

## Review

## A review of torrefaction of oil palm solid wastes for biofuel production



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## ABSTRACT

Palm oil industry is recognized as one of the major agriculture contributions to the abundant production of oil palm solid wastes. These include empty fruit bunches, palm kernel shell, mesocarp fiber, oil palm frond, and oil palm trunk, which were obtained from plantation and milling activities. In terms of increasing the economic value and solving environmental problems, the use of these wastes as an alternative fuel is very important. However, the properties of oil palm solid wastes, i.e. low calorific value, high moisture content, hygroscopic nature, and high oxygen content, have limited the biomass usage as fuel. This review evaluates on the use of torrefaction technology to improve the fuel characteristics of these wastes. Several viewpoints concerning current research on the torrefaction of oil palm solid wastes, characterization of the raw material, properties and potential applications of the torrefied yield were provided. In addition, the potential development of the torrefaction process for the palm oil industry was also discussed.

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## Contents

1. Introduction	102
2. Production of oil palm solid wastes	103
2.1. Current utilization of oil palm solid wastes	103
2.2. The importance of torrefaction process for oil palm solid wastes	104
3. Structure and characterization of oil palm solid wastes	105
3.1. Lignocellulosic oil palm solid wastes	105
3.2. Properties of oil palm solid wastes as a feedstock for torrefaction process	107
3.2.1. Proximate analysis	107
3.2.2. Ultimate analysis	107
3.2.3. Calorific value	107
4. Torrefaction process	108
4.1. Overview of torrefaction process	108
4.2. Torrefaction parameters	108
4.3. Difference between torrefaction, pyrolysis, and carbonization	111
5. Torrefaction products	111
6. Exploration studies of the torrefaction of oil palm solid wastes	112
6.1. Current research on the torrefaction of oil palm solid wastes	112
6.2. Properties of the torrefied oil palm solid wastes	114
7. Potential applications of torrefied oil palm solid wastes	115
8. Discussion on the torrefaction scenarios of oil palm solid wastes	116
9. Economic potential	117

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10. Conclusion ..... 117  
 Acknowledgment ..... 118  
 Reference ..... 118

**1. Introduction**

Palm oil production is vital for the economy of Malaysia, which is the second largest producer of palm oil in the world, after its neighboring country Indonesia. Since 1960, oil palm plantation areas have rapidly increased. In 1985, 1.48 million hectares were planted with palm trees and this has increased to 4.85 million hectares in 2010 [1]. Based on the latest MPOB statistics, the total planted area in 2016 was 5.74 million hectares, including mature and immature oil palm trees. From these lands, the production of palm oil products has reached a total of 25.64 million tonnes. An interesting fact is that the oil only contributes about 10% of the total dry matter of the palms; the remaining 90% being oil palm biomass [2] which can be potentially used in multiple applications.

The palm oil industry generates an abundance of biomass wastes, which are mainly obtained from plantation and milling activities. The biomass wastes from the oil palm plantations are the oil palm frond (OPF) and oil palm trunk (OPT) [3]. Meanwhile, major sources of biomass waste from the processing of fresh fruit bunches (FFB) in palm oil mills include empty fruit bunches (EFB), palm kernel shell (PKS), and mesocarp fiber (MF) (Fig. 1).

The OPF is usually naturally decomposed on the ground for soil fertilization, erosion control, and long-term benefit of nutrient

recycling [4]. OPT can be converted into saw-wood, medium density fiber board (MDF), plywood or lumber for manufacturing of furniture. EFB is mostly used as a mineral fertilizer substitute by direct application in the field, or in a few cases, after incineration and occasionally after composting. Palm oil mills in Malaysia have been mainly combusting MF and PKS in their boilers to generate steam and produce electricity, which is then used to power the milling process as well as for other uses within the facility [5]. EFB are usually air-dried until the moisture content reaches approximately 40% before they can be used as a fuel in the palm oil processing plant. Owing to the inferior properties of oil palm solid wastes, including high moisture content, low energy density, hygroscopic nature, low heating value, and soot formation during combustion, its usage for energy production is limited. Therefore, a pre-treatment process is required to convert oil palm solid wastes into a high quality solid biomass as a fuel. One of the pre-treatment processes that was often applied is torrefaction. Recently, the pre-treatment of biomass using the torrefaction process has received a considerable amount of attention in R&D for their promising applications in obtaining the final product.

Torrefaction is a mild thermochemical treatment of biomass at 200–300 °C under atmospheric pressure in the absence of oxygen or air to treat organic by-products for thermal conversion [6–9].

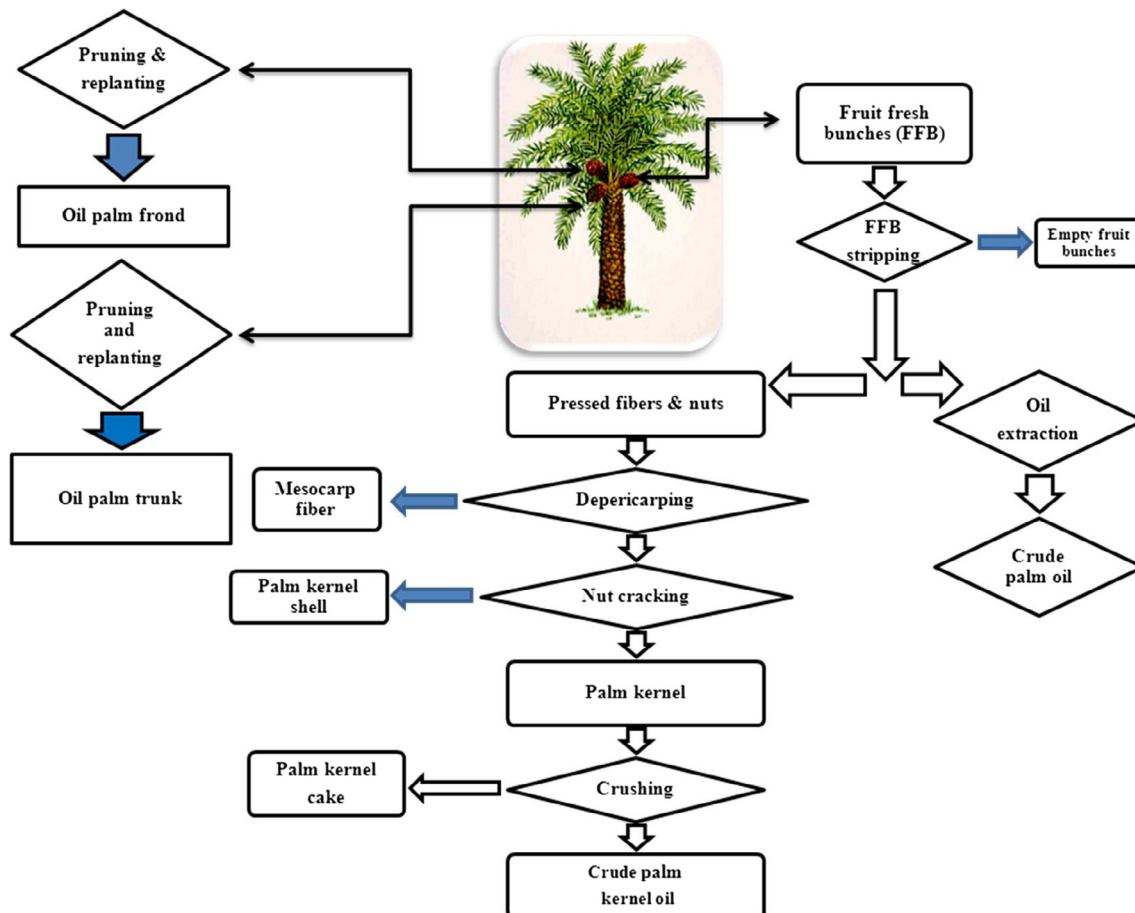


Fig. 1. Oil palm solid wastes production in a palm oil mill and an oil palm plantation.

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