Enzymic Extraction of Palm Oil

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INTRODUCTION

In palm oil milling, the fruits are steam-sterilized and digested before the oil is extracted. The aim of these pre-treatment steps is basically to break up the oil-bearing cells in order to facilitate the release of the oil. Plant cell walls can also be degraded by the action of a group of enzymes, namely cellulase, xylanase and pectinase (collectively referred to as the cell wall degrading enzymes). Enzymic action on the cell wall can therefore be employed to aid cell breakage. It is thus envisaged that an enzymic process could be incorporated as a pre-treatment step during milling in place of steam treatment in the digestion process. This procedure could be carried out at a lower temperature which might help improve the quality of the oil extracted.

In a study carried out by PORIM and the Agricultural University of Malaysia (UPM), the effect of treatment of oil palm mesocarp with commercial cellulase and pectinase preparations on the efficiency of oil extraction was investigated.

MATERIALS AND METHODS

Materials

Tenera oil palm (*Elaeis guineensis*) fruits (18 to 21 weeks after fertilization) were obtained from the PORIM Research Station at Serdang. The enzymes, Celluclast (a cellulase preparation) and Pectinex 3XL AP-18 (a pectinase preparation), were gifts from NOVO (Kuala Lumpur).

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Effect of enzymes on oil release into the reactant medium

The oil palm fruits were autoclaved at 2.1 kg cm^{-2} steam pressure (135°C) for 30 min and the mesocarp was separated from the kernels. Mesocarp mash was prepared by blending four parts mesocarp with three parts of water. A 50 g mesocarp mash was put into a conical flask with 50 ml water. The contents of the flask were equilibrated at 60°C for 30 min. Enzymes (1 ml Celluclast, 1 ml Pectinex and 1 ml Celluclast + 1 ml Pectinex) were added to separate flask. The flasks were shaken at 100 rpm for 1 h at 60°C. After incubation, the flasks were transferred to a water bath at 90°C for 10 min to inactivate the enzyme. The oil released was separated from the mesocarp fibres by filtering through a domestic stainless steel sieve. The filtrate (containing oil, water and fine solids) was dried in an oven at 105°C. The oil in the dried filtrate was extracted with 3 X 50 ml pet. ether (b.p. 40 – 60°C). The residue remaining after extraction was subjected to further extraction with pet. ether in a Soxhlet apparatus. The extracts were combined and the solvent removed by evaporation on a rotary evaporator. The weight of oil obtained was then determined. For the control experiment, the mesocarp mash was not treated with enzyme. The amount of oil released was expressed as a percentage of the total oil in the mesocarp. The oil content of the mesocarp was determined using the AOAC (1975) procedure.

Effect of pressing the mesocarp after enzyme treatment

For this experiment, 250 g mesocarp mash in 250 ml water was treated with 1.25 ml Celluclast. The experimental conditions were as given above except that after inactivation of the enzyme at 90°C, the contents of the flask were immediately filtered through muslin cloth. The residue retained on the cloth was immediately pressed using a hydraulic press

TABLE 1. EVALUATION OF THE EFFECT OF CELLULASE AND PECTINASE ON OIL EXTRACTION FROM PALM MESOCARP

Treatment	Oil released (%)
No enzyme (control)	28 ± 2
Cellulase	57 ± 6
Pectinase	29 ± 2
Cellulase + Pectinase	60 ± 4

* Total oil in 50 g mesocarp mash was 16.3 g.

(Apex Construction Ltd., London, U.K.). The hydraulic pressure used was 4 280 kN/m^2. (Force applied was 4 000 kg with a ram of diameter 10.8 cm). The pressed mash or cake was dried in an oven at 105°C and the oil remaining in the cake was extracted with pet. ether using a Soxhlet apparatus. The oil content of the palm mesocarp used was determined by the AOAC (1975) method.

Analysis of oil quality

The peroxide and acid values were determined using AOCS (1974) procedures. IUPAC (1979) methods were followed for the evaluation of $E^{1\%}_{1cm}$ at 232 and 268 nm and p-anisidine values. The oil used for analysis was pipetted directly from the oil layer in the filtrate after sieving.

RESULTS AND DISCUSSION

Effect of enzymes on oil release from palm mesocarp

Table 1 shows the results of the action of the enzymes on oil release. The cellulase preparation enhanced oil yield as compared to the untreated control sample whereas the pectinase preparation did not. The addition of pectinase together with cellulase did not result in an appreciable increase in the amount of oil released by comparison with the yield obtained after treatment with cellulase alone.

Observations were also made on the effect of pressing the fibres on the amount of oil released after enzyme treatment. Hydraulic pressing of the enzyme-treated mesocarp mash released 97.7% of the total oil present, while the untreated sample yielded 91.1% *(Table 2)*.

These results show that treatment of mesocarp with the cellulase preparation enhances the efficiency of oil extraction. It is probable that the enzyme facilitates the release of oil by its degradative action on the cell wall polymers. Although pectinase has been found to improve oil extraction from coconut kernels (McGlone *et al.*, 1986) and avocado mesocarp (Buenrostro and Lopez-Munguia, 1986), this enzyme was found to be ineffective for palm

TABLE 2. OIL EXTRACTION FROM CELLULASE-TREATED AND UNTREATED MESOCARP BY HYDRAULIC PRESSING

	Cellulase-treated	Untreated
Weight of mesocarp (g)	143	143
Weight of oil in mesocarp (g)	76.9	76.9
Weight of oil in pressed fibres (g)	1.74	6.87
Weight of oil released (g)	75.16	70.03
% oil released	97.7	91.1

TABLE 3. QUALITY CHARACTERISTICS OF OIL RELEASED FROM PALM MESOCARP

	Oil released	
Quality Parameter	Without enzyme	With cellulase
Peroxide value (meq/kg)	0.08	0.06
p-Anisidine value	1.50	1.20
Acid value (mg KOH/g)	0.15	0.15
$E^{1\%}_{1cm}$ at 232 nm[a]	1.23	1.25
$E^{1\%}_{1cm}$ at 268 nm[a]	0.50	0.50

[a] *Not corrected for triglyceride and carotene absorption.*

mesocarp. The absence of an effect of pectinase on oil release when it is added alone or in conjunction with cellulase to palm mesocarp can be plausibly explained. During ripening, the protopectins are converted into soluble pectins. In the experiments described here, the process of steam sterilizing the fruits prior to the preparation of the mesocarp mash solubilizes the pectins thus making the pectinase treatment unnecessary for enhancing oil extraction efficiency. Indeed, steam sterilization of fruit bunches prior to oil extraction is a routine practice in palm oil milling, and pectins have been found to be present in the condensate obtained from the sterilization process (Barker and Worgan, 1981).

Oil quality

The quality of the oil released from palm mesocarp is shown in *Table 3*. The similarities between: (a) the peroxide values and $E^{1\%}_{1cm}$ at 232 nm (which represents the degree of primary oxidation), (b) p-anisidine values and $E^{1\%}_{1cm}$ at 268 nm (which indicates the degree of secondary oxidation), and (c) the acid values of the oil extracted with and without enzymes indicate that treatment of mesocarp with cellulase does not affect the quality of the oil extracted. The quality characteristics thus clearly indicate that good quality oil is obtainable by this process.

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