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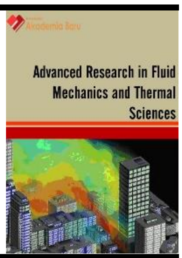

Effects of Pressed Palm Conditions on Acceleration of Palm Drying Rate and CPO Quality

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Ameen Alimalbari[1,2], Sherly Hanifarianty[3], Anil Kumar[4], Thanet Khomphet[5], Theera Eksomtramage[5], Makatar Wae-hayee[1,2,*]

[1] Department of Mechanical Engineering, Faculty of Engineering, Prince of Songkla University, 90112 Hat Yai, Songkhla, Thailand
[2] Energy Technology Research Center, Faculty of Engineering, Prince of Songkla University, 90112 Hatyai, Songkhla, Thailand
[3] Sembawa Research Center, Indonesian Rubber Research Institute (IRRI), Jln. Raya Palembang-Betung KM. 29, P.O. BOX 1127, Palembang, South Sumatera, 30001, Indonesia
[4] Department of Energy (Energy Centre), Maulana Azad National Institute of Technology, Bhopal 462003, India
[5] Department of Plant Science, Faculty of Natural Resources, Prince of Songkla University, 90112 Hat Yai, Songkhla, Thailand

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ABSTRACT

The objective of this study is to investigate the effects of pressed palm conditions on acceleration of palm drying rate and CPO (Crude Palm Oil) quality. Three pressed palm conditions were dried in hot-air tray dryer, namely (1) conventional palm, (2) slightly-broken palm and (3) fully-broken palm. The velocity of hot air was fixed at 0.7 m/s with hot air temperature of 80 and 100ºC. The hot air was blowing through the drying chamber approximately 30 hours as imitate the same condition with conventional drying in factory. The result shows that the drying rate of broken palm is faster than the case of conventional palm. Especially, the drying rate of fully-broken palm is the fastest. This expectation can minimize energy consumption in drying process. For CPO quality, however, FFA of CPO for the case of the broken palm was higher than the case of conventional palm which degrade the CPO quality. The suggestion using this method can be developed and applied in oil palm milling process which is acceptable for getting low CPO quality as oil palm for blending in animal food.

1. Introduction

Palm fruit is most commonly edible vegetable oil. It produces about 45.3 million tonnes worldwide [1]. It is consumed as food, cosmetic and many other uses. Palm fruit is extracted from mesocarp and kernel throughout several processes that could affect the amount of crude palm oil (CPO) [2 - 5]. Palm fruit need to be heated up to inactivate enzyme and to soften before extraction process. After CPO (Crude Palm Oil) extraction, CPO is processed to rough filtering and then fine filtering.

In Thailand, oil palm factory is divided into two types, namely large factory and small factory. For large factory, it processes palm fruit with bunch, while for small factory processes defoliate palm

[*] *Corresponding author.*
E-mail address: wmakatar@eng.psu.ac.th (Makatar Wae-hayee)

fruit. In large factory, palm need to be separated with the bunch through the sterilization process. Then, it processes into bunch separator for further processes [6].

After receiving from field, palm fruit need to be processed at milling factory not more than 24 hours to minimize low quality oil palm. Therefore, sterilization process plays the most important role to produce high quality oil palm [7]. The sterilization process in a large factory uses sterilizer with pressure of 40 psi (140°C) about 75 – 90 minutes [8, 9]. The function of sterilization process, such as enzyme inactivation, soften fruit and facilitate oil extraction [10].

In small factory, defoliate palm is undergoing sterilization process by heating up in conventional batch dryer as shown in Figure 1. Firewood is used as fuel to grill the palm fruit. The hot air is blowing throughout the drying chamber. This type of drying technique need workers to turn over the palm fruit from the upper layer to the bottom layer. It produces not uniform cooked palm and also it take long time of drying process about 30-40 hours. In order to decrease drying period, heat transfer in drying process from hot air transferring to drying palm should be enhanced.

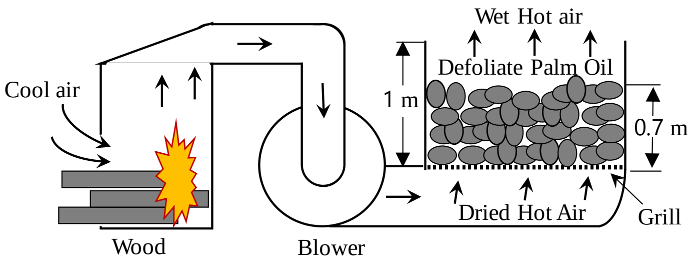

Fig. 1. Grilling pattern of oil palm in factory

Drying is process of removal moisture content. During drying process, heat is transferred from hot air to a product. Generally, different product has their different drying rate and drying duration. In palm drying, the duration is very long as aforementioned. In order to minimize the palm drying duration, heat transfer from hot air to drying palm could be enhanced. During drying, chemical changes was happened such as hydrolysis [11]. Its process could increase oil yield for production [5, 12].

Umudee *et al.,* [13] investigated drying oil palm by using microwave at 50-80°C which is the optimum temperature range for heating oil palm in using microwave heating. Besides, microwave heating was also applied in pyrolysis process using oil palm biomass as feedstock [14]. Another studied also reported that hot pressing method at 160°C could produce core-board for oil palm sandwich board in a good quality [15]. Choto *et al.,* [16] studied about drying oil palm by using Radio-Frequency Heating with 27, 12 MHz for 6 minutes. Pootao and Kanjanapongkul [17] reported that ohmic heating could possible use as an alternative in drying oil palm at 60°C for 4 minutes. Hanifarianty *et al.,* [18] also mentioned that oil palm drying could possible conduct by using rotary drum dryer at 120°C.

In this research, a possibility to enhance heat transfer from hot air transferring to drying palm by pressing palm to brake it before drying process is concerned. The comparison schematic diagram of heat transferring and moisture leaving between conventional and broken palms is shown in Figure 2. The expectation of this research hypothesis is that the heat transfer and the moisture removal of broken palm is higher rate than the case of conventional palm due to larger heat transfer surface area (cracking surface) of broken palm. For conventional palm, heat is transferred and moisture is leaved through mesocarp surface while for the case of broken palm, heat transferring and moisture leaving are take place through both mesocarp surface and cracking surface.

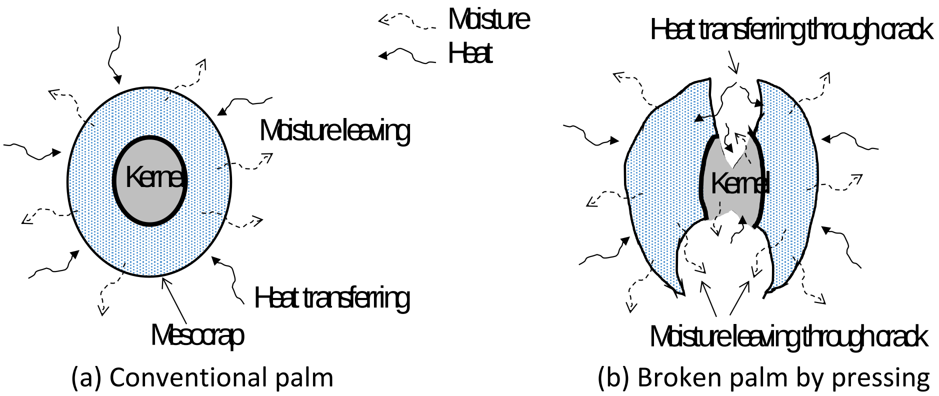

Fig. 2. Mechanism of heat transferring and moisture leaving

Therefore, the objective of this research is to examine the effects of pressed palm conditions (Conventional and broken palms) and the effect of hot air temperature on acceleration of palm drying rate and CPO quality.

2. Methodology

2.1 Experimental Apparatus

The experimental apparatus of hot-air tray dryer was build up with metal sheet as shown in Figure 3. The hot air was heated up and controlled by electrical heater and power controller unit. The thermocouple for measuring hot air temperature were located in dryer chamber. An average velocity of hot air was measured at dryer chamber outlet using anemometer. An outlet pipe which connected to the dryer chamber outlet was long enough to produce a fully developed flow. The dryer chamber consists of three layer of trays to put the palm. Palm samples were averaged from the three layer of the dryer chamber. The setup was insulated to prevent heat losses transferring to environment. In this study, the velocity of hot air was fixed at 0.7 m/s, and the hot air temperature was varied at 80 and 100°C. The weight of the samples was measured using digital balance during drying duration.

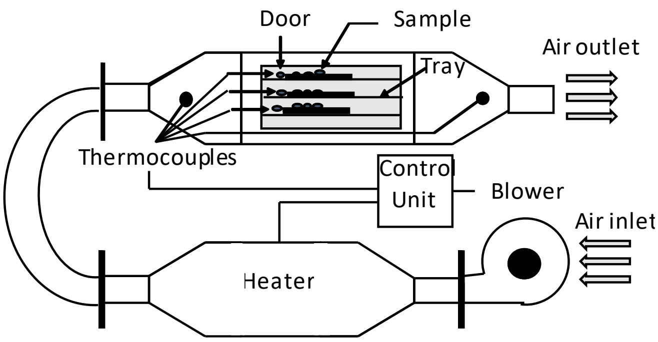

Fig. 3. Experimental apparatus of hot-air tray dryer

2.2 Pressing Device and Pressed Palm Conditions

In this research, the effects of pressed palm conditions before drying process is concerned. Palm pressing devise is shown in Figure 4. A palm was pressed at the end of the bar whereas the opposite end of the bar was pulled through a digital balance. The digital balance was used to ensure the pressing force being the same rage in the same pressing condition.

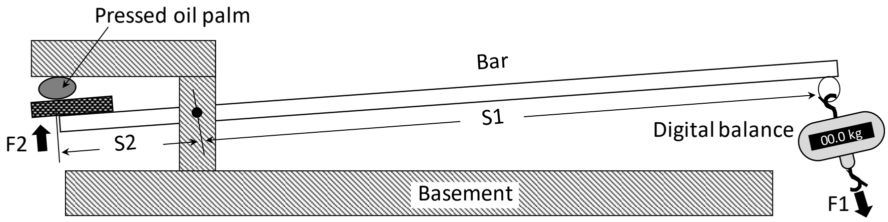

Fig. 4. Pressing device

In this study, pressed palm fruit were examined in three conditions, namely (1) conventional palm (without pressing), (2) slightly broken palm (palm kernel was not broken) and (3) fully-broken palm (palm kernel was broken) as shown in Figure 5.

(a) Conventional palm (b) Slightly-broken palm (c) Fully-broken palm

Fig. 5. Different condition of pressed palm

2.3 Moisture Ratio (MR) Evaluation

Moisture content (MC) determined by weighting sample at various time. Moisture content was measured using following Eq. (1) [17].

$$\%\ MC(db) = \left(\frac{W-D}{D}\right)\times 100 \tag{1}$$

Where MC (db) is the dry basis moisture content of dried palm (% dry-basis), W is the weight at every time weighing of dried palm, and D is the dry weight of dried palm. For evaluation of dry weight (D), a palm sample was placed in electrical oven about 110^{o}C for 72 hours.

Moisture Ratio was determined using following Eq. (2) [17].

$$MR = \frac{(MC_t - M_{eq})}{(M_{in} - M_{eq})} \tag{2}$$

where MC_t is the moisture content of palm at time of drying (%MC(db) from those Eq. (1), M_{eq} is the final moisture content of palm and M_{in} is the initial moisture content of palm.

2.4 CPO Quality Evaluation

The CPO extraction process was done manually by using hydraulic pressing machine under the same pressing force. Therefore, CPO was separated from palm cake. Three samples of CPO were prepared. Free Fatty Acid (FFA) of CPO was analyzed by titration. MPOB test method [19] was adopted in this experimental method. Chemical used in this FFA measurement, such as CPO, ethanol, potassium hydroxide and phenolphthalein. Three samples of FFA measuring were averaged.

3. Results and discussions

3.1 Drying Characteristics

The comparison of moisture ratio (MR) in different conditions along drying time is shown in Figure 6. The decreasing of MR means moisture content drying palm leaving during drying. Generally, the trend of MR can be categorized in two stages. First stage, the MR decrease suddenly in the initiation of drying time which is approximately in the first 5 hrs. Second stage, the MR decrease gradually after approximately 5 hrs of initiation of drying time. Fast drying rate in the first stage refer to the surface moisture content removal by convection heat transfer while slow drying rate in the second stage refer to the internal moisture in drying palm need to be evaporated by conduction heat transfer (From internal palm to external palm surface) which would take logger time than the first stage.

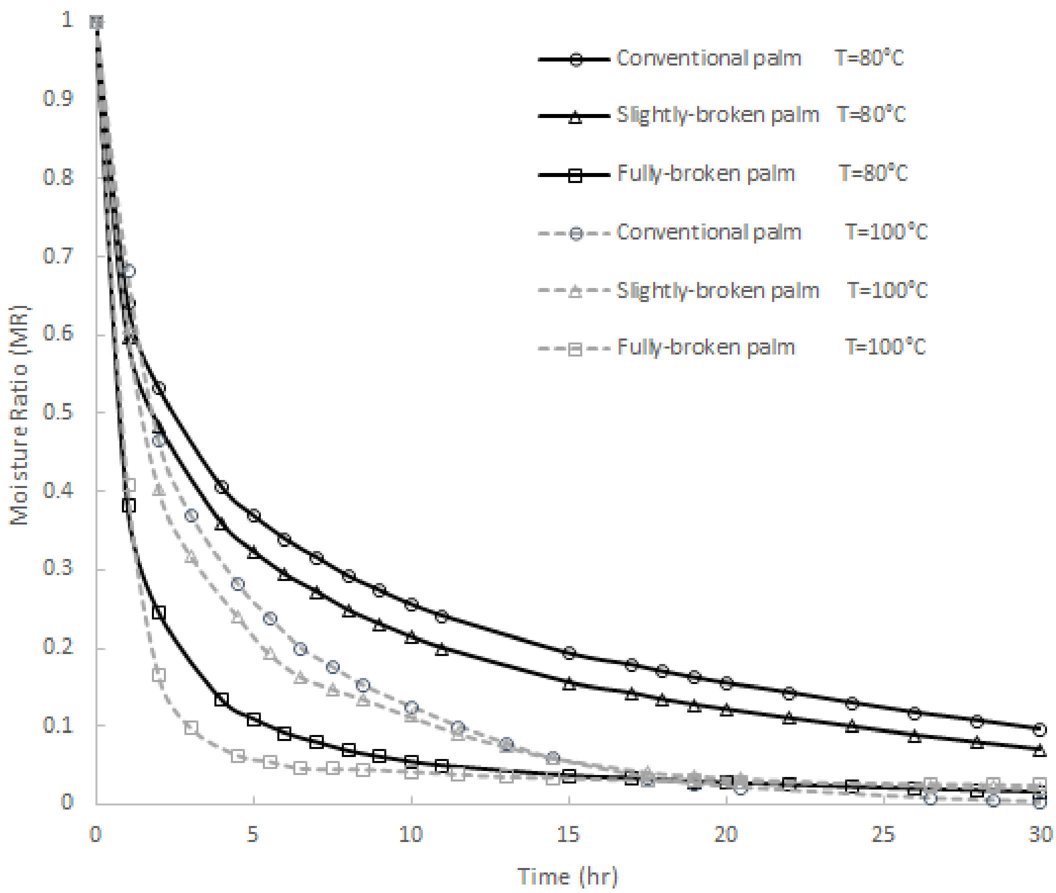

Fig. 6. Moisture ratio (MR) of dried palm in different conditions ($V_{hot\ air}$ =0.7 m/s)

For the effect of breaking palm, the trend of MR decreasing of broken palm is faster than the case of conventional palm. Especially, the condition of fully-broken palm which MR decreasing is the fastest. This can be attributed that heat transferring and moisture leaving take place through both mesocrap surface and cracking surface. More cracking surface would accelerate the heat transferring and moisture leaving of drying palm. The hypothesis expectation as aforementioned in 'Introduction' was proved by this results.

For the effect of hot air temperature, it was found that the MR decreasing of high temperature (100°C) is faster than the case of low temperature (80°C). However, the hot air temperature differences would not be effective in the condition of broken palms after drying approximately 18 hours which can be justified by the similar MR trend for the case of slightly-broken palm and fully-broken palm at T=80°C and 100°C.

3.2 CPO Quality

Free fatty acid (FFA) of crude palm oil (CPO) from different pressed palm conditions is shown in Figure 7. The FFA of COP from fresh palm (Without drying) was also included. Generally, low FFA value refer to high CPO quality. The highest of FFA was found in the case of fresh palm due to no inactivation of enzyme lipase.

In this research, the tendency of FFA increasing depends on more breaking of palm. It this can be explained that more cracking surface area (Which refer to the case of fully-broken palm) would more contact to oxygen (in environment air). It will accelerate the activation of enzyme lipase which would increase the FFA in CPO. It contrasts to the case of conventional palm which oxygen (in environment air) would contact only palm external surface. This results getting low FFA in CPO of conventional palm.

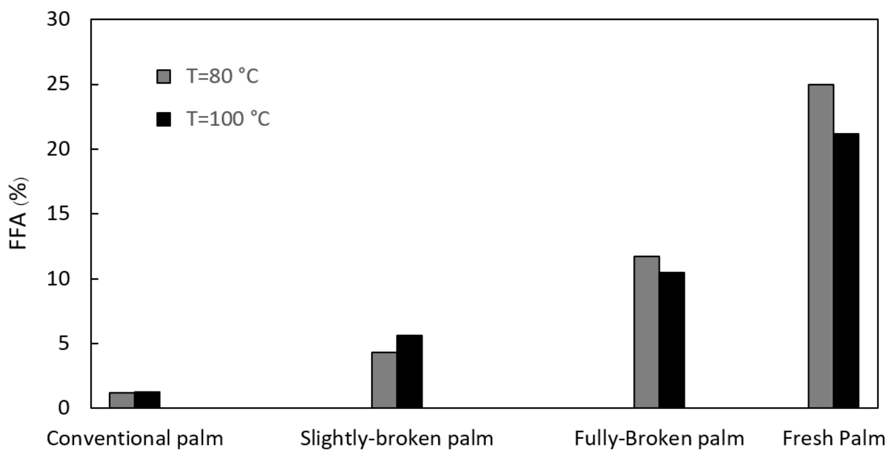

Fig. 7. FFA of CPO extracted from dried palm

4. Conclusions and Suggestion

In this research, the effects of pressed palm conditions namely: conventional palm, slightly-broken palm and fully-broken palm on acceleration of palm drying rate and CPO quality were concerned. The palm sample were dried in tray dryer under the hot air temperature at 80°C and 100°C. The results were concluded as follow:

- The MR decreasing of broken palm is faster than the case of conventional palm, especially in the condition of fully-broken palm which MR decreasing is the fastest. For the effect of hot air temperature show the MR decreasing of high temperature (100°C) is faster than the case of low temperature (80°C). However, the hot air temperature differences would not be effective in the condition of broken palm after drying approximately 18 hours.
- The tendency of FFA increasing depends on more breaking of palm condition. Exception of fresh palm, the fully-broken palm shows the highest FFA, followed by slightly-broken palm and conventional palm.

Acceding to the results from this work, the effect of breaking palm before drying process can minimize drying time which can minimize energy consumption in drying process; however, it would be effect on increasing FFA of CPO which would degrade CPO quality. This method can be developed and applied in oil palm milling process which is acceptable for getting low CPO quality as oil palm for blending in animal food.

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