ENZYMATIC PALM OIL RECOVERY FROM POME

NOORSHAMSIANA ABDUL WAHAB; MOHAMAD SULONG;
NOR FAIZAH JALANI and ASTIMAR ABDUL AZIZ

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Oil losses occur at various stages of milling, particularly at the sterilizer station and oil recovery station. It is estimated that the oil content in the sterilizer condensate and sludge/decanter is about 0.16% and 0.46% of the fresh fruit bunches (FFB), respectively (Othman and Ng, 2003). These two sludges are mixed and normally referred to as mixed raw effluent (MRE), or more often known as palm oil mill effluent (POME). On the other hand, the recovered oil from MRE or POME is termed as sludge palm oil (SPO). Recovery of oil from MRE is one of the options to minimize oil losses during the milling processes.

Conventionally, oil recovery from sludge is done by skimming the oil from the surface of the cooling pond. However, this method only recovers the free oil from oil settling. Another method to extract oil from sludge is by using Soxhlet extraction and hexane or petroleum spirit as the solvent, but the sludge needs to be dried first to remove water in the sludge (Chow, 1996).

Another SPO recovery technique was developed by MPOB recently. The use of enzymes as a biological means to recover oil from sludge is believed to be more benign to the environment. Cellulase enzyme (0.3% w/v) was used in an attempt to obtain the oil from sludge. The recovery of SPO will help to enhance the oil extraction rate as well as contribute towards additional income for the palm oil mills.

FIELDS OF APPLICATION

SPO is regarded as a third grade oil as it has inferior quality compared to the typical crude palm oil (CPO) due to its high free fatty acid (FFA), high moisture and impurity contents (Ainie *et al.*, 1995). Therefore SPO is sold at a discount, generally about 40%-60% of the CPO price. Currently, SPO is used for non-edible applications such as in the making of laundry soap, fatty acids, candles and biodiesel.

However, enzymatically extracted SPO is expected to have a better quality compared to the conventional SPO because the oil is recovered immediately after the sludge (condensate and oil room sludge) discharges from the mill. In addition, the use of enzymes as processing aids in the extraction of oil from sludge can preserve the oil quality because of the mild conditions employed in the process.

DESCRIPTION OF THE PROCESS

The unit operations used in enzymatic SPO extraction generally consist of mixing, solid-liquid separation, centrifugation and oil purification. Basically, the enzymatic treatment is incorporated during the mixing step at a suitable pH, temperature and mixer speed.

A simple economic analysis of SPO recovery via this technology is shown in *Table 1*. *Figure 1* shows the flow diagram for the recovery of SPO from POME by enzymatic extraction. The results of the study are shown in *Figures 2* and *3*.

Free Oil Recovery by a Dissolved Air Floatation Unit

Dissolved air floatation (DAF) is a process that clarifies wastewater by the removal of suspended matter and oil. It is achieved by dissolving air in the wastewater under pressure, and then releasing the air at atmospheric pressure in a floatation tank or basin. The released air forms tiny bubbles which adhere to the oil causing the oil to float to the surface of the wastewater where it may then be removed by a skimming device.

Encapsulated Oil Recovery via Enzymatic Treatment

Enzymatic oil extraction is a biological route for oil extraction. Encapsulated oil in the sludge is found inside the fibre, and is linked with proteins and a wide variety of carbohydrates such as cellulose, hemicellulose, pectin and starch. In

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Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia
P. O. Box 10620, 50720 Kuala Lumpur, Malaysia. *Tel*: 03-87694400 *Website*: www.mpob.gov.my *Telefax*: 03-89259446

order to facilitate its extraction from the cell, it is necessary to degrade the cell walls to increase the permeability of the oil. The use of enzymes as a biocatalyst for cell wall degradation will increase the permeability of the oil through the cell membrane, thus facilitating the release of oil globules and their coalescence.

TABLE 1. ECONOMIC ANALYSIS OF SLUDGE PALM OIL (SPO) RECOVERY FROM A TYPICAL 60 t hr^{-1} PALM OIL MILL

Potential free oil	1 962.0 t yr^{-1}
Potential encapsulated oil	392.4 t yr^{-1}
Assuming 65% and 80% of SPO recovery by DAF and enzymatic treatment, respectively	
Potential revenue from recovered SPO	RM 1.53 million/year
Enzyme cost (RM 4 enzyme for every tonne of sludge)	RM 784 704 yr^{-1}
DAF operating cost (RM 400 000 per unit over a 10-year life-span)	RM 40 000 yr^{-1}
Expected income	RM 705 296 yr^{-1}

Note: Assumptions: sludge production of 40.20 t yr^{-1}, 305 working days/year, RM 960 SPO price (60% of crude palm oil price). SPO in sludge is 1.2% of total sludge (free oil 1.0% and encapsulated oil 0.2%) (Susanto, 1981). DAF – dissolved air floatation.

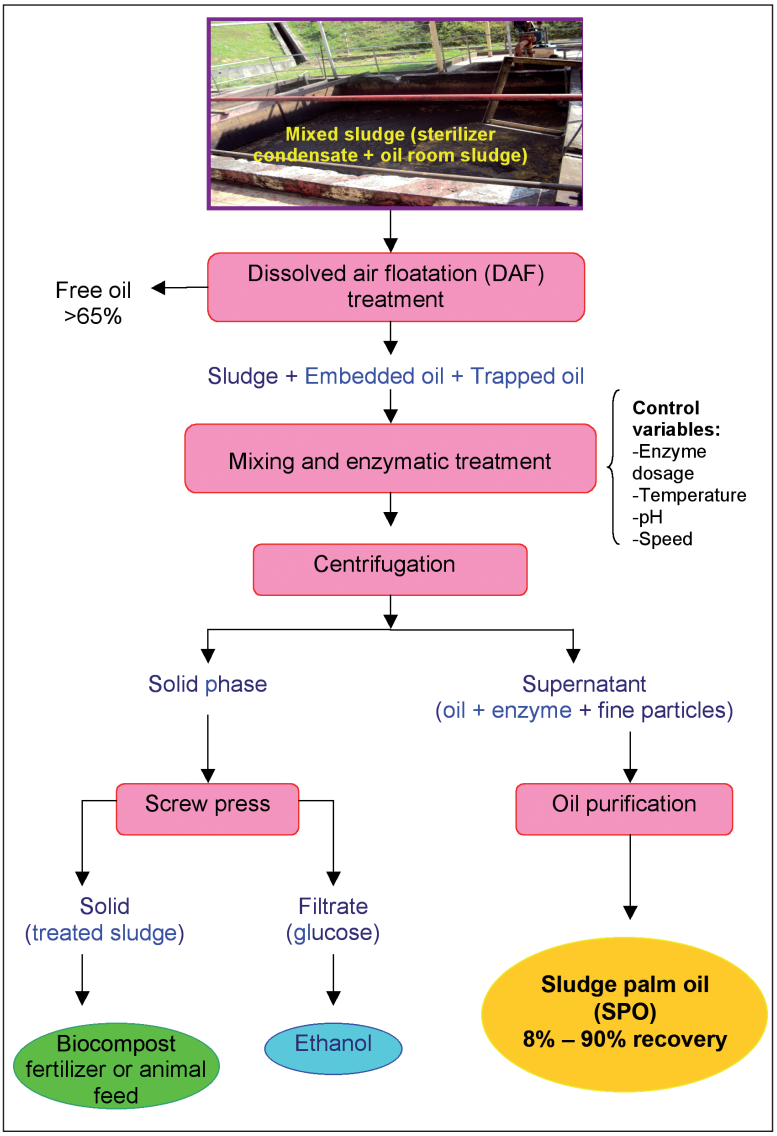

Figure 1. Process flow of enzymatic sludge palm oil (SPO) extraction from palm oil mill effluent (POME).

RESULTS

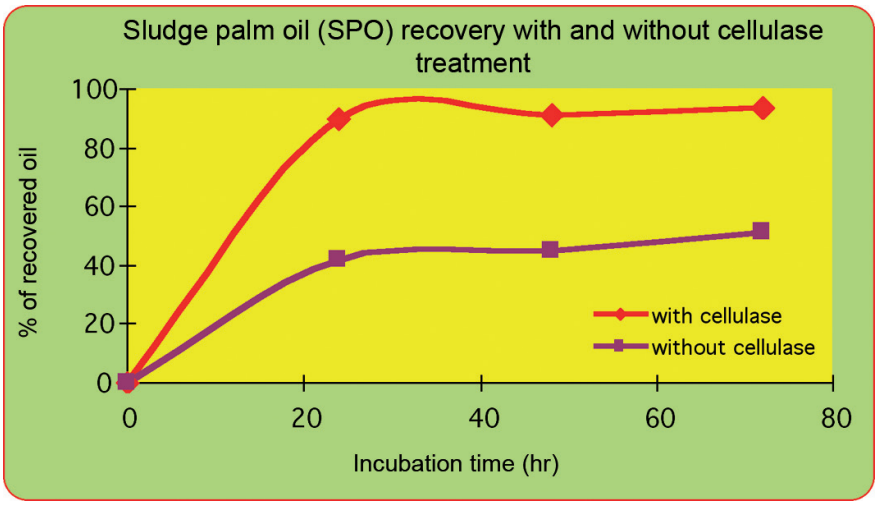

Figure 2. Oil recovery from palm oil mill effluent (POME) by two different treatments.

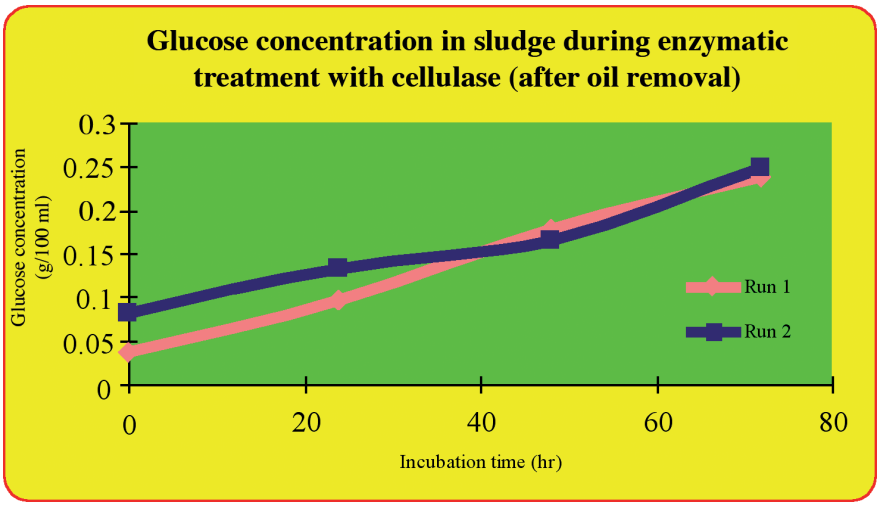

Figure 3. Glucose concentration in treated sludge.

CONCLUSION

Enzyme-assisted oil recovery from POME is a viable process to generate additional income for the mill. It offers an additional benefit to anaerobic treatment by reducing the oil and grease constituents of POME.

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For more information, kindly contact:

Director-General
MPOB
P. O. Box 10620
50720 Kuala Lumpur, Malaysia.
Tel: 03-8769 4400
Fax: 03-8925 9446
www.mpob.gov.my