THE RELATION OF *Jatropha curcas* L FRUIT MATURITY LEVEL WITH THE COMPOUND AND THE OIL CONTENT

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Abstract

Jatropha curcas plant as a non edible oil prospective for biodiessel source in the future. The objectives of this research is to analyze the relationship of *Jatropha curcas* fruit maturity level with the compound and the oil content. This research shows that oil content from *Jatropha curcas* with yellow seed bulk (24.40%) is higher than from green seed bulk (2.38%). Oil content will decrease if the seed is harvested late (after bulk colour is black).

Key words: *jatropha curcas* L, *oil, and maturity level.*

1. Background

Indonesia is facing the problem of decreasing source of fosil fuel resources and its following by rapid increase of oil price and this makes this country has to find a renewable energy resources in which the plant of *Jatropha curcas* (jarak) could be one of the alternative resources.

Oil produced from *Jatropha* has some advantages if compared with another plant, one of them is the *Jatropha* oil categorized as non-edible oil, in which the use will not affected the consumption of oil for edible, such as national stock on crude palm oil and oleo-chemical industry.

The current problem face by Indonesia is the scarcity of oil price for cooking, its shown by the high price of oil which is sold Rp. 15.000 a liter. Jatropha plant is a perennial plant and grow in a dry land and this makes this plant is early to maintain in a marginal land like in the eastern part of Indonesian archipelago.

Indonesia is one of the richest countries harbours with natural resourches and has many potential for development. Agricultural sector is one of the most potential for development due to the Indonesia agroclimate and human resourches avaibility. Tropical climate and the rainfall as well as the land avaibility supported by the technological achievement has made the agribusiness development is possible.

Malinau district is one of the new develop district east Kalimantan in the scheme of the “Gerbang Dema” or development program for the agropolitan area. One of the program that crucial is the Jarak plant cultivation for bio-energy an a renewable resources. Plot trial for Jarak plant cultivation has been trying for small scale in Malinau for one hectare. Based on this plot it seems that Jarak is growing very well but the oil content of the seeds need to analysis for further development. This information will be important for the

development of Jarak plantation in Malinau district.

2. The Objectives of Research

1. To analyze the oil content of Jarak fruit from plot trial of Malinau district
2. To analyze the relationship between fruit maturity with the oil content
3. To evaluate the land suitability of Jarak Plantation in Malinau District

3. Research Methods

Jarak fruits harvested at different level of maturity (young green, old green, yellow and black/brown) from the plot trial of forestry Malinau District. Debulking is conducted for further processing of seed. The analysis will be conducted for bulk, seed and starch and the rendemen such as shown in table 1.

Table 1. Methods and seeds characteristics for analysis

No	Example species	Test species	Methode
1	Bulk seed (yellow)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy
2	White seed (bulk white)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy
3	Black seed (bulk green)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy
4	Black seed (bulk yellow)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy
5	Black seed (bulk brown/black)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy

6	Starch (yellow bulk)	1) Water content	Gravimetri
		2) Starch content	Gravimetri
		3) Oil content	Soxhlet
		4) Protein content	Kjeldahl-mikro
		5) Carbohydrate content	By difference
		6) Energy	Proxy

4. Results and Discussion

The percentage of Bulk, Seed, and Kernel of Jarak and Seed Parameter

Jarak fruit is rounded and form like eggs, Jarak Fruit consists of 3 spaces, each of them contains seeds in each fruit found 3 seeds. Seed form and brown if the seed is mature. Slicing bulk found the bulk contains 24,54% or (1350g/5500g x 100), from green bulk found 22,41% or (1950g/8700g x 100) and from black bulk found 47,83% or (1100g/2300g x 100) and the average seed of the bulk is 26,66% or (440g/16500g x 100).

The average of seed diameter is 34 mm, length 18 mm, heigh 10 mm, weight 0,62 gram. The percentage of seed kernel is 58% (1160g/2000g x 100) and 42% is bulk.

Bulk and Seed Contents

The analysis for bulk and seed of Jarak reveals that water is the highest composition of bulk, followed by carbohydrate (6,64%) and fat (1,06%) as describe in table 2.

Table 2. The Composition of Bulk Content

No	Components	Total
1	Water content	90,71 %
2	Starch content	0,91 %
3	Fat content	1,06 %
4	Protein content	0,68 %
5	Carbohydrate content	6,64 %
6	Total Energy	42,48 K calorie

The composition of the optimum seed maturity of yellow fruit consist of water (40,06%) carbohydrate 33,06% and fat 14,16% as shown in table 3 below.

Table 3. The Comparison of Seed Content from Malinau with The Standard Products

No	Components	Jarak from Malinau District	Stegar and van Loon (1941)
1	Water content	40,06%	6,2 %
2	Starch content	2,35%	5,3 %
3	Fat content	14,16%	38,0 %
4	Protein content	10,37%	18,0 %
5	Carbohydrate content	33,06%	32,5 %

Based on table 3 above it can be seen that the different composition of Jarak from Malinau with the reference (Stegar and van Loon) is found in the water and fat 38 %. This is lower than the concentration of standard where 2,5 times higher if compare with the Malinau Product.

The Relation between Fruit Maturity with Oil Content

Fruit maturity is connected with the composition of seed and oil from the kernel. The following discussion will describes the relation between fruit maturity with the seed composition and oil content.

Seed Composition based on Maturity Level

The differentiation of bulk colour was conducted for 3 different groups before the fruit was sliced. Further differentiation of seed based on colour (white and black), from green bulk was conducted. The analysis of the water, starch, oil, protein, carbohydrate, and energy the based on fruit maturity can be seen itn table 4 below.

Table 4 describes that water content will be decrease following the maturity level of the fruit, or indicated by the colour from yellow to black bulk. This further explain that carbohydrate content is decreased in the mature fruit, the yellow bulk seed indicated the highest concentration of carbohydrate content (33,06%) if compare with the green bulk seed (15,26%).

Table 4. The composition of Jarak in different level of fruit Maturity

No	Component	Percentage (%)	Percentage (%)	Percentage (%)	Percentage (%)
1	Water content	76,16	54,27	40,06	28,41
2	Starch content	1,47	1,97	2,35	3,41
3	Fat content	1,38	4,04	14,16	10,28
4	Protein content	5,73	10,19	10,37	4,89
5	Carbohydrate content	15,26	29,53	33,06	53,01
6	Total Energy	106,87 kkal	215,09 kkal	322,40 kkal	354,04 kkal

Starch concentration is increased following the maturity of the fruit harvested. This research found that starch content higher in the brown or black fruits. The starch content indicates the mineral component is the bulk of the seed. There is no different protein content in the green and yellow bulk seeds.

The component of oil is following the maturity level of the fruit from green to yellow bulk. The yellow bulk seed has a four times fat content compared with the green bulk seeds, but it reduces if the fruit is harvested after the bulk is black.

This information is shown in table 5 where the oil content from yellow fruit is higher (14,16%) compare with the oil from black bulk fruit (10,28%). This finding is in line with the research by Stegar and loon (1941) and Yeyen et al, 2006, Hambali et al 2007, that fruit maturity of Jarak is correlated with fruit maturity level, and if it collected too late the oil content will be reduced.

b. The Relation Between Kernel Maturity level with The Oil Content

The differentiation for fruit bulk colour to 4 different groups has been conducted to analyze the oil content of Jarak. These are; 1) white kernel with green bulk, 2) black kernel with green bulk, 3) black kernel with yellow bulk, 4) black kernel with brown or black (see figures below).

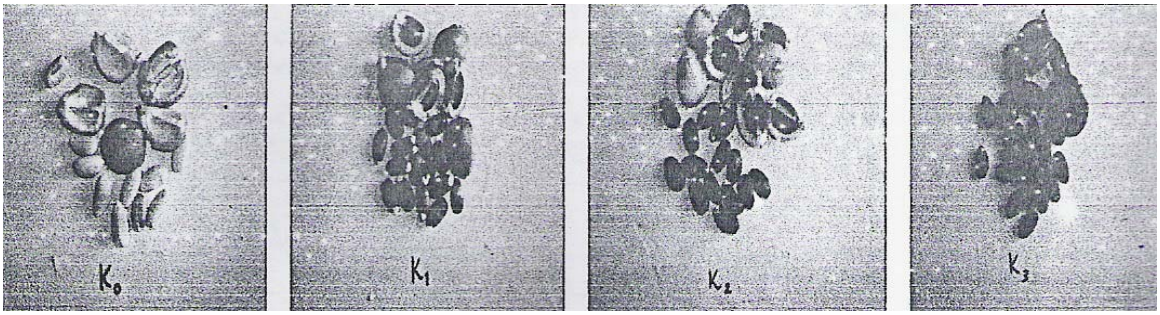

Figure 1. Jarak Seeds at different maturity level

The analysis of oil from different seed maturity is found on follows; the highest concentration of oil is found from yellow bulk seed (24,40%) and the lowest is found from green bulk seed (2,38%) (see table 5). The oil content is increased from the green bulk seed with white kernel to the black and yellow bulk. But the concentration of oil from brown and black bulk with yellow kernel is lower.

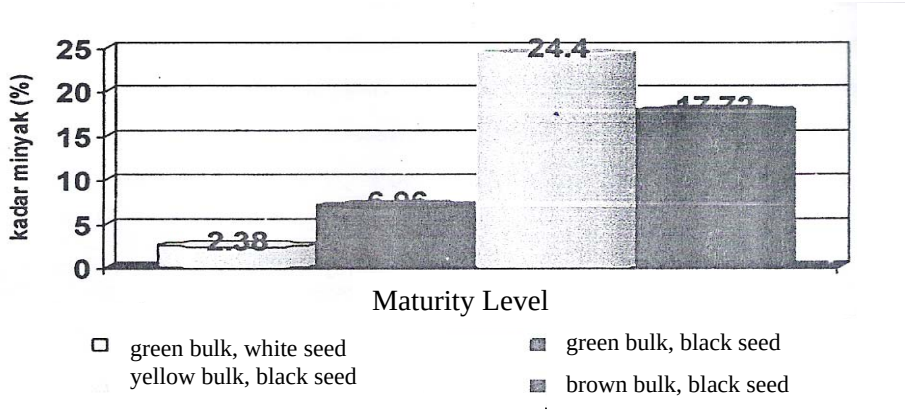

Figure 2. the relation of fruit maturity with oil content of Jarak

This research is found that the optimum oil production produced from the yellow fruit. The late harvesting in particular if bulk is to be black the oil content is reduced. This finding is also supported by the research (Yeyen et al, 2006) in Ampenan West Nusa Tenggara (see Table. 5).

Table 5. The relation of fruit maturity level with oil content of jarak fruit

No	Bulk Colour	Jarak in Malinau District	Jarak in Ampenan West Nusa Tenggara (NTB)
1	White Kernel	2,38%	-
2	Black Kernel	6,96%	-
3	Yellow Kernel	24,40%	29,38%
4	Brown Kernel	17,72%	23,68%

The reduction in oil content could be happenned if the harvesting of fruit is conducted after the bulk fruit is black or brown. This could be happened due to the conversion and the oxidation of fat by enzyme (lipace) which could convert the fat to be carbohydrate and protein as a result of crebs cycle. This implies that the maturity level of Jarak fruit is very important factor to consider if the product of oil to be optimized and the yellow fruit is the best one.

Oil content of Jarak produced from the trial plot of Malinau is lower than the one produced from West Nusa Tenggara. The Malinau products is 24,40% oil content this lower concentration with West Nusa Tenggara (29,38%), this is also below the products from South America Santiago (59,78%), Fogo (52,83%) Sao Tome (46,72%) and Toubacouta (42,3%) (Heller, 1992).

Low oil content of Jarak from Malinau caused by the environmental and soil fertility factors. By looking at the well growth of the plant in this plot it can be determine that the major factor of water availability could be the main reason for this low oil content. This was indicated by the water saturated at the soil of planted area, as the Jarak plant lately not tolerate with water pond.

Fat metabolism of plant is synthesized from the carbon and hydrogen components, this fatty acid process causes hydrophobic and almost all are not mixed with water (H2O). Fatty acid synthesize from carbon and hydrogen elements will be influenced if the water transported by plant is too high that could form the triglyceride components. Too high water components of the plant area effects the production of carbohydrate by the increased of photosynthesis. Jarak plant needs of 700 – 1300 mol water (H2O) for fixation of 1 mol CO2, water is taken from the soil roof and transported by xylem to leaf (Hans-Walter Heldt 2005). Carbohydrate 15 the key for metabolism of the green plant and other organic photosynthetic plants which are doing sun energy for carbohydrate synthesis from CO2 and H2O (Lehninger, 1995).

Fatty acid synthesis is occurred in the plastid, and influencing by enzyme of fat acid from by the acetate and piruvat to be acetil coenzyme A (see visual 3).

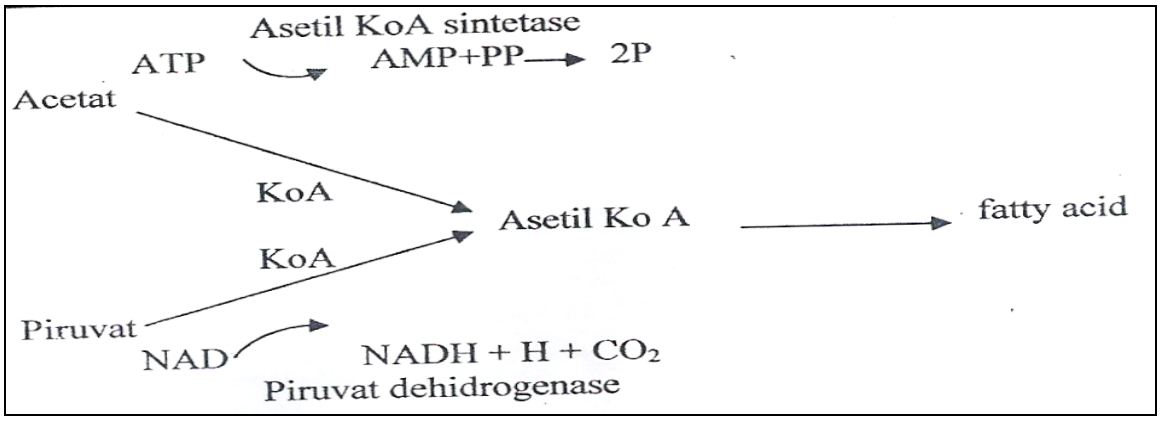

Figure 3. Fatly acid synthesis (hans-walter heldt2005)

The enzyme activates the reaction as shown visual 3 is acetil coenzyme-A sythesize and piruvat dehydrogenase. Fatty acid will be transforming by elongation of the carbon chain and will be reacted with gliserol by esterification and forms mono, di and triglyceride.

Climate and soil fertility is two major important aspects that has to be considered in the production of oil from Jarak. This plant is growing well at the elevation of 500 above sea level with the rainfall of 625mm/year. But this plant can also grow in the rainfall of 300-2.380 mm/year. The range of temperature available for Jarak is 20-26°C and for the extreme temperature (above 35°C) or if it to low (below 15°C) the growth will be slowly and could reduced the oil produced from this plant. The Jarak plant roof system is able to share the water and soil and this makes them tolerate to the extreme dry season and also able to protect the soil erotion. Above of it, Jarak plant adapts to the low soil fertility or marginal land with good drainage, no water pond and the Ph is 5,0-6,5 (Hambali et al, 2006)

5. Conclusion and Recomendation

Conclusion

1. Analysis shows that the highest oil concentration of Jarak fruit (24,40%) is found from the mature seeds with yellow bulk and the lowest (2,38%) is produced from the seed with green bulk.
2. Oil concentration will be reduced if the fruit is not harvested at mature age.
3. The oil content of Jarak from Malinau experimental plot was lower if compared to other sources.
4. The oil content of Jarak produced from experimental plot is higher if compared with local production.

Recommendation

1. Plot experimental area was not suitable to the needs of Jarak to produce high oil content and therefore recommended the local government to find another land without water pond.
2. If this result is used for the development of Jarak plantation in Malinau, it is not recommended to plant in the same area with the experimental plot, rather than to find a land with good drainage and good sun intensity.

3. It is recommended to disseminate the method of oil extraction from Jarak to the interested community group.

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