

Comparative Analysis of Oil Content in Dura and Tenera Palm Fruit Varieties

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Abstract

The oil palm (*Elaeis guineensis* Jacq.) is a vital crop in global agriculture, known for its high oil production. Among the oil palm varieties, Dura and Tenera stand out as the most prominent fruit types. Despite the economic significance of the oil palm, there has been limited research aimed at thoroughly examining the components of oil content between Dura and Tenera fruits. It is crucial to comprehend how these fruit types affect oil content, particularly in terms of the percentage of oil to bunch (OTB%), percentage of oil to fruit (OTF%), and percentage of oil to dry mesocarp (%OTDM), as this knowledge is crucial in determining the quality of oil palm cultivation and ensuring sustainable oil production. This study seeks to bridge the existing knowledge gap by investigating the influence of different fruit types, Dura and Tenera, on %OTF, %OTB, and %OTDM. We have gathered a dataset of %OTF, %OTB, and %OTDM from oil palm plantations representing both Dura and Tenera fruit types. Our analysis reveals substantial differences in the percentages of %OTF, %OTB, and %OTDM between Dura and Tenera oil palm fruit types. Particularly noteworthy is the significant variation in the oil-to-fruit percentage, underscoring a marked distinction between Tenera and Dura palms, characterized by a p-value of 0.00 and a robust t-value of 11.56 by using the statistical examination. This finding aligns with the industry's perception of Tenera as a superior cultivar for oil yield, supported by its significantly higher oil accumulation within individual fruits.

1. Introduction

The oil palm, scientifically known as *Elaeis guineensis*, is a cornerstone in global agriculture due to its pivotal role as a primary source for vegetable oil production. Within this species, two distinct cultivars, Dura and Tenera, have appeared, each possessing distinct traits that have a notable influence on both oil yield and economic sustainability [1][2]. These cultivars are of profound interest to researchers and stakeholders in the agricultural sector. Despite the recognition of marked differences in oil content between Dura and Tenera palms, there exists a substantial knowledge gap regarding the underlying factors that give rise to these variations.

The crux of the current problem lies in the intricate genetic diversity present within Dura and Tenera palm varieties. This genetic diversity has long been associated with differences in oil content, with Tenera palms frequently regarded as superior in terms of oil yield [3][4].

The need for this research is underscored by the potential benefits it offers to the oil palm industry. By investigating the nuances of oil composition and distribution in Dura and Tenera palms, this study aims to unveil the driving forces behind oil content variations. This knowledge not only advances our fundamental understanding of oil palm biology but also holds practical significance. It can guide refinements in cultivation practices and oil extraction methods, ultimately contributing to increased efficiency and profitability in the palm oil industry while promoting sustainable agricultural practices.

The principal objective of this research is to employ a systematic approach that harnesses the precision of the Soxhlet extraction method to quantitatively compare oil content between Dura and Tenera palm varieties. By focusing on crucial parameters such as the oil-to-fruit percent, oil-to-bunch percent, and oil-to-dry mesocarp percent, this study aims to offer a comprehensive view of the disparities in oil content between these two cultivars.

2. Methodology

2.1 Study Area

The study was conducted at Trial 1, located within the Ladang Seed Garden of Pusat Penyelidikan dan Pembangunan FELCRA Berhad, situated in Bota, Perak ($4^{\circ}18'43.0''\text{N}$ $100^{\circ}58'03.0''\text{E}$) (Figure 1). This specific estate encompasses a total land area of 9.15 hectares and is home to 1181 oil palm trees.

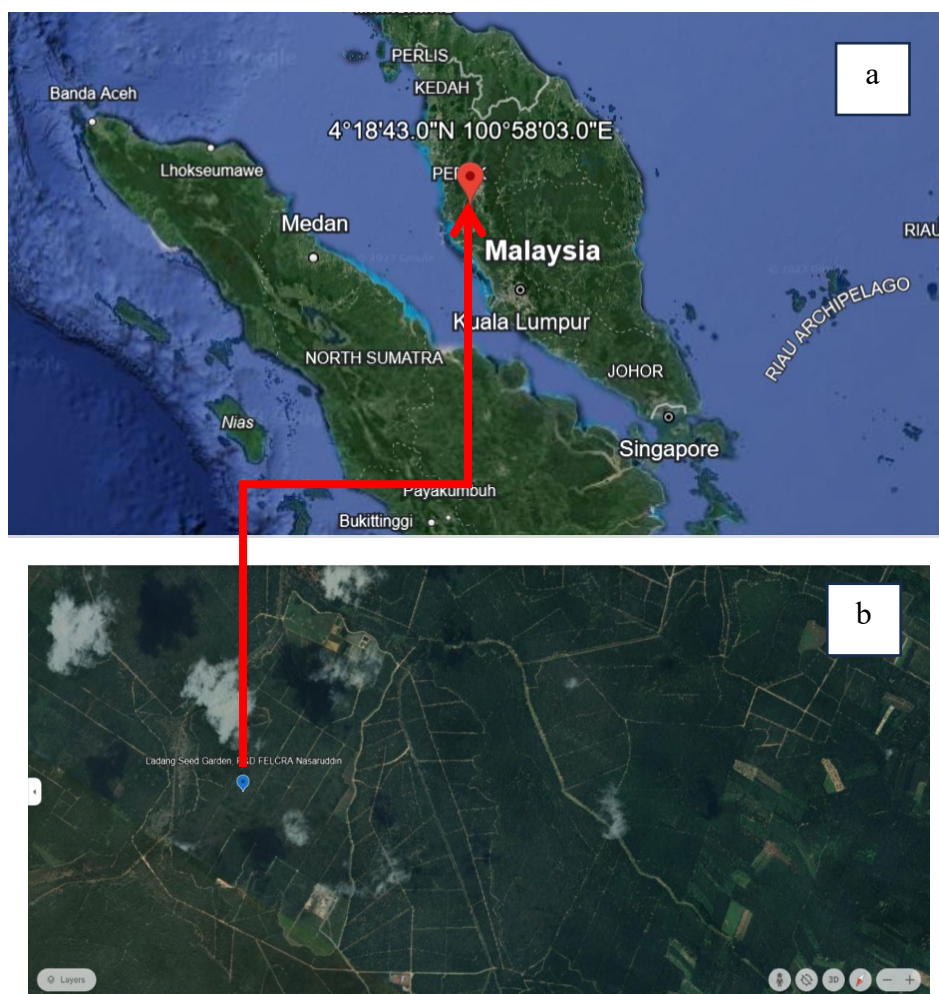


Fig. 1 Map of peninsular Malaysia (a) and location of study plot Ladang Seed Garden, R&D FELCRA Berhad (blue point) in (b)

2.2 Data Collection

In 2017, we collected data from a total of 290 oil palm samples, consisting of 232 Dura and 58 Tenera specimens. To calculate the percentages of Oil to Bunch (OTB%), Oil to Fruit (OTF%), and Oil to Dry Mesocarp (OTDM%) for each oil palm, we followed the established methodology outlined in previous studies [5][6].

OTB% (oil to bunch):

$$= \frac{F/B \times M/F \times O/WM}{10,000}$$

Where: F/B is percentage for fruit to bunch

M/F is percentage for Mesocarp to fruit

O/WM is percentage for Oil to wet mesocarp

OTF % (Oil to Fruit):

$$= \frac{TDMWT - TWT \times OTDM}{FSWT}$$

Where: TDMWT is Tin + dry mesocarp weight

TWT is Tin Weight

OTDM is Oil to dry mesocarp percentage

FSWT is Fruit Sub sample weight

OTDM % (oil to dry mesocarp):

$$= \frac{ETMWT - ETFWT \times 100}{ETMWT - ETWT}$$

Where: ETMWT is Extraction thimble + tin weight

ETFWT is Extraction thimble + fibre weight

ETWT is Extraction thimble + mesocarp weight

2.3 Data Analysis

In this study, we used SPSS 21 to conduct our data analysis, specifically employing t-tests. These t-tests were instrumental in evaluating and comparing oil content differences between the Dura and Tenera palm varieties, encompassing oil to fruit percent (%OTF), oil to bunch percent(%OTB), and oil to dry mesocarp percent (%OTDM). To determine statistical significance, our threshold was set at $p < 0.05$, ensuring robust and meaningful comparisons.

3. Result and Discussion

Our study provides critical insights into the oil content variability between Dura and Tenera oil palm varieties, a subject of considerable importance in global agriculture and particularly in the palm oil industry. The significant differences observed in the percentage of oil to fruit (%OTF) between these two varieties underline a key aspect of oil palm cultivation that has, until now, not been extensively explored.

The remarkable distinction in the oil-to-fruit percentage, where Tenera palms exhibit significantly higher oil content compared to Dura palms, is a pivotal finding. With a p-value of 0.00 and a t-value of 11.56, the statistical analysis not only confirms the robustness of these results but also highlights the practical implications for the palm oil industry (Figure 2a). This finding aligns with the industry's understanding of Tenera palms as a superior cultivar for oil yield, primarily due to their enhanced oil accumulation within the fruit. This insight is particularly valuable for cultivators and stakeholders focusing on maximizing oil production efficiency [3][4].

However, our analysis of the percentage of oil to bunch (%OTB) and the percentage of oil to dry mesocarp (%OTDM) does not demonstrate a significant difference between the Dura and Tenera varieties (Figure 2b and 2c). The p-values associated with these measurements exceed the conventional threshold of statistical significance, suggesting that any observed variations in these aspects might be attributed to random variability rather than inherent differences between the cultivars. This aspect of the findings indicates that while Tenera excels in oil content per fruit, the overall oil distribution in relation to the bunch weight and dry mesocarp weight remains comparably consistent between the two varieties.

The economic implications of these findings are substantial. The superiority of Tenera in terms of %OTF suggests a clear preference for this cultivar in plantation strategies aiming for higher oil yield per fruit. However, the lack of significant differences in %OTB and %OTDM also suggests that for certain cultivation objectives, such as those focused on oil yield per bunch or per dry mesocarp weight, the choice between Dura and Tenera may be more flexible.

The pronounced difference in the oil to fruit ratio can be attributed to the genetic and physiological differences inherent in Tenera and Dura palms. Existing research suggests that Tenera palms, being a hybrid of Dura and Pisifera varieties, inherit traits conducive to enhanced oil yield, mainly due to a higher proportion of mesocarp tissues dedicated to oil storage. This genetic composition plays a pivotal role in boosting the oil content, rendering Tenera palms economically attractive in the palm oil industry.

Conversely, the lack of significant differences in the oil to bunch and oil to dry mesocarp percent suggests a comparable distribution of oil within the bunch and dry mesocarp weight between the two varieties. This

indicates that while Tenera excels in oil content per fruit, the overall oil distribution within the bunch and dry mesocarp weight remains consistent, likely due to shared genetic traits or common environmental influences that impact these specific oil distribution metrics.

Our findings also highlight the complex interplay of genetic and environmental factors influencing oil palm traits. Tenera palms, owing to their hybrid nature, inherit favorable traits from both parental varieties, resulting in improved oil accumulation. However, this study underscores the need for multifaceted investigations to fully comprehend the biological and environmental factors at play.

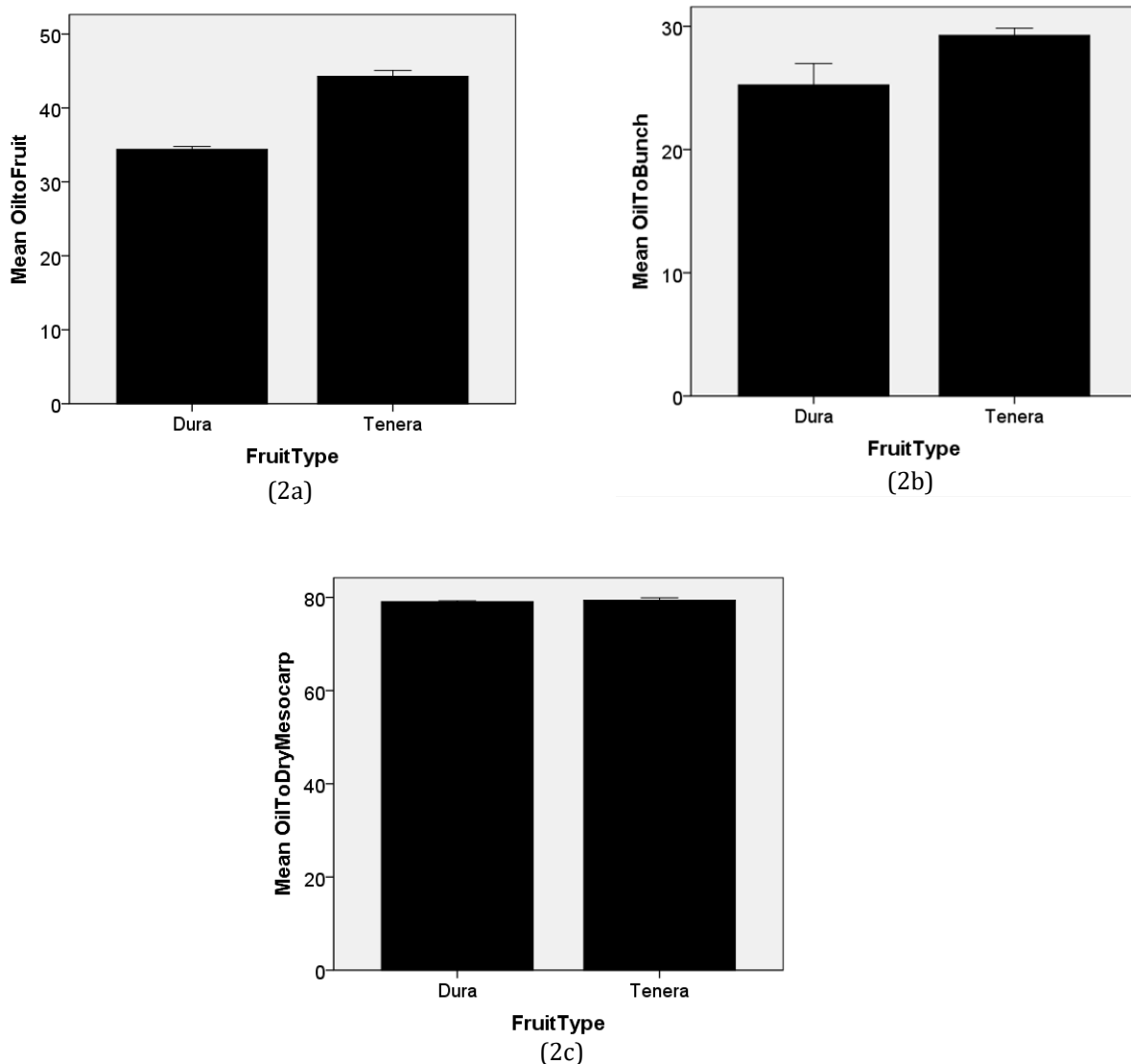


Fig. 2 Mean ($1 \pm SE$) of an oil a) Oil to fruit; b) Oil to bunch; c) Oil to dry mesocarp between Dura and Tenera

4. Conclusion

This study has elucidated key differences in oil content between Dura and Tenera palm varieties, offering valuable insights for the global palm oil industry. We found that Tenera palms exhibit a significantly higher oil content per fruit compared to Dura palms, affirming their superiority in oil yield. This finding is particularly relevant for enhancing the efficiency of oil palm cultivation, as it underscores the economic attractiveness of Tenera palms. Moreover, the study indicates that the oil distribution in relation to bunch weight and dry mesocarp weight is similar across both varieties.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Mohd Amirulhakim Shaari, Sari Indra Saputra Mohd Arbain, Nadia Fadzli, **data collection:** Mohd Amirulhakim **analysis and interpretation of results:** Noraini Ruslan; **draft manuscript preparation:** Mohd Amirulhakim Shaari, Najma Syahmin Abdul Halim, Noraini Ruslan, Muhammad Syazwan Shahidan

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