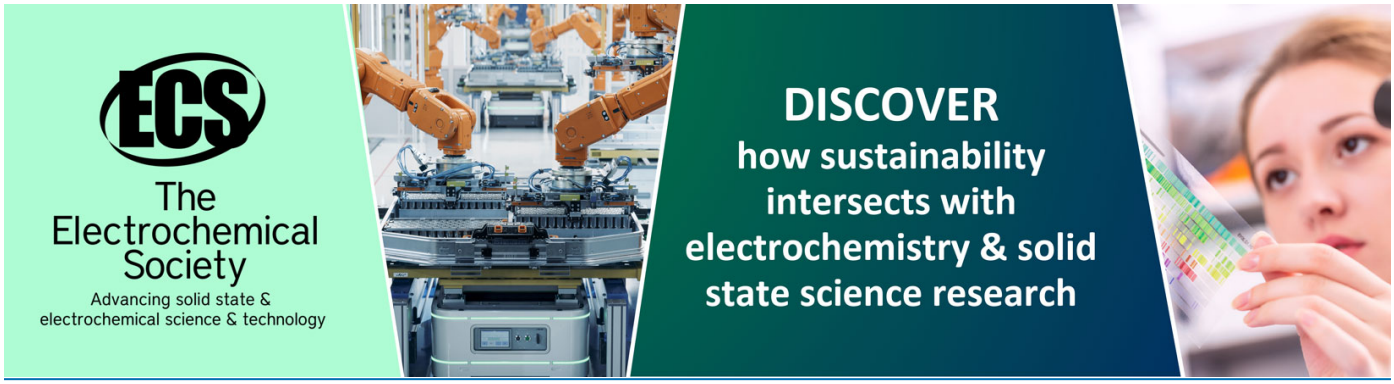
Red palm oil production by microwave irradiation



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Red palm oil production by microwave irradiation

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Abstract. Preliminary study of red palm oil (RPO) production from palm fruitlets by microwave irradiation carried out in domestic microwave oven equipped with thermocouple. The various mass of fruitlets (800, 900 and 1000 g) were heated for 10-18 minutes with 2 minutes interval and microwave power of 400, 560 and 800 Watt respectively. Heated fruitlets were pressed by hydraulic presser to obtain RPO. This study observed heating time parameter was more crucial to RPO quality rather than temperature. Prolonged heating degraded carotenoids in the fruitlets during heating process yielded less carotenoids content in the palm oil. The best time and microwave power combination to produce RPO in this study was 14 minutes and 800 Watt respectively which yielded 11.67% RPO with 1.27% FFA content and carotenoids concentration of 1219.37 ppm. Overall, RPO production by microwave irradiation proceeded faster as compared to conventional process.

1. Introduction

Sterilization is a way to obtain sterile products [1]. It is a process that eliminates viruses, bacteria, fungi, spores [2] and enzyme [3,4]. It can be reached through heating, chemicals, irradiation, high pressure and filtration [3]. The popular method of heating process is heating by microwave irradiation [2]. Microwave offers many advantages such as faster heating and less nutritive loss [4].

In palm oil mill, the aim of sterilization is to inactivate oil splitting enzymewhich accelerates FFA formation, softens the palm fruitlets and facilitates fruits detachment from the bunch [5-7]. In conventional way, sterilization carries out by pressurized steam of 15-45 psi for 90 minutes (temperature more than 100 °C [6] and [8]). In fact, lipase inactivation only requires heating at low temperature (approximately 55 °C [9]). Since the process envolves steam, high FFA content is inevitable. The presence of water will promote the hydrolysis reaction of oil to FFA [5].

Palm oil is well-known as the most abundant resource of carotenoids especially β- and α- carotene (provitamin A) [10-14]. The high content of carotenoids can be utilized to prevent deficiency of vitamin A [10,12,14]. Besides that, palm oil also has good benefit to human body that is antioxidant. It can modulate cardiovascular diseases, cancer, cataract, aging, diabetes, etc [12,14]. However, carotenes are supceptible to degradation by oxidation and thermal process due their highly unsaturated nature [15]. Karer and Jucker (1950) in Santoso *et. al* (2006) reported carotene deterioration at temperature above 60°C while Rutishauser (1992) in Santoso *et. al* (2006)found carotene is not stable at temperature heating more than 100°C [16].

To protect carotenoids content in palm oil, sterilization should carries out at low temperature (below 60^{o}C). Palm oil obtained from extraction of this sterilized fruit is Red Palm Oil (RPO). RPO consist of carotenoids that mainly found between 700-800 ppm as β-carotene (Sambanthamurthi et al., 2000). Among others RPO production is heating or sterilization of oil palm fruit by using microwave irradiation. Some researchers reported utilization of microwave energy to heat and sterilize oil palm fruits [3,5,7,9,17]. As compared to the conventional process, this method can reduce heating time and prevent loss of nutritive components in palm oil. This study evaluates performance of RPO production by microwave irradiation.

2. Materials and Methods

2.1. Materials

Materials used in this study were fresh palm fruit *Tenera* variety taken from Galang-Deli Serdang, chemicals (acetone, NaOH, n-hexane, ethanol, phenolpthalein, and Na_2HPO_4 supplied by Merck, microwave oven (Sharp Model: R-249IN(S)/(W)), thermocouple type K (Krupp and Closs size diameter of 3 x 300 mm (Mineral Insulated) C/w Cable 2 m) connected with thermo controller (Shimaden)) and hydraulic presser (fabricated).

2.2. Methods

2.2.1. Sample Preparation. Fruitlets removed manually from the bunch, cleaned to remove any dirt, weighed and placed at cavity inside microwave oven.

2.2.2. Microwave Sterilization Process. Prior sterilization/heating, we adjusted heating time and microwave power. Fruitlets irradiated by microwave energy at various power levels (medium, medium high and high power level). The temperatures recorded every 2 minutes interval. After the sterilization, the fruitlets were pressed using hydraulic presser to extract the oil.

2.2.3. Lipase Assayed. The palm oil (0.1 g) dissolved in water and stirred at temperature of 37°C.We added acetone and ethanol mixture (50:50 v/v) of approximately 10 ml to inactivate the lipase after 30 minutes and titrated with 0.1 N sodium hydroxide solution using phenolpthalein as indicator until the first permanent pink colour appears[18,19,20].

2.2.4. FFA Test. It conducted according to AOCS Official Method Ca 5a-40. Palm oil sample of 7.05 ±0.05 g dissolved in 75 ml ethanol 95% and was titrated with standard solution of sodium hydroxide of 0.25 N with phenolphthalein as indicator until the first permanent pink colour appears [21].

2.2.5. Water Content. Water content determination was conducted according to AOAC (1995). The empty porcelain dish were dried in the oven at 105°C for 3 hours, transferred to desiccator to cool down the temperature, and weighed. Palm oil sample of 5 g was put in the dish, weighed and placed inside the oven. We dried the sample for 3 hours at temperature of 105 °C. Porcelain dish with dried sample was transferred into desiccator to cool down temperature. The dish and its dried sample were reweighed [22] to determine water content.

2.2.6. Carotenoids test. This study determined carotenoids by using spectrometer UV-VIS according to MPOB Test Method [24]. We diluted 0.1 g oil palm sample using 25 ml n-hexane and shakes vigorously. The absorbance was measured at 446 nm [23].

3. Results and Discussions

Figure 1 shows profile of RPO yield during heating period. The yield increased at the increment of heating period during the first 16 minutes exclude treatment of oil palm fruitlets using power level of medium for 12 minutes. This study obtained maximum RPO approximately 17.6% after oil palm exposure for 12 minutes using microwave power of medium high level. Prolonged heating decreased the yield of RPO, especially those from treatment using power of medium level.

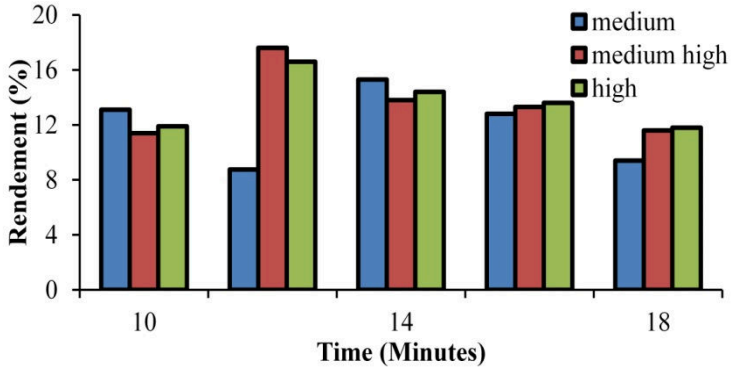

Figure 1. Yield of RPO in this study

Prolonged heating caused evaporation of water inside palm fruits occurred very fast, leaving dried and hard fruitlets. The removal of water from oil palm fruitlets was part of the heating process [17]. Water are being used to generate heat. Higher amount of water removed will produce higher temperature and finally caused temperature increment in the mesocarp and kernel. This mechanism led to the drying effect and hardened mesocarp.Thus heated/sterilized fruitlets were difficult to be pressed resulting low yield of RPO. Increment of microwave power had not affected the rendement significantly at various heating time. The best condition to obtain greater rendement were combination of heating time ranged between 12-14 minutes and microwave power of medium high and high power level.

Figure 2 shows activity of enzyme lipase after the heating complete. The lowest activity was 1.83 U/ml. Increment of heating time decreased activity of lipase indicates microwave irradiation inactivated enzyme successfully during RPO production.

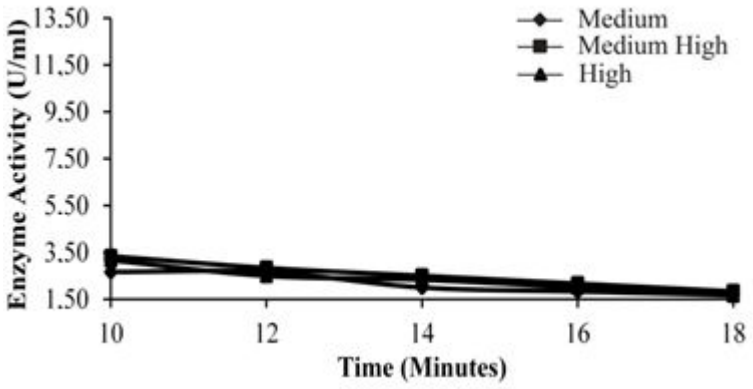

Figure 2. Enzyme activity profile in RPO

Carotene content usually measured as β-carotene in typical CPO. It usually presence in the CPO approximately ranged between 500-700 ppm [5]. The highest carotene content obtained from this study was 1291.96 ppm. During heating process, carotene was broken into another compound. Prolonged heating affected to the increment of temperature which destroy carotene.

FFA content is the most common criterion for determining the quality of palm oil, includes RPO. In this work, FFA content was below maximum standard (below 5%) as the Codex Allimentarius (FAO/WHO) norms [24]. The highest FFA content was 4.09%. Figure 3b (FFA content) shows inconsistent result. This expressed the destruction process of lipase enzyme during microwave heating. The longer period of heating and high temperature usually decreased the activity of enzyme that led to low level formation of FFA.

Typical crude palm oil (CPO) for moisture content is 0.15 – 3%. It obtained from conventional palm oil milling process [5]. In the present study, moisture content was range between 0.07 – 3.46%. Figure 3c shows water content decreased as heating time was extended. Low level of water content in product associated with water utilization to generate heat during microwave irradiation.

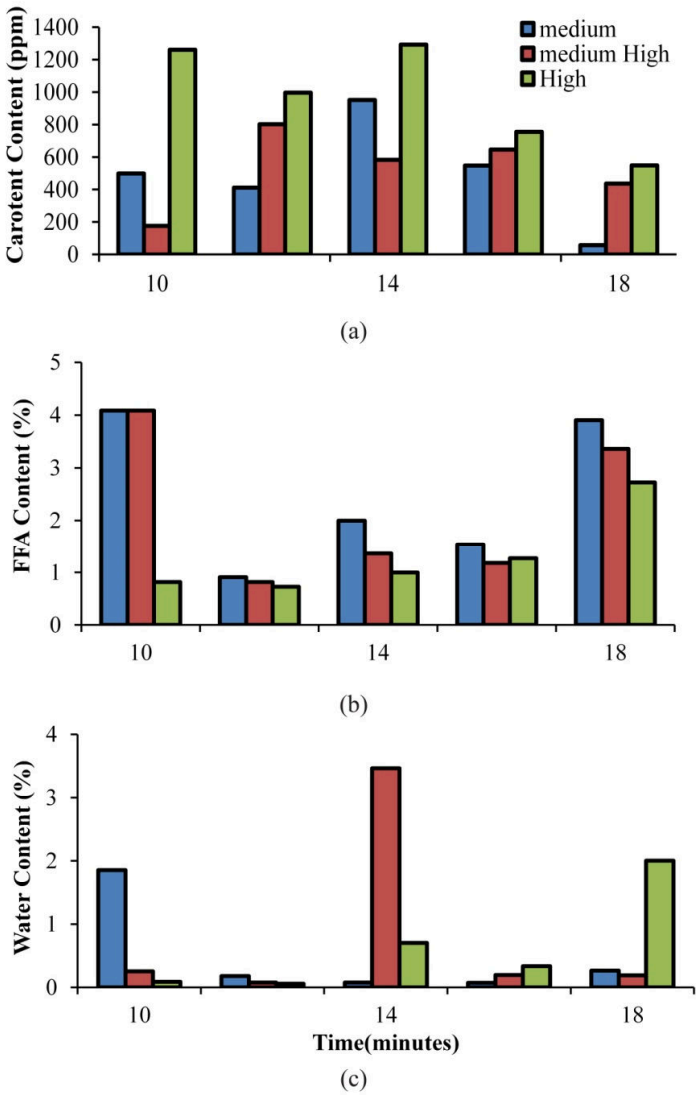

Figure 3. Effect of heating time to RPO quality: (a) carotene content (b) FFA content (c) water content

4. Conclussion

RPO production by microwave heating required less time as compared to conventional milling.FFA conncentration was below the maximum standard and carotene concentration was higher than typically CPO. Low level FFA content showed that sterilization was also completely done. Due to shorter time heating, carotene in RPO was significant.

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