SPSS 23.

3. Results and Discussion

3.1. Standard Error

Table 1. Standard Error for each parameter

Parameter	Standard Error
Endosperm Thickness	0.6476
Oil Yield	3.1358
Water content	1.2558

3.2. Endosperm Thickness

Observation data on the age parameter of coconut plants on endosperm thickness. The results of the BNJ follow-up test at the 5% significance level are presented in Table 2. The test results in Table 2 show that 25-year-old coconut plants produce thicker endosperm compared to 15-year-old and 20-year-old coconut plants. This result occurs because, as the coconut tree ages, the endosperm (the fruit flesh) becomes more compact, increasing in thickness. Coconut trees typically reach peak productivity and physiological stability after their teenage years (15-20 years), when the root system is fully developed, allowing for optimal nutrient and water absorption and a more stable tree metabolism.

Table 2. *Endosperm* thickness at several ages of Inner Coconut plants

Age of Coconut Plants	N	Subset for α = 0.05	
		1	2
15 years	6	11,353a	
20 years	6	11,610a	
25 years	6		13,587b
Sig.		0.918	1,000

Description: The numbers in the rows in the columns followed by the same lowercase letter are not significantly different according to the further test of honest significant differences (HSD) at the 5% level.

Based on research by Tuhumuri and Sancayaningsih (2018), 24-year-old coconut trees produce thicker endosperm than 16-year-old coconut trees, with a difference of 3.5 mm. This result suggests that mature trees (20-30 years old) achieve optimal endosperm formation and fruit development duration, resulting in thicker endosperm. The thickness of the coconut endosperm is influenced not only by the age of the plant but also by the water content of the coconut fruit. The water content decreases as the plant ages due to the endosperm tissue changing from liquid to solid. This finding aligns with the opinion of Rindengan et al. (1995) that as the coconut plant ages, the water volume decreases and is replaced by a harder kernel and thicker flesh. According to Suhardiyono (1995), when the plant reaches maturity, the weight of fresh fruit begins to decrease due to the shrinkage of the fiber weight, but the weight of the shell and the thickness of the fruit flesh increase.

3.3. Coconut Oil Yield

Observation data on the effect of plant age on coconut oil yield. The results of further BNJ testing at the 5% level can be seen in Table 3.

Table 3. Coconut oil yield at various ages of coconut plants

Age of Coconut Plants	N	Subset for alpha = 0.05	
		1	2
15 years	6	45,448a	
20 years	6		55,053b
25 years	6		57,483b
Sig.		1,000	0.724

Description: The numbers in the rows in the columns followed by the same lowercase letter are not significantly different according to the further test of honest significant differences (HSD) at the 5% level.

The test results in Table 3 show that 25-year-old Coconut plants significantly produce more oil yield compared to 15-year-old Coconut plants, but the difference is not substantially different from that of 20-year-old Coconut plants. This finding is because the production of oil yield and Virgin Coconut Oil (VCO) derived from the

dense endosperm of the Coconut fruit increases with the age of the Coconut plant. Based on the research results of Sari and Rusmanida (2023), oil yield differs from 3 to 25 years. In 5-year-old plantation plants, the oil yield reaches 19.89%, increasing to 21.86% at the age of 25 years. This increase in oil yield is believed to be due to the coconut plants reaching their peak growth. Research by Banowati *et al.* (2021) showed that oil yield from 10-month-old coconuts increased compared to 13-month-old coconuts, from 5% to 19.23%. This finding aligns with Muis's (2016) finding that processing methods and plant age influence yield, chemical properties, and phenolic compound content in coconut oil.

Oil yield is thought to be influenced not only by the age of the fruit's harvest but also by the formation of buds in the coconut fruit. According to Bewley and Black (1985), the fat reserves in the coconut flesh are hydrolyzed by the lipase enzyme into fatty acids, which supports the germination process characterized by the formation of buds. This finding is thought to have an impact on reducing the oil content in coconuts that have formed buds, which is 33.3% lower than in coconuts that have not formed buds.

3.4. Oil Water Content

Observation data on the parameters of plant age on oil water content. The results of the BNJ follow-up test at the 5% significance level are presented in Table 4. The test results in Table 4 show that 15-year-old Coconut plants actually produce more oil water content compared to 20-year-old and 25-year-old Coconut plants. This result occurs because, as the age of the Coconut plant increases, the oil-water content decreases as it solidifies into the fruit endosperm, resulting in an increase in oil yield and Virgin Coconut Oil (VCO) in the fruit.

Research by Muis (2016) shows that the older the coconut tree, the higher the oil yield and the lower the water content of the fruit produced at harvest. This finding is evident in the decrease in water content from 0.16% in fruit produced approximately 10 months after fruiting to 0.12% in plants that have been producing fruit for 13 months.

Table 4. Oil and water content in coconut plants at various ages.

Age of Coconut Plants	N	Subset for alpha = 0.05	
		1	2
15 years	6	0.715a	
20 years	6		4,552b
25 years	6		5,050b
Sig.		1,000	0.917

Description: The numbers in the rows in the columns followed by the same lowercase letter are not significantly different according to the further test of honest significant differences (HSD) at the 5% level.

The moisture levels present in coconut oil directly impact the amount of oil obtained from the coconut fruit. An increase in oil production results in a decrease in water content, while a reduction in oil production results in an increase in water content. As posited by Rindengan et al. (1995), it was observed that the water content of the coconut fruit decreases as the coconut plant matures and the fruit reaches maturity.

4. Conclusion

Conclusions drawn from a study conducted in the Tembilahan Hulu District of the Indragiri Hilir Regency indicate that the age of the coconut plant has an impact on the quality of the coconut crop. These variables encompass endosperm thickness, oil productivity, and moisture levels.

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