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The Effect of The Tree Rats (*Rattus Tiomanicus* (Miller, 1900)) Attack on The Quality of The Crude Palm Oil (CPO) in Oil Palm (*Elaeis Guineensis* Jacq.) Plantations of Palangkaraya Central Kalimantan

(Pengaruh Serangan Hama Tikus Pohon (*Rattus tiomanicus* (Miller, 1900)) terhadap Kualitas *Crude Palm Oil* pada Perkebunan Kelapa Sawit (*Elaeis guineensis* Jacq.) Palangkaraya Kalimantan Tengah)

Diva Rosa Nirwana Dasuki*, Nuning Nurcahyani, Dzul Fithria Mumtazah, Jani Master

Biology Department, Faculty of Mathematics and Science, Universitas Lampung
*Corresponding author: nirwanadivarosa@gmail.com

Abstrak

Indonesia adalah produsen terbesar *Crude Palm Oil* (CPO) di dunia. Tikus pohon (*Rattus tiomanicus* (Miller, 1900)) menjadi masalah signifikan di perkebunan kelapa sawit karena memakan dan merusak bagian mesokarp, mengurangi berat buah serta memengaruhi tingkat *Oil Extraction Rate* (OER) dan *Free Fatty Acid* (FFA) dalam CPO. Penelitian ini mengkaji dampak gigitan tikus terhadap kualitas CPO, dengan fokus pada OER dan kadar FFA. Metode percobaan yang digunakan adalah metode eksperimental dimana kelompok buah sawit dengan tingkat serangan tikus yang bervariasi dibandingkan dengan kelompok buah sawit restan atau tertunda pengangkutan dan kelompok buah yang diserang hama lainnya. Hasil uji ANOVA satu arah dan Post Hoc LSD menunjukkan bahwa serangan tikus berat (>50%) secara signifikan memengaruhi OER dan FFA dibandingkan kondisi lainnya.

Kata kunci: Kelapa Sawit, *Crude Palm Oil* (CPO), Hama Tikus Pohon, *Oil Extraction Rate* (OER), *Free Fatty Acid* (FFA).

Abstract

Indonesia is the world's largest producer of Crude Palm Oil (CPO). Tree rats (Rattus tiomanicus (Miller, 1900)) pose a significant problem in palm oil plantations by eating and damaging the mesocarp, reducing fruit weight, and affecting the Oil Extraction Rate (OER) and Free Fatty Acid (FFA) levels in CPO. This study investigates the impact of rat bites on CPO quality, focusing on OER and FFA levels. Using an experimental method, palm fruit groups with varying rat attack levels were compared to rested (3 days delayed in transport) and other pest attacked fruit groups. Results from a one-way ANOVA and Post Hoc LSD test showed that severe rat attacks (>50%) significantly affected OER and FFA compared to other conditions.

Keywords: Palm Oil, Crude Palm Oil (CPO), Tree Rat Pests, Oil Extraction Rate (OER), Free Fatty Acid (FFA).

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INTRODUCTION

Indonesia has the largest oil palm plantations and is the world's top producer of Crude Palm Oil (CPO), generating 51.8 million tons annually in 2019. In addition to being a key source of national revenue, Indonesia supplies 47% of the global demand for vegetable oil.

Oil palm (*Elaeis guineensis* Jacq.) plays a vital role in Indonesia's economy [1]. The quality of CPO is assessed based on both quantity and Free Fatty Acid (FFA) content, with high-quality fruit yielding CPO with FFA levels below 3%. Since FFA levels are directly linked to the quality of harvested fruit, where higher FFA signifies lower CPO quality, it is vital to understand the factors influencing FFA [2].

Indonesia faces the challenge of maintaining consumer trust by consistently producing high-quality, certified CPO that meets national and international standards. The country must also remain competitive in the global vegetable oil market, meeting domestic demand while boosting economic growth [3]. In oil palm cultivation, one unavoidable issue is the presence of pests, particularly rodents [4]. Among them, the tree rat (*Rattus tiomanicus* (Miller, 1900)) is the most dominant species, commonly found in almost all oil palm plantations [5][6]. A single tree rat can consume 6–14 grams of fruit flesh daily, leading to CPO losses of 828–962 kg per hectare annually [7]. Their attacks on ripe Fresh Fruit Bunches (FFB) ready for harvest reduce CPO quality by biting into the mesocarp, which increases the Free Fatty Acid (FFA) levels in the palm oil [8].

High FFA levels in CPO make the refining process more difficult, resulting in downstream products with elevated FFA content. High free fatty acid levels indicate increased acidity in the oil, which leads to a decrease in quality [9]. A higher peroxide value in the oil signals greater oxidation, which accelerates rancidity, further lowering oil quality [10]. Additionally, high FFA levels in palm oil derivatives pose health risks if consumed [11]. Beyond rodent pests, another factor affecting CPO quality is the presence of 'restan' fruit—oil palm fruit that is delayed in processing due to late transportation or handling [12].

Although tree rats are the most dominant pests in oil palm plantations, caterpillar infestations can also impact the Oil Extraction Rate (OER) and Free Fatty Acid (FFA) content in Crude Palm Oil (CPO) [13], such as the attack by the stem borer caterpillar (*Tirathaba mundella* (Walker, 1864)) [14]. As the age of 'restan' fruit increases, the FFA percentage rises, while the OER remains largely unaffected, as testing shows minimal changes in OER percentages [15]. Further research is needed to confirm whether delayed transport or other pest infestations contribute to the decline in CPO quality by affecting both OER and FFA levels in oil palm plantations in Palangkaraya, Central Kalimantan.

METHODS

Selection of Sample Location

The research location was determined using purposive sampling, based on a prior survey indicating high tree rat pest infestation levels in Block N26 (marked as D on the map). The spacing between trees is 9.2 meters, with rows spaced 7.97 meters apart. The oil palm trees in Block N26 were planted simultaneously in 2009, making their age approximately 15 years. Samples were collected using random sampling, where oil palm fruits were randomly selected from different trees for testing in the laboratory.

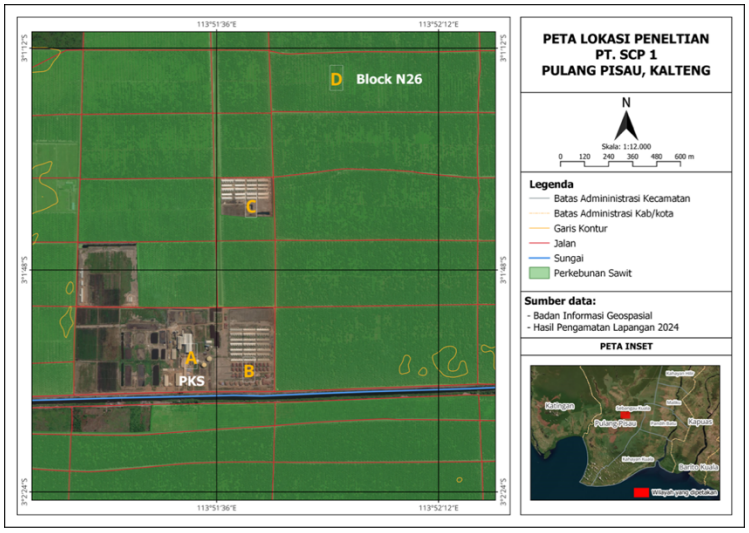

Figure 1. Research Location

Grouping of Oil Palm Fruit

This study used an experimental method with four treatments, as follows: oil palm fruits with 0% infestation (control variable), fruits with 25-50% infestation, fruits with less than 50% infestation, and fruits with more than 50% infestation. Each treatment was repeated five times.

(A)	(B)	(C)	(D)
Control Variable (0% Rat Infestation)	Oil palm fruit with rat bite infestation of less than 25%	Oil palm fruit with rat bite infestation of 25–50%	Oil palm fruit with rat bite infestation >50%

Figure 2. Severity levels of rat bite damage

The palm fruit samples used in this study consisted of 8 fruits from five different attack categories, selected from a total of 127 fruits (32 fruits per repetition). The restan fruit samples were those that were not attacked by pests, harvested on the same day, and then left in the laboratory for the required restan period. For this study, the restan palm fruits used for comparison were those aged 3 days. Meanwhile, for the palm fruit samples affected by caterpillar pests, two categories were used: palm fruits attacked by caterpillars and the control variable, which was only used for comparison purposes.

To categorize the palm fruit based on surface damage, measurements can be taken using a ruler or measuring tape. If the damaged surface area is less than half of the total length of the palm fruit, the damage is categorized as Category 1, indicating a light attack of less than 25%. If the damaged surface area is more than half of the total length, it falls into Category 3, indicating a heavy attack of more than 50%. If the damaged surface area is between these two extremes, the damage is categorized as moderate, with an attack percentage of 25–50% of the total length of the fruit.

Comparison sample for the rat damaged palm fruit is fruit that has been stored for 3 days, as palm fruit typically begins to show changes after resting for about 3 days (36 hours) [16].

Palm fruit infested by caterpillar pests is also used as a comparison. The bite marks from caterpillars differ from those left by rats. Caterpillar damage typically affects young oil palm plants (3-4 years old) but in certain conditions it can also be found on older palms or fruit older than 10 years. The characteristic signs of caterpillar infestation include bite marks on the fruit and flowers, often accompanied by droppings and plant fibers. Fresh bite marks appear pink, while older ones turn black [17].

Figure 3. Palm fruit damaged by caterpillar pests

Processing Palm Fruit into CPO

The collected palm fruit samples are first cleaned to remove dirt, then grouped (each treatment group contains 8 fruits) and labeled with a code according to the severity of damage, ranging from light to severe. For example, 1A (control; scale 0), 1B (light damage; scale 1), 1C (moderate damage; scale 2), and 1D (severe damage; scale 3). The number "1" before the letter indicates the first repetition in the first week, followed by the same process in subsequent repetitions. After labeling, each group of palm fruit is weighed using an analytical balance. For the groups with rested fruit and those affected by caterpillar pests, labeling is done based on the treatment applied.

Figure 4. Grouping of palm fruit according to category before processing into CPO.

The mesocarp of the palm fruit is then peeled with a knife, separating it from the seed. The separated mesocarp is then weighed and placed in an oven at 105°C for 6 hours. After being placed in the oven, the mesocarp sample is cooled to room temperature, then 200 ml of n-hexane solution is added as a solvent, followed by extraction using a Soxhlet extractor for 4 to 5 hours until the oil is fully separated and CPO is formed.

Calculation of OER Percentage

The OER percentage is determined by dividing the total weight of the palm fruit by the weight of the CPO produced [18].

$$\%OER = \frac{CPO}{TBS}\ x\ 100$$

where :
OER : Oil Extraction Rate percentage (%)
CPO : CPO produced (g)
TBS : Weight of processed palm fruit (g)

Testing and Calculation of FFA Content

The FFA content in CPO oil will be tested using the acid-base titration method. A 5 g sample of CPO is placed in an Erlenmeyer flask, and 50 ml of Iso Propyl Alcohol (IPA) is added to the flask containing the CPO. Then, 4 drops of phenolphthalein (PP) indicator are added, and the solution is homogenized by shaking. Afterward, the solution is titrated with NaOH until the color changes to brick red. The volume of NaOH solution used during the titration is recorded [19]. The FFA percentage is calculated using the following formula

$$\%FFA = \frac{N\ NaOH\ x\ V\ titration\ \ x\ 25{,}6}{Weight\ of\ CPO\ Sample}$$

where:
N NaOH = Normality of NaOH
V titration = Volume of NaOH used in the titration
25,6 = Molecular weight of palmitic acid

Data Analysis

he average values were analyzed using a one-way Analysis of Variance (ANOVA) to determine the differences in FFA percentages and compared with the control variable to assess the impact of tree rat bites on FFA levels in CPO from each oil palm fruit sample group. To assess the significance of each treatment's effect on CPO quality and identify the most influential treatment, statistical analysis was performed using the Statistical Program for Social Science (SPSS). This analysis determined the significance of tree rat pest attacks on CPO quality and compared the results with OER and CPO levels from oil palm fruits damaged by stem borer pests and rested fruit.

RESULT AND DISCUSSION

Based on the research conducted on the impact of tree rat pests on CPO quality, focusing on the OER and FFA parameters at the PKS PT. SCP 1 Laboratory, the results, including the OER percentage (yield) and FFA levels in CPO, are presented in Table 1.

The first test result is the OER parameter test for six categories of oil palm fruit. The study showed that the control variable (Category A) had the highest OER percentage, 44.41%. The lowest OER content was found in fruit heavily attacked by tree rats (Category D), with 34.68%. Other data indicated that light tree rat attacks (Category B) caused a 4.78% decrease, and moderate tree rat attacks (Category C) caused a 7.32% decrease. From these results, it can be concluded that the largest difference in OER percentage reduction occurred between the control variable and Category D, with a decrease of 9.73%.

Table 1. Average OER and FFA Content of CPO Samples

Category	Treatment	Parameter (%)	
		OER (Mean ± St. Dev)	FFA (Mean ± St. Dev)
A	0% (Control)	44,41 ± 1,64	3,65 ± 0,85
B	Rat Damage < 25%	39,63 ± 2,24	4,59 ± 0,22
C	Rat Damage 25% – 50%	37,09 ± 2,69	5,42 ± 0,96
D	Rat Damage >50%	34,68 ± 2,09	6,77 ± 1,55
E	3-Day Rested Fruit	44,4 ± 2,58	4,84 ± 0,41
F	Other Pest Damage	44,2 ± 1,93	4,4 ± 1,28

In addition to rat damage, the data also show that both 3-day rested fruit and fruit damaged by other pests led to a decrease in OER, though the reduction was not significant. The OER of 3-day rested fruit was 44.4%, resulting in a minor decrease of only 0.01% compared to the control group. The OER of fruit damaged by pests was 44.2%, which represents a 0.21% decrease compared to the control. To assess the significance of these reductions, a One-way ANOVA was performed using SPSS software. The analysis revealed a significant effect of rat damage on the reduction of OER in CPO (P-value < 0.05).

In contrast to the OER results, the FFA analysis showed that the control group (category A) had the lowest FFA percentage at 3.65%, while the highest FFA was observed in fruit with severe rat damage (category D) at 6.77%. The increase in FFA between categories A and D, a difference of 3.12%, is undesirable. To confirm the significance of this increase, the data were again analyzed using One-way ANOVA with SPSS. The results indicated a significant effect of rat bites on the increase in FFA in CPO (P-value < 0.05).

The data also showed that mild rat damage (category B) led to a 0.94% increase in FFA, and moderate rat damage (category C) caused a 1.77% increase. In addition to rat damage, 3-day rested fruit and fruit damaged by other pests also led to an increase in FFA, though the increase was minimal. The FFA percentage of 3-day rested fruit was 4.84%, indicating a decrease of 1.19% compared to the control group. The FFA percentage of fruit damaged by pests was 4.4%, representing an increase of 1.19% compared to the control. A One-way ANOVA was conducted to assess the significance of these changes, and the analysis revealed that the increase in FFA was not statistically significant (P-value > 0.05).

The discussion above indicates that the presence of pests in oil palm plantations significantly affects production quality. Pest attacks on oil palm plants can also impact their growth and development. In addition to reducing CPO quality, pest damage can affect overall production quantities [20].

CONCLUSION

Tree rat infestations significantly increased FFA but had no significant effect on the decrease in OER. Rat damage had a greater impact on reducing OER and increasing FFA compared to 3-day rested fruit and pest damage from caterpillars.

CONFLICT OF INTEREST

I hereby declare that there is no conflict of interest in the writing of this scientific paper.

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