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# Challenges in biodiesel industry with regards to feedstock, environmental, social and sustainability issues: A critical review

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ABSTRACT

This paper addresses the challenges in developing a sustainable biodiesel industry especially in Malaysia. The challenges discussed in this paper are divided into three main sections covering issues before, during and after biodiesel processing. The pre-processing problems concern the feedstock market, legislation through policies, fuel–food competition, deforestation issue and alternative feedstock conflict. Problems with regards to the uncontrollable glycerol production and its global market crisis are also reviewed. Besides, some suggestions on poising back the glycerol market stability are reviewed through several upgrading processes and methods that can convert glycerol to its functional chemicals. The last section covers the social issue of biodiesel in obtaining people's acceptance and capability of this industry to cultivate the sustainable practices along the processing line. Moreover, challenges in verifying its commercial value by fulfilling the global biofuel standards are also highlighted.



**Contents**



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## 1. Introduction

The great invention of biodiesel by Rudolf Diesel in 1970s has been a historical beginning of alternative fuel to replace the fast depleting fossil fuel. Started when he demonstrated an impressive replacement of engine fuel with peanut oil [1]. The unexpected brilliant replacement was favorable and the research has evolved. Currently, efforts towards producing biodiesel from vegetable oil are widely studied.

The high demand for biodiesel in replacing fossil fuels has driven many researches to come out with new ideas and inventions. Moreover, acts, policies and legislations on biodiesel implementation programs have been developed. They include the selection of sustainable feedstock, production process improvement, improvement in the quality of biodiesel, possible blending with petroleum fuels and etc. [2]. However, even though the burgeoning of biodiesel industry indicates more advantages than disadvantages, several obstacles remain. The challenges include problem faced during pre-processes, during processes (waste problem) and after-processes (quality and sustainability). Pre-processes are the most important in starting a good and economical biodiesel production. Problem will arise when the feedstock selection gets insufficient attention from the producer. It happens when the feedstock is too expensive compared to the processing cost itself. There is also a significant challenge to biodiesel industry when the demand for feedstock fluctuates and destabilizes their market. It sequentially causes another arising issues with regards to the policy, fuel–food competition, deforestation issue and waste oil feedstock problem.

In the processing line, there are several problems that cannot be resolved with regards to the waste management problem, especially the by-production of crude glycerol. Less attention has been given until the glycerol has experienced a serious downturn in the market. This problem does not only affect the economic itself but it also severely creates an environmental issue with regards to the decomposition of glycerol.

After the processing stage, quality verification step should be done to evaluate whether the biodiesel produced can be ideally used for engine and comparable with the existing fossil fuel. If its quality fulfills the international standard of biofuels which is the ASTM D 6751 [3], it can be used for transportation and industry purposes. Besides, the physic-chemical properties of the produced biodiesel should comply with the ASTM limits to meet the commercial specification of biofuels [4]. However, to fulfill that high quality standard, optimization and refinement of crude biodiesel are needed. Besides, there is also an acceptance issue by the society whereby biodiesel usually receives poor acceptance that might lead to the downturn of the biodiesel industry.

This review will discuss about the challenges regarding the in-line biodiesel processing problems including feedstock, policies, glycerol market crisis, product quality, societal acceptance and sustainability issues. In addition, some possible solutions to overcome the problem are suggested accordingly.

## 2. Feedstock issues

### 2.1. Feedstock demand and price fluctuation

Before determining the biodiesel processing system, feedstock selection is the most important aspect that should be taken into account. The inappropriate selection of feedstock could cause the first problem which is the over budget production. In every production line, the feedstock price should not be more than 50% of the production cost. Higher cost (50–70%) of feedstock might result if refining and treatment are needed before feeding into the processing line. The addition of a treatment plant only for feedstock would lower the net profit of the industry.

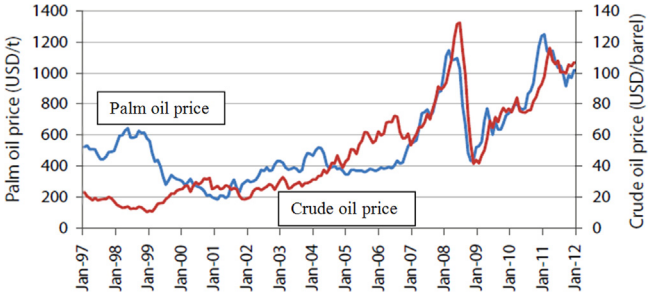


**Fig. 1.** Palm oil and crude oil price fluctuation from 1997 to 2012 [5].

In Malaysia, palm oil is the most commonly used biodiesel feedstock as this country is among the biggest producers of palm in the world. Yield of palm oil in Malaysia is recently about 4–5 t per hectare [3] and palm oil trees can have commercial lifespan of about 25 years [5]. The oil production can start as early as in 3 years after cultivation but 8–9 years are generally considered the maturity age for the trees [3]. The comparison has been made between the price of crude palm oil and crude petroleum oil (Fig. 1) and it shows that their prices are comparable [5]. From January 2005 to January 2007, the price for crude petroleum oil was higher than crude palm oil. At the beginning of 2007, the prices were more or less the same but a sudden increase in the crude palm oil price occurred. The fluctuation trend of the prices for both oils started when Malaysia carried out a massive promotion on their palm oil as the source of alternative fuel [1]. The increase in stockpile has further encouraged the promotion to create the demand for crude palm. In tandem with that, the price of crude palm oil also increased up to USD 1150 per ton in early 2008, defeating the price of crude petroleum oil.

The feedstock prices also experienced severe fluctuation as illustrated in Fig. 1. The price for both oils experienced either sharp increases or sudden decreases throughout 2007 and 2008. Sometimes, there is no benefit of producing biodiesel even if the price for of feedstock is comparable with that of the crude petroleum oil. The estimated biodiesel price should be relatively higher so that it is better to stick to the conventional fuel. It is made worse when there is insufficient publicity given to biodiesel and its advantages to the society. Thus, efforts to replace fossil fuel will not receive favorable response. Malaysia used to have bad experience with regards to this issue when its government mandated the use of B5 biodiesel. As a result, the license of the biodiesel plant had to be reduced [1].

Mekhilef et al. [6] reviewed the potential and capability of palm oil as a major feedstock in producing biodiesel. They concluded that the selection of palm oil as feedstock for biodiesel can significantly affect its market situation and subsequently causes the palm oil price fluctuation. However, the growth of biodiesel industry has created vast opportunity for the diversification of palm oil utilizations to create the demand for this oil. Janaun and Ellis [7] in their perspective view suggested that sequential scenario that will result from this issue could be related to the prognosis of the future outlook of palm oil industry. It includes the replacement of palm oil with alternative oils as feedstock. This might show the benefits of developing biodiesel industry to the sustainability of palm oil industry. Currently, palm oil is the most preferred choice for most biodiesel producers.

Malaysia was stricken by dry spell starting from early December 2013 until April 2014. The draught significantly affected the palm oil plantation area and directly undermined the crude palm oil production. Over a period of 6 months (end of November 2013 until April 2013), the stockpile was at the low level and with this