The effect of lard concentration and ozonation on

by Fajar Arianto

The effect of lard concentration and ozonation on changes in polarization angle of olive oil

The effect of lard concentration and ozonation on changes in polarization angle of olive oil

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Abstract. This research aims to analyze the effect of ozone exposure time and lard mixture on the polarization angle of transmission of olive oil. The study uses a transmission polarization method with a laser (λ = 532 nm) as a light source. The research sample in the form of olive oil mixed with lard at a concentration of 10, 20, 40, and 80%, with an ozone exposure time of 0-30 minutes. The sample is subjected to external electric fields with variations from 0-4.5 x 10^2 kV/m to increase the change's polarization angle. The results showed that the change in polarization angle would change linearly with the increase in lard concentration with olive oil. Olive oil with a low concentration of lard (10%) experienced an increase in the change in polarization angle with a value of 0.31 ° due to the effect of 90 minutes of ozone exposure. In general, the results of the study showed that increased concentrations of lard, ozone exposure time, electric field strengths caused an increase in changes in the polarization angle in a mixture of olive oil and lard.

1. Introduction

Vegetable oil is one of the main ingredients used to meet the daily needs of the community. Currently, people's use of vegetable oil tends to be without regard to quality [1]. As a result, there have been many cases of impure vegetable oils. These oils have often mixed with animal oils for a savory effect on food preparations, such as lard [2]. Not all people know and consume lard.

Efforts to detect the presence of a mixture of lard have not been practical so far because it only depends on physical properties, namely turbidity and color. The presence of lard in vegetable oil can be detected using transmission polarization and fluorescence polarization methods [3-6]. A previous research report that the method has a transmission polarization angle changes on average lower than the fluorescence polarization method [5]. This method can identify the purity of vegetable oil-based on changes in its polarization angle. The oil that has been contaminated by lard will result in an enormous change in angle [6].

Various treatments can be performed to improve detection efficiency based on changes in polarization angle, such as radiofrequency application, oil blending, ozonation, and external electric field [7]. Previous research using these treatments has been extensively reviewed in references [8-12]. In this study, olive oil was chosen as a representation of vegetable oil. Furthermore, intensive observations were made to determine the correlation between the increase in lard concentration, changes

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in ozone exposure time, and an external electric field's application to changes in olive oil's polarization angle.

2. Method

The olive oil samples were mixed with lard with concentrations of 0, 10, 20, 40, and 80%. The samples were then treated with ozonation with a volume of 5 mL for 0, 30, 60, and 90 minutes. The samples were tested using an electro-optic transmission polarization method with diode laser λ = 532 nm, referring to Ainurrofik et al. (2020) and Azzahroh et al. (2019) research. The external electric field strength used is 0 to 4.5 x 10^2 kV / m. The research tool scheme can be seen in figure 1.

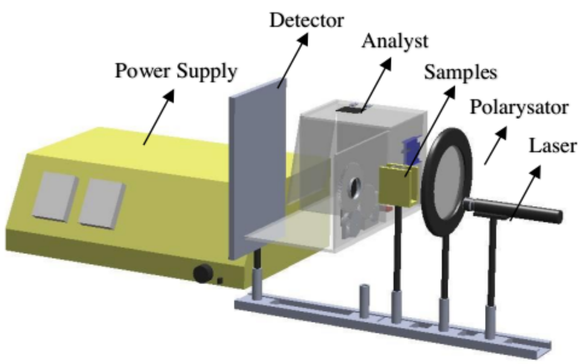
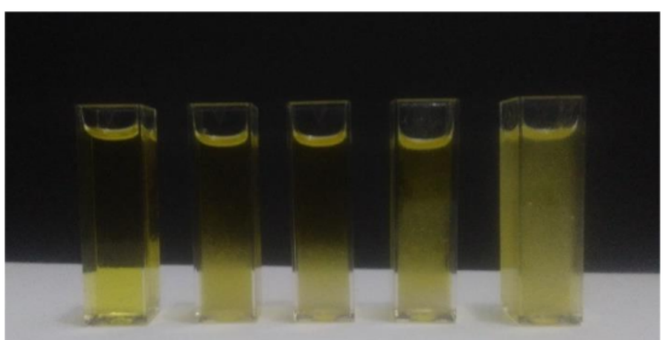


Figure 1. Schematic of the research tool

3. Results and discussion

Figure 2 shows visually olive oil mixed with lard based on the difference in concentration. Physically, increasing the concentration of lard added to olive oil causes the sample's color to become darker and cloudier. This phenomenon can be attributed to lard's saturated fatty acid content greater than olive oil [13-14].



(a) (b) (c) (d) (e)

Figure 2. Samples of mixed olive oil samples with various concentrations of lard (a) 0%, (b) 10%, (c) 20%, (d) 40%, (e) 80%

Figure 3 shows the relationship between lard concentration and the angle of polarization of olive oil. The smallest change in polarization angle was found at 0% lard concentration of 0.06°, and the enormous change in polarization angle was found in an 80% lard concentration of 0.31°. Increasing the lard concentration causes changes in the angle of polarization in olive oil to be more significant. This phenomenon is because the saturated fatty acid content is increasing due to lard concentration [15].

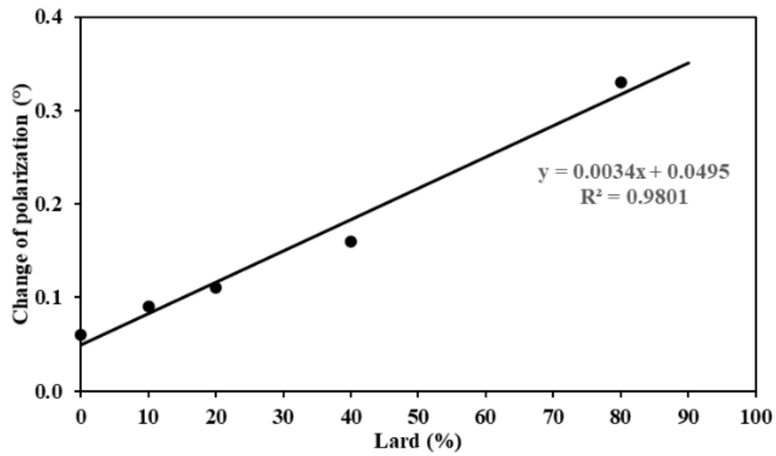


Figure 3. The relationship between the addition of lard concentration to changes in the polarization angle of olive oil

Figure 4 shows the relationship between ozonation time and changes in the polarization angle of olive oil. The mixture of olive oil and lard at various concentrations showed a polarization angle change, increasing ozonation time. The ozonation process will reduce the levels of unsaturated fatty acids in the oil. Unsaturated fatty acids will be oxidized to form free fatty acids during the ozonation process. The increase in free fatty acid content will make the polarization angle change higher [16]. The change in polarization angle in the 80% lard mixture tends to be linear, and it is because the composition of the oil mixture is close to the characteristics of lard [13].

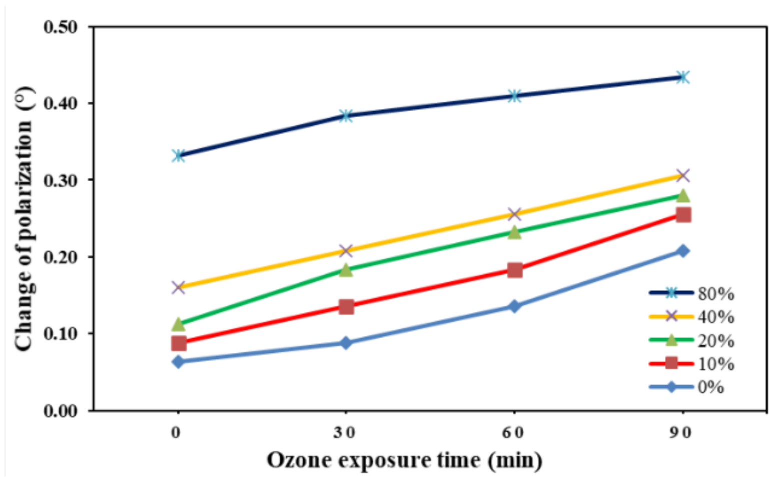


Figure 4. Relationship between ozonation time and changes in polarization angle

The change in the polarization angle of olive oil produced based on the change in the external electric field forms a quadratic graph as shown in Figure 5. This quadratic increase is due to free radicals' initial presence and the formation of free radicals when exposed to an external electric field [17]. The external electric field will impact the oil molecules and interact with the electric field from the light source to produce a resultant electric field. The resultant electric field affects the magnitude of the change in the angle of polarization [13].

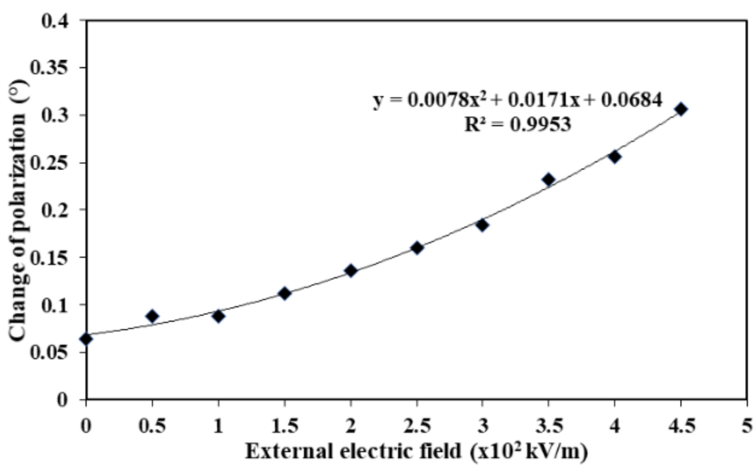


Figure 5. The relationship between the addition of an external electric field to changes in the polarization angle of olive oil

The relationship of the external electric field to the change in olive oil's polarization angle is shown in Figures 6 and 7. The addition of the external electric field strength to various lard concentrations and various variations in the time of ozonation causes an increase in the change in the polarization angle.

An external electric field's presence causes an increase in saturated fatty acid levels in olive oil, and then it becomes non-linear electric dipoles so that the polarization angle increases [15].

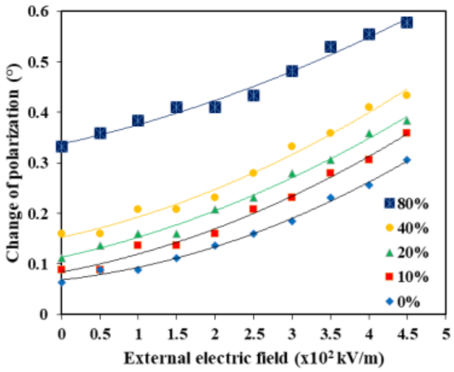


Figure 6. The relationship between the application of external electric fields to changes in the angle of polarization at various concentrations of lard

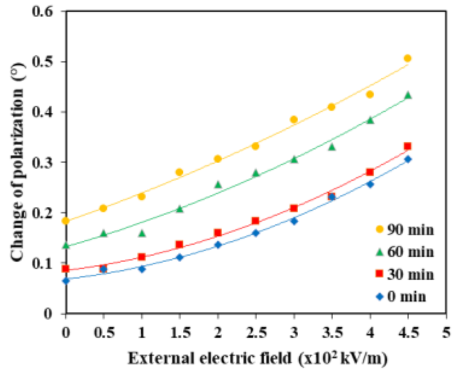


Figure 7. The relationship between providing an external electric field to changes in the angle of polarization at various times of ozonation

Combining ozonation and applying a strong external electric field will oxidize the oil, causing the triglyceride bonds to break into glycerol and free fatty acids. These free fatty acids are then induced by the external electric field, which causes the change in the angle of polarization to get more significant [18]. In general, this study's results can be an early indicator of vegetable oil's purity and quality, especially olive oil, based on changes in the resulting transmission polarization angle.

4. Conclusion

The increase in lard concentration, ozonation time, an electric field caused an increase in the polarization angle of transmission of olive oil. The addition of lard concentration to the angle of polarization of olive oil formed a linear relationship while applying an external electric field to the change in olive oil's polarization angle formed a quadratic relationship. The transmission polarization method effectively detects the presence of lard in olive oil in low concentrations (10%) based on the resulting change in angle.

Acknowledgments

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PAGE 1

PAGE 2

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PAGE 4

PAGE 5

PAGE 6

PAGE 7