

OIL PALM FRESH FRUITS (FFB) RENDEMENT IN THE EAST REGION OF ACEH PROVINCE

Romano¹, Ramayana², Pratiwi Putri Lestari², Emmia Tambarta Kembaren³, Bagio⁴

¹Program Studi Agribisnis, Fakultas Pertanian, Universitas Syiah Kuala

²Jurusan Teknik Kimia, Akademi Teknik Indonesia

³Program Studi Agribisnis, Fakultas Pertanian, Universitas Malikussaleh

⁴Program Studi Agribisnis, Fakultas Pertanian, Universitas Teuku Umar

Email: ¹⁾romanos_agri@unsyiah.ac.id, ²⁾ramayanaitm@gmail.com,
²⁾pratiwi.putri.lestari@aticutmeutia.ac.id, ³⁾emmia.tambarta@gmail.com, ⁴⁾bagio@utu.ac.id,

Abstract

The purpose of this research analyzed the determinants of oil palm FFB yield on each character of coastal land and mineral land in the eastern region of Aceh Province based on variety and harvest fraction. Research has been carried out using survey methods and experiments in laboratories with 36 samples of palm FFB were taken for three parts which would be used as a repeat in determining the yield of CPO and fatty acids from the palm FFB. The results showed that the yield of CPO was determined by various factors, including: suitability for oil palm development areas, types (Dura and Tenera), and maturity fraction. In Dura palms with thinner mesocarp, the yield of CPO is lower than Tenera. The FFB maturity fraction at harvest greatly determines the yield of CPO and the quality of the oil. The best yield and quality of CPO on the F2 and F3 maturity fractions. The KPO yield of Dura palm is higher than that of Tenera, so it is more profitable to plant the Tenera type. Therefore it is necessary to evaluate the use of dura and tenera seeds for the development of smallholder oil palm in the east coast of Aceh to obtain the quantity and quality of CPO.

Keywords: *yield, palm fruit bunches, CPO*

1. INTRODUCTION

Oil palm (*Elais guineensis* jacq) is classified as an annual plant which begins to produce after 30 months from the time the seeds are planted in the field. The productive period of the plant can last 25-30 years. Fruit formation takes about 6 months after pollination. In general, the basic identification of oil palm can be seen in table 1 (Hartley, 1988).

The productivity of oil palm plants is largely determined by various factors, including plant variety, plant age, soil type, treatment methods and other cultivation technical factors. According to the character of the thickness of the fruit shell, oil palm is divided into several types, namely Dura (D), Pisifera (P) and Tenera (D x P). Dura type of oil palm has a thick shell (2 to 5 mm), Tenera which has a shell thickness of 1 to 2.5 mm and Fisifera (almost) has no core and shell. Tenera is a hybrid from the cross of Dura and Pisifera, as shown in Table 1.1 below.

Table 1.1. Characteristics of Dura, Pisifera and Tenera Oil Palm Types

No.	Type	Shell(mm)	Mesocarp/fruit (%)	Palm kernel (%)
1.	Dura	2 - 5	20 - 65	4 – 20
2.	Pisifera	There isn't any	92 - 97	3 – 8
3.	Tenera	1 - 2.5	60 - 90	3 – 15

Source: Soh Aih Chin, 1983 (in Dirjenhutbun, 2009)

The Tenera type of oil palm has thick mesocarps and rather thin shells, making it a favorite type for commercial plantations. The thickness of this shell is very closely related to the percentage of mesocarp per fruit (associated with oil content) and the percentage of core/fruit

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(associated with core yield). The thicker the mesocarp, the higher the coconut oil content. On the other hand, the thicker the shell, the thinner the mesocarp layer, the lower the CPO content.

Hartley, 1988 (In Dirjenhutbun, 2009), divides oil palm fruit into two components of oil sources and based on the age of the plant. The first fruit that comes out (sand fruit) cannot be processed at PKS because of its low oil content. Normal oil palm fruit is 12-18 g/grain which sits on the grain. Each grain contains about 10-18 grains depending on the perfection of pollination. The grains are arranged in fruit bunches which weigh an average of 20-30 kg/bunch, each bunch containing about 600-2,000 palm fruits. This FFB is harvested and processed at the PKS. The fruit of the Tenera oil palm (hereinafter referred to as oil palm is Tenera) has a kernel (which contains palm kernel oil) which is surrounded by a pericarp. The pericarp is composed of three layers: the hard endocarp (shell), Mesocarp which is fibrous and contains palm oil (CPO) and esocarp (waxy outer layer). When ripe, the mesocarp contains about 49% crude palm oil, 35% water and 16% non-oil solids, or in other words, contains about 70-75% (dry basis) palm oil. The general characteristics of the DxP type of palm fruit are described in more detail in Table 1.2.

Table 1.2. General Characteristics of DxP (Tenera) Oil Palm Fruit

No.	Characteristics	Score	Characteristics	Weight value %
1.	Number of finished fruit (fruit)	57-60	Fruit/FFB	61 - 62
2.	Average fruit weight (kg)	13.0 - 13.5	Mesocarp/Fruit	72 - 80
3.	Seed weight (kg)	3 - 4	Fruit seed	20 - 28
4.	Normal fruit weight (kg)	14 - 16	Core/Fruit	8 - 10
5.	Parthenocarphy fruit weight (kg)	0.5 - 1.0	Shell/fruit	12 - 20
6.	Unfinished fruit weight (kg)	1.0	Oil/mesocarp	76 - 77
7.	Fresh fruit/oil (%)	35 - 39	CPO/FFB	20 - 25
8.	Core oil/fresh fruit (%)	3.6 - 4.5	Core/TBS	5 - 7

Source: PORIM (1985)

FFB harvested when fruit maturity is reached, marked by the release of at least 1 loose fruit for every 1 kg of FFB. In other words, if the FFB weighs 20 kg, then at least 20 loose fruits are released. With these harvest criteria, it is expected that the oil content in the FFB is optimal with a very low Free Fatty Acid (ALB) content. According to Naibaho and Taniputra (1986), the yield of palm oil (CPO) is largely determined by the standard of FFB maturity, variety and post-harvest treatment. The FFB maturity fraction at harvest is recommended for Fraction 2 and 3. In the above two fractions, the yield of CPO has been optimal. Even though fraction 4 yields the highest CPO, it is usually followed by high levels of free fatty acid (ALB) of the CPO produced. A series of activities that affect the yield of palm oil CPO starting from plant maintenance, harvesting of oil palm FFB, transportation, and every stage of processing at a palm oil processing plant must be carried out correctly and precisely. In addition, these activities determine crop productivity, oil quality, and production cost efficiency.

The highest oil yield is in overripe fruit, but it also contains the highest fatty acids. Therefore, the overripe fraction of this fruit is not recommended, but what is recommended to be harvested is slightly ripe fruit and ripe fruit. Loose fruit (fruit released from FFB) must be transported entirely to the factory to avoid low yields and a decrease in the bleaching ability of the CPO produced. Generally, there are 10% (standard: 12.5%) loose fruit from the total fruit received at the factory. The oil content in loose fruit can reach 37 to 45%. In principle, the handling of FFB yields from the plantation to processing in factories which can affect the yield of palm oil is grouped into 2 parts, namely handling at the smallholder level and handling by the PKS.

Several factors greatly determine the yield of CPO (cruded palm oil) and KPO (kernel palm oil), including: (a) the area of planting, (b) the age of the plant, (c) the type of oil palm, (d) the maturity fraction of the FFB at harvest. Therefore, in sampling FFB, follow a sketch of the location

of the plantation plot which contains the differences in the age of the plants for sampling; Zoning system based on land and agro-climate based on respective regional regulations; the type of palm cultivated by the people, and the maturity fraction of FFB at harvest. In connection with the implementation of the study on determination of the next yield, it is also necessary to consider in terms of:

- The number of samples to be more evenly distributed so as to ensure representation of the existence of oil palm plantations in each development area, taking into account the representation of plant ages, varieties and geographical conditions.
- In carrying out sampling in the field, it must involve various elements of stakeholder representatives, namely smallholders, partner companies, and the government.
- The conversion rate of 0.85 is basically the Factory Productivity Index (IPP), which has a minimum value of 0.85 (Naibaho, 1996; Ditjenbun, 1997).

Arrange age groups (don't go into too much detail), because replanting causes oil palm plants to have very different age levels. Yields of CPO (crude palm oil) and KPO (kernel palm oil) will reach high numbers, if the FFB harvest criteria meet the requirements. The quality of FFB also needs to be maintained in good condition. To achieve this goal, smallholders need to be guided and directed so that they are able to harvest according to the criteria.

In preparing this yield measurement guideline, the line of thought starts from the importance of oil palm as the main source of income for the plantation business from the supply side. Viewed from the demand side, the need for CPO has increased which has an impact on increasing its price. With the preparation of the FFB yield measurement guidelines, it is hoped that all stakeholders will be able to guide them so that oil palm development will be more focused and well implemented.

The purpose of this study is to analyze the determinants of the yield of oil palm FFB in each production area in Aceh Province in 2021. The results of this study can be used by interested parties in efforts to develop smallholder oil palm in each region.

2. LITERATURE REVIEW

Oil palm is an important plantation crop producing edible oil, oil industry, vegetable oil, and fuel (biodiesel). In 2009 Indonesia was the world's second palm oil producer after Malaysia. To increase oil palm production, it is necessary to expand the planting area, rehabilitate existing plantations and intensify them (Kiswanto et al., 2008). The reason for the low productivity of smallholder oil palm plantations is that the production technology used is still relatively simple, starting from seeding to harvesting. The application of appropriate cultivation technology will have the potential to increase palm oil production.

The problem that is often faced in smallholder plantations is the low productivity and quality of oil palm. The average productivity of oil palm plantations is 16 tonnes of Fresh Fruit Bunches (FFB)/ha/year. Meanwhile, the potential for production using superior seeds is an average of 30 tonnes/ha/year. The productivity of CPO in smallholders only reaches 2.5 tonnes of CPO/ha/year and 0.33 tonnes of palm kernel oil (PKO)/ha/year. State plantations produce an average of 4.82 tons of CPO/ha/year and 0.91 tons of PKO/ha/year, while private plantations produce an average of 3.48 tons of CPO/ha/year and 0.57 tons of PKO/year. ha/year (Gatti et al., 2019; Gourichon, 2019; Pye, 2019).

According to Porim (1986) and Romano et.al (2012); The yield of CPO is an indicator of the quality of FFB which is influenced by various factors, including: (1) variety of oil palm, (2) area of cultivation, (3) fraction of fruit bunch maturity, and (4) age of the plant. There are three varieties of oil palm that are popular in Indonesia, namely: (a) Dura, (b) Pisifera, and (c) Tenera. The tenera variety is the result of a cross between Dura and Pisifera, which produces better quality FFB than the two parents. Oil palm cultivation areas in Indonesia consist of mineral soil areas and peatland areas. These two fields will produce different quality FFB. During the rainy season, the yield of CPO from FFB from oil palm plantations on mineral soils is higher. However, during the dry season, the yield of CPO from FFB of oil palm plants on peatlands is higher. This is due to the adequacy of water and different nutrient content. The FFB maturity fraction and the age of the

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plant also play a role in determining the quality of FFB. Optimal maturity fraction at the age of the plant between 9 to 12 years will produce a higher yield of CPO.

The yield of CPO for oil palms differed from 3 to 25 years of age, for oil palm plants aged 5 years, the yield of palm oil was 19.89%, increasing until the age of 20, namely 21.86%. The oil palm variety Marihat is a high-yielding oil palm, where the FFB potential reaches 31 tons/ha/year with CPO production reaching 7.9 tons/ha/year and PKO potential of 7.1 tons/ha/year (IS Harahap et al., 2020; NN Harahap, 2018). The yield of palm oil is an indicator to determine the quality of CPO and PKO from the palm oil itself. If the yield of palm oil is high, the quality of CPO and PKO will also be high.

3. IMPLEMENTATION METHOD

The time for carrying out research on the yield of oil palm FFB in Aceh Province in 2021 is set for five months (July to November 2021). The location of the study is set in the central areas of the oil palm commodity in Aceh Province, by taking samples from three PKS in the eastern region of the province aceh. The implementation of research on palm oil FFB refers to the Guidelines for Measurement of Palm Oil Yields issued by the Directorate of Agricultural Product Processing-Directorate General of Processing and Marketing of Agricultural Products in 2010. Observations of FFB yields will be based on sample samples and the results of oil palm FFB processing according to production areas and harvest time. As additional information, interviews were also conducted with 40 oil palm farmers.

FFB samples were taken from oil palm plantations which were selected purposively (purposive sampling), based on several criteria that affect the yield of CPO, Kernel and ALB. As stated in the literature review, these factors include: (a) Planting area (D), (b) Plant age (U), (c) Oil palm variety/type (V), and (d) FFB maturity fraction oil palm when harvested (F).

The planting area in the eastern region of Aceh Province is divided into two areas, namely the coastal area (D1) and the mineral land area (D2). The age of the oil palm plants is divided into three age groups, namely: Age group ≤ 5 years (U1); age group 6/d 10 years (U2); and the age group above 10 years (U3). The FFB maturity fraction when harvested was divided into three fractions, namely the zero fraction (F1); fraction 1 and 2 (F2); and fraction (F3). Varieties/types of smallholder oil palm plants are divided into (V1) Dura and Tenera (V2),

This age group differentiates the yields of CPO, kernel and ALB. At both locations, for each plant age, for each variety; and the oil palm FFB maturity faction were taken as samples, with 3 samples each (replications). Thus, the total sample size was 36 FFB bunches from 36 treatment combinations as shown in Table 3.1 below.

Table 3.1. Combination of Regional Treatment, Age of Oil Palm Plants, Varieties and Maturity Fraction of Oil Palm FFB at Harvest.

Origin	Age	V1			V2		
		F1	F2	F3	F1	F2	F3
D1	U1	D1U1V1F1	D1U1V1F2	D1U1V1F3	D1U1V2F1	D1U1V2F2	D1U1V2F3
	U2	D1U2V1F1	D1U2V1F2	D1U2V1F3	D1U2V2F1	D1U2V2F2	D1U2V2F3
	U3	D1U3V1F1	D1U3V1F2	D1U3V1F3	D1U3V2F1	D1U3V2F2	D1U3V2F3
D2	U1	D2U1V1F1	D2U1V1F2	D2U1V1F3	D2U1V2F1	D2U1V2F2	D2U1V2F3
	U2	D2U2V1F1	D2U2V1F2	D2U2V1F3	D2U2V2F1	D2U2V2F2	D2U2V2F3
	U3	D2U3V1F1	D2U3V1F2	D2U3V1F3	D2U3V2F1	D2U3V2F2	D2U3V2F3

Of the 36 FFBs of oil palm, three samples were taken which would be used as a repeat in determining the yield of CPO, Kernel and ALB from the FFB. Therefore, yield measurements will be carried out 108 times. In accordance with the instructions for measuring the yield of CPO, attachment to the Minister of Agriculture No. 395 of 2005, the sampling procedure for determining the yield of CPO to FFB is fully described below:

1. FFB collection from each plant age according to the determination of the sample of 3 bunches each from blocks with high, medium, and low FFB production were selected by purposive sampling. The tools used for collecting FFB are dodos for short trees and agrek for tall trees. The bunches harvested are included in the zero fraction; 1; 2 and 3. The harvested bunches are put into sacks, then taken to the weighing place to be weighed.
2. The spikelets and fruit (grains) are removed from the bunches using an axe. The bunches were then weighed. If the bunch weighs more than 15 kg, the grain is separated into 2 parts and each grain A and B grain are weighed. For further analysis, only A grain is used.
3. Some fruit is released from its spikelet and then Some fruit is weighed. Spikelet A or empty grain A is also weighed.
4. 30-40 fruit that has been released from the spikelets are taken and weighed and counted.

Analysis of the yield of CPO, kernel and ALB was carried out at the TPHP Laboratory of the Faculty of Agriculture, Unsyiah. Meanwhile, the analysis of oil loss in various slags was carried out at PTPN I Langsa Laboratory and PT. Dawn Baizuri. The steps for determining the yield of CPO to FFB are as follows:

1. Fruit samples according to each of the above criteria were peeled off the fruit flesh (mesocarp) with a stainless-steel knife on a base made of iron plate. Seeds that have been cleaned from the mesocarp are weighed.
2. The seeds obtained were dried for 7 days, then the seeds were broken, and the core was weighed.
3. The sliced fruit flesh is then determined for its water content by weighing the weight of the can. Weighing the weight of the can + mesocarp. These cans and mesocarp were heated in an oven at 105 °C for 20 hours. The dry mesocarp was weighed.
4. Dried fruit pulp slices are ready to be analyzed for their oil content in the laboratory with a soxlet.

4. RESULT AND DISCUSSION

4.1 Measurement of CPO Yield

Measurement of CPO yield from predetermined samples was carried out based on the criteria or combination of treatments mentioned above. Complete measurement results consisting of 108 variations of each criterion. In general, the yield of CPO from smallholder oil palm FFB in the coastal peat area (D1) is higher than that in the Aceh mineral area (D2). The yield of CPO from the FFB of the Tenera variety is higher than that of Dura.

Effect of Type and Maturity Fraction of Palm TSB on CPO Yield

OnLiterature review has mentioned that the variety/type and maturity fraction of FFB determine the yield of CPO. The results of the analysis show that the variation in CPO yield between Dura and Tenera types is relatively significant. Likewise, between the maturity fractions of oil palm FFB when harvested. This variation is shown in Illustration 1. below.

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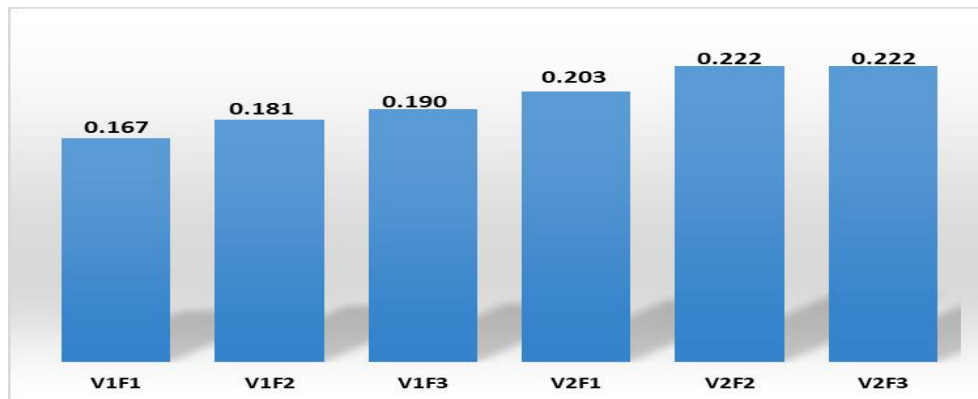


Illustration 1. Yield of CPO FFB According to the Combination of Varieties and Fraction of Harvest Maturity.

In the illustration above, it can be seen that the highest yield of CPO was in the combination of the Tenera type criteria with the perfect maturity fraction (V2F3). On the other hand, the lowest CPO yield was in the combination of Dura type criteria with the lowest maturity fraction (V1F1). The results of the analysis of variance also showed that there were significant differences in the yield of CPO between the maturity fractions of oil palm FFB. The yield of oil palm FFB with the F1 maturity fraction was much lower than the F3 fraction. Therefore, it can be concluded that to obtain the highest yield of CPO it is recommended to develop the Tenera type and the Tenera FFB is harvested with the perfect maturity fraction.

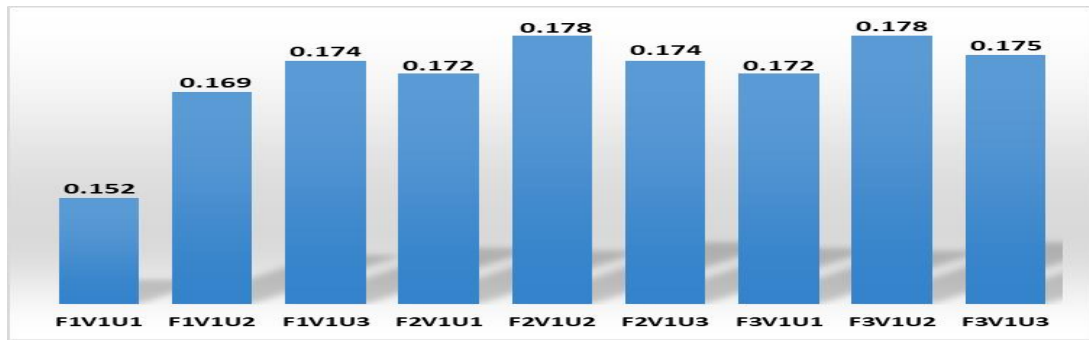
Effect of Origin and Plant Age on CPO Yield

In this study, the suitability of agro-climate, land and oil palm ecology was distinguished according to the development areas of the East coast of Aceh and the West coast of Aceh. According to the classification of the Indonesian Plantation Research Institute (LRPI), 2008; these two regions are significantly different, so it is estimated that productivity will be different. In this study, differences in productivity in each of these regions were used as one of the criteria in determining the combination of treatments.

Results analysis shows that there are variations in the yield of CPO between regions. Likewise with the age criteria for oil palm plants, the closer to the optimum age, the higher the yield of CPO from the harvested FFB. This is shown in illustration 2. below.



Coastal Area (D1)



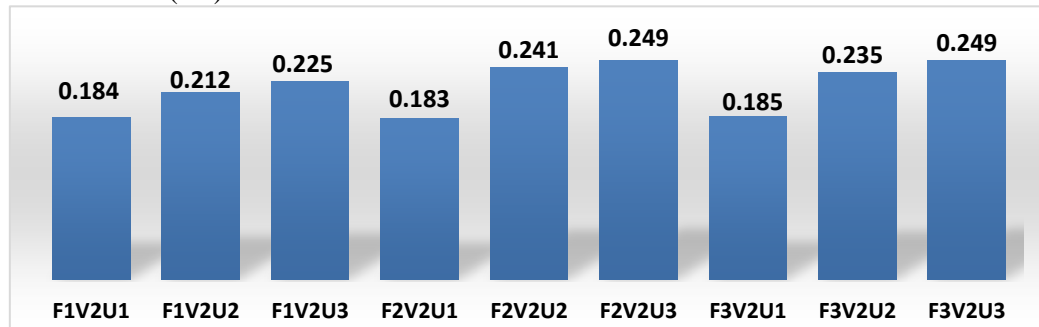
Mineral Region (D2)

Illustration 2. Yield of CPO FFB Dura Palm Planting Area D1 and D2 at U1 U2 and U3 Age and Maturity Fractions F1, F2 and F3

In the illustration above, it can be seen that the yield of CPO from oil palm FFB D1 (D1 area) is higher than D2 (mineral land area). Based on the age of the plants, it also appears that for each age classification of oil palm plants (U1, U2, and U3) there are significant variations in the two oil palm development areas. For these two regions, the age of the oil palm which has the highest CPO yield is at the age of more than 20 years. The results showed that the average yield of Dura-type CPO from the two regions was 16.8 percent for the F1 maturity fraction; 18.1 percent for the maturity fraction F2 and 18.9 percent for the maturity fraction F3.

ResultsMuslim research, et al (2008). Support this finding; it turns out that most of the western region is in the S3 classification (somewhat suitable), so that greater efforts are needed to increase the yield of palm oil in the D2 region. If we examine the effect of plant age and FFB maturity fraction on CPO yields, it is clear that there are variations between the three factors above: as shown in Illustration 3. below.

Coastal Area (D1)



Mineral Land Area (D2)

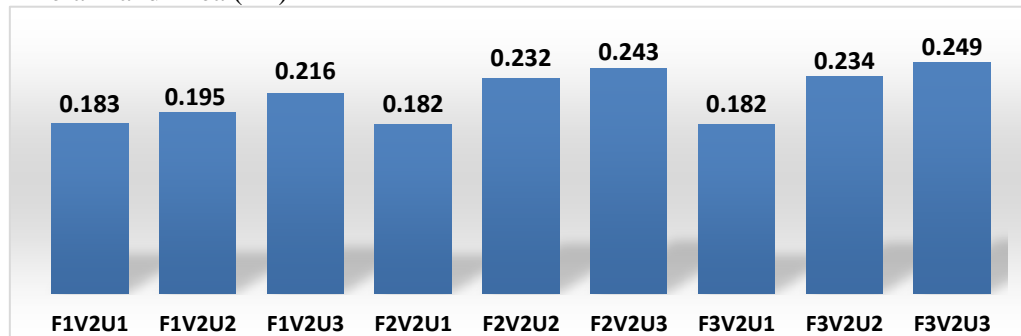


Illustration 3. Yield of CPO FFB Tenera Palm Planting Area D1 and D2 at U1 U2 and U3 Age and Maturity Fractions F1, F2 and F3

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From the illustration above, it can be seen that the yield of CPO is highest when the plants are more than 10 years old, with the perfect FFB maturity fraction in the D1 coastal area. The lowest CPO yield was found in palms that were less than 5 years old, with a less than perfect FFB harvest maturity fraction (F1) in area D2. The effect of FFB blood origin, variety and maturity fraction on the yield of CPO, is shown in the ANOVA table below.

Table 4.1. ANOVA Effect of Cultivation Area, Variety and Ripe Fraction of FFB on CPO Yield.

Source of Variances	df	SS	Ms	Fcal	Sig.
Zone	2	1.37359	0.68679	18,571	0.005
Variety of Palms	2	1.38420	0.69210	18,715	0.006
Maturity Fraction	3	1.37542	0.45847	12,397	0.021
Error	28	1.03549	0.03698		
Total	35	5.16870			

From the results of the analysis shown in the table above, it can be understood that the area of origin of FFB (zone) and the variety of oil palm plants have a very significant effect on the yield of CPO. While the FFB maturity fraction had a significant effect on the CPO yield and acid number,

Measurement of Free Fatty Acids (ALB)

The yield of free fatty acids is an indicator of the quality of CPO found in palm FFB with certain criteria. The measurement results showed that there were variations between types, ages and maturity of FFB when harvested. Illustrations 8 and 9 show the ALB levels of CPO originating from regions D1 and D2. In Illustration 8 the CPO ALB content in the Eastern region varied at each plant age and the FFB maturity fraction at harvest. The highest ALB content was in CPO from Dura palm FFB over 10 years old with a perfect maturity fraction.

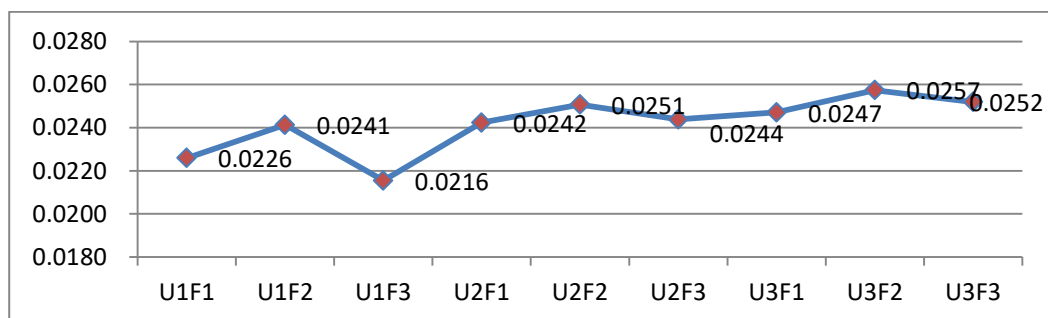


Illustration 8. ALB content of CPO Dura Palm Eastern Region on Various Criteria for Plant Age and Fraction of Fruit Maturity.

While the lowest fat content in Dura palm in the eastern region is FFB aged less than 6 years with a perfect maturity fraction as well. CPO from Tenera's FFB in the eastern region also has variations in ALB levels at plant age and FFB maturity fraction, as shown in Illustration 9 below. The highest CPO ALB content was in FFB with more than 10 years of age and perfect FFB maturity fraction.

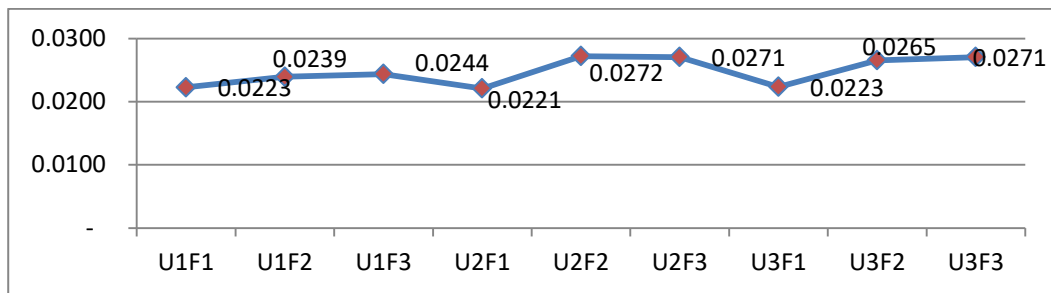


Illustration 9. ALB content of CPO of Tenera Palm Oil in the Eastern Region on Various Criteria for Plant Age and Fraction of Fruit Maturity.

The illustration above also shows that the CPO ALB content for the Dura oil palm age group in the eastern region did not vary significantly. CPO ALB content is largely determined by the FFB maturity fraction at harvest. Although the yield of CPO is high in the perfect maturity fraction, it also has a relatively high ALB content. Therefore, it is not recommended to harvest FFB that is too ripe.

Almost the same as oil palm in the eastern region, the ALB content of palm CPO in the western coastal region of Aceh also varies. There was no significant variation in ALB CPO levels between Dura and Tenera types. Likewise, between age groups there were no significant variations in ALB levels, but varied between FFB maturity fractions at harvest. The highest ALB content was in Dura palm FFB which was over 10 years old with a perfect maturity fraction. The lowest ALB content was in palm FFB aged less than 6 years with F1 (underripe) maturity fraction.

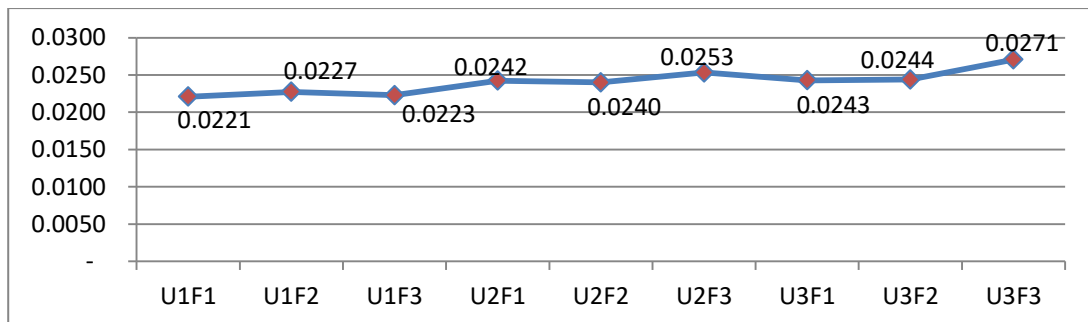


Illustration 10. ALB content of CPO Dura Palm Western Region on various criteria of plant age and fruit maturity fraction.

The highest CPO ALB content from Tenera palm FFB in the western region was also in the age group above 10 years with a perfect maturity fraction. The CPO ALB content was the lowest for all age groups with the F1 (underripe) maturity fraction.

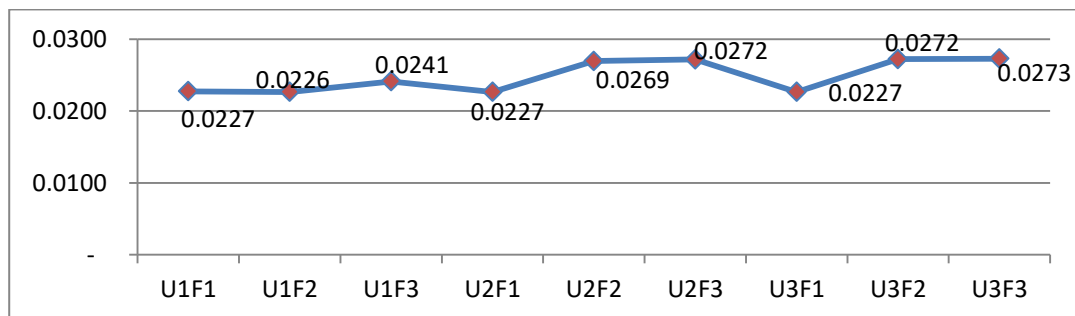


Illustration 11. ALB content of CPO of Tenera palm in the western region on various criteria of plant age and fruit maturity fraction.

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In illustration 11 above, it can be seen that there is a significant variation in ALB levels in each FFB maturity fraction at harvest. This means that the CPO ALB content for Tenera palms in this region also varies according to the FFB maturity fraction at harvest.

5. CONCLUSIONS AND SUGGESTIONS

5.1. CONCLUSION

1. The yield of CPO is determined by various factors, including: the suitability of the oil palm development area, type (Dura, Fisifera, and Tenera), plant age, and maturity fraction. In Dura palms with thinner mesocarp, the yield of CPO is lower than Tenera.
2. The FFB maturity fraction at harvest greatly determines the yield of CPO and the quality of the oil. The best yield and quality of CPO on the F2 and F3 maturity fractions.

5.2. SUGGESTIONS

From the results of the research above, some suggestions can be put forward as follows:

1. It is necessary to evaluate the use of dura and fissivera seeds for the development of smallholder oil palm in the east and west coast of Aceh to obtain the quantity and quality of CPO and kernels.
2. The development of tenera varieties in these two areas should become the basis for government policies in the development of oil palm plantations in private and smallholder plantations.

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