Preliminary Study of Water Repellent Properties of Red Pepper Seed Oil

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Abstract. The water-repellent properties of red pepper seed oil (capsicol) have been studied. The oil was coated on the glass surface by spray technique. Water repellent properties were performed by measuring the contact angle of water droplets. The measurement was conducted by varying the drying time of the oil coating at room temperature. The optimum contact angle of the droplets on the glass with capsicol coating is 46.77°, which can be achieved in 30 min of drying time. It also obtained the smallest diameter of the droplets (0.47 cm). The longer drying time decrease the contact angles and increases the diameter. The results were compared with the bare glass and commercial water repellent. The contact angle of the droplets on the glass surface with capsicol coating is higher than bare glass, but lower than glass with commercial water repellent coating. It means that capsicol has the water-repellent properties.

1. Introduction

During this time, the cleaning process of glass requires a significant financial cost for the use of equipment, chemicals and special skills. One of methods to overcome the problem is modification the glass surface in order to have hydrophobic properties but still in its original colour. The modification can cause a self-cleaning effect [1]. This effect can significantly simplify the process of cleaning glass due to the water droplets slide by itself with carrying the dirt [2]–[4]. Self-cleaning associated with water repellent properties of the materials [5]. The properties defined as a surface that can hold water, but the air is still possible to pass through the hydrophobic coating. This hydrophobic coating can be determined by measuring the contact angle of the water droplets and the surface observed [6]–[8].

Capsicol is the oil that is extracted from red pepper seed [9]. The oil usually used as anti-inflammatory and can be used as a substitute for eucalyptus oil [10], [11]. In addition, capsicol also are antioxidants [12], [13], anticorrosive [9] and antimicrobial [14]. Because of its properties, capsicol has a potential to be used as a coating material on the glass surface to form hydrophobic properties. There is no report that uses capsicol to modify the glass surface.

In the present work, we study the water-repellent properties of capsicol on the glass surface. The testing was conducted by measuring the contact angle of water droplets on the surface of the glass which was coated with thin layer of capsicol. The capability of the water-repellent properties was compared to the bare glass (without coating layer) and the glass which was coated with commercial water repellent. The effect of drying time of coating material on the water-repellent properties was also investigated. The water-repellent properties of capsicol has been proved which it has a higher
contact angle and lower droplets diameter in comparison with the bare glass. It indicates that capsicol has modified the glass surface to have hydrophobic properties. This is a preliminary study to fabricate a hydrophobic glass using plant extract.

2. Experimental

2.1. Extraction of red pepper seed oil (capsicol)
Capsicol, the oil of red pepper seed, obtained according to Kurniawan and Madurani, 2015 [9]. A portion of seed powder was extracted using 99% ethanol (purchased from Merck, Germany) by Soxhlet technique. The extraction process produces a concentrated extract with a yellow and orange layer after evaporated, centrifuged and cooled. The orange layer is the red pepper seed oil or capsicol (Figure 1).

![capsicol](image)

**Figure 1.** Red pepper seed oil (capsicol).

2.2. Preparation of glass plates
The glass plates were washed using detergent. Furthermore, it was cleaned using ultrasonic cleaner for 30 minutes. The plates were dried at room temperature prior to use.

2.3. The coating process on the glass surface
Capsicol was coated by spray method on the glass surface that have been prepared. The coating of capsicol was flattened to obtain a thin layer, and then dried at room temperature. Drying time was varied at 10, 20, 30, 40, 50 and 60 minutes. The same steps were conducted in the coating process of commercial water repellent.

2.4. The measurement of contact angle
The contact angle and diameter of water droplets were monitored using a goniometer dual channel, which developed in our laboratory. The measurement was carried out according to Syahara et al., 2015 [15]. The glass with capsicol coating was placed on the goniometer and adjusted its position to be seen by the camera. Then, 25 µL waters were dropped on the glass surface with capsicol coating and captured from side and top view. The image obtained was processed by ImageJ software, where determination of contact angle was done using the Plugins Drop Analysis-Drop Snake. For comparison, the measurement also conducted for the glass with and without the coating of commercial water repellent. All Measurements were performed three times reduplication.

3. Results and discussion
Images of the water droplets on the bare glass, the glass with capsicol coating and the glass with commercial water repellent coating were successfully captured. The images can be seen at Table 1 and 2. The contact angle was measured from the side view of the image. Figure 2 is an example of the contact angle determination using ImageJ software. The contact angle of water droplets is summarized
in Table 3. Whereas, the diameter of water droplets determined from the top view of the image. The lines in the image are proportional to 0.1 cm. The droplets diameter is presented in Table 4.

**Table 1.** The result of measurement on the glass with and without coated by commercial water repellent.

| Drying time (minutes) | Side view | Top view |
|-----------------------|-----------|---------|
| **Bare glass**        | All variation of drying time | ![Images](image1.png) |
| **Glass with commercial water repellent coating** | | |
| 10                    | ![Images](image2.png) | ![Images](image3.png) |
| 20                    | ![Images](image4.png) | ![Images](image5.png) |
| 30                    | ![Images](image6.png) | ![Images](image7.png) |
| 40                    | ![Images](image8.png) | ![Images](image9.png) |
| 50                    | ![Images](image10.png) | ![Images](image11.png) |
| 60                    | ![Images](image12.png) | ![Images](image13.png) |

**Table 2.** The result of measurement on the glass with capsicol coating.

| Drying time (minutes) | Side view | Top view |
|-----------------------|-----------|---------|
| **Glass with capsicol coating** | | |
| 10                    | ![Images](image14.png) | ![Images](image15.png) |
| 20                    | ![Images](image16.png) | ![Images](image17.png) |
| 30                    | ![Images](image18.png) | ![Images](image19.png) |
| 40                    | ![Images](image20.png) | ![Images](image21.png) |
| 50                    | ![Images](image22.png) | ![Images](image23.png) |
| 60                    | ![Images](image24.png) | ![Images](image25.png) |
Figure 2. Determination of contact angle by ImageJ software.

Table 3. Contact angle of water droplets at drying time variation.

| Drying time (minutes) | Bare glass | Average value | Glass with commercial water repellent coating | Average value | Glass with capsicol coating | Average value |
|------------------------|------------|---------------|-----------------------------------------------|---------------|-------------------------------|---------------|
|                        | 1          | 2             | 3                                             |               |                               |               |
| 10                     | 35.5       | 35.0          | 35.0                                          | 35.17         | 88.9                          | 88.8          | 88.9                          | 88.86         | 25.5                          | 27.0          | 25.9                          | 26.13         |
| 20                     | 35.5       | 35.0          | 35.0                                          | 35.17         | 82.6                          | 82.3          | 82.0                          | 82.30         | 41.5                          | 42.0          | 43.7                          | 42.40         |
| 30                     | 35.5       | 35.0          | 35.0                                          | 35.17         | 81.1                          | 80.9          | 80.6                          | 80.87         | 47.5                          | 46.1          | 46.7                          | 46.77         |
| 40                     | 35.5       | 35.0          | 35.0                                          | 35.17         | 76.0                          | 78.0          | 76.9                          | 76.97         | 42.6                          | 42.7          | 43.8                          | 43.03         |
| 50                     | 35.5       | 35.0          | 35.0                                          | 35.2          | 74.5                          | 75.5          | 73.6                          | 74.53         | 41.5                          | 42.6          | 41.1                          | 41.73         |
| 60                     | 35.5       | 35.0          | 35.0                                          | 35.2          | 74.5                          | 74.5          | 73.8                          | 74.27         | 39.4                          | 38.5          | 39.6                          | 39.17         |

Table 4. Diameter of water droplets at drying time variation.

| Drying time (minutes) | Bare glass | Average value | Glass with commercial water repellent coating | Average value | Glass with capsicol coating | Average value |
|------------------------|------------|---------------|-----------------------------------------------|---------------|-------------------------------|---------------|
|                        | 1          | 2             | 3                                             |               |                               |               |
| 10                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.60                          | 0.60          | 0.60                          | 0.60          |
| 20                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.45                          | 0.50          | 0.50                          | 0.48          |
| 30                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.45                          | 0.45          | 0.50                          | 0.47          |
| 40                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.50                          | 0.50          | 0.50                          | 0.50          |
| 50                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.50                          | 0.50          | 0.50                          | 0.50          |
| 60                     | 0.50       | 0.50          | 0.50                                          | 0.50          | 0.30                          | 0.30          | 0.30                          | 0.30          | 0.50                          | 0.50          | 0.55                          | 0.52          |
The contact angle measurement on the glass that coated by capsicol show optimum conditions in drying time of 30 minutes. The longer of drying time decrease the contact angle (Figure 3) and increases the diameter of the droplets (Figure 4). According to Table 3 and 4, the average value of...
contact angle and droplets diameter in the optimum condition for capsicol coating was 46.77° and 0.47 cm, respectively. The contact angle is higher than the bare glass, but lower if compared to the measurement on the glass surface that coated by commercial water repellent. While, the diameter value is lower than the bare glass and higher than the droplets diameter on the glass with commercial water repellent coating. The results show that capsicol has a water-repellent property. This property also shown from the image in Table 2, where the droplets on the glass surface with capsicol coating looks more rounded shape than the droplets on the bare glass (Table 1).

Generally, the low value of contact angle between the liquid and substrate will show the adhesion, and on the contrary the high value of the contact angle shows the cohesion. The adhesion cause wetting process by liquid, if θ > 0° was called partial wetting [8]. In addition, if the contact angle of the droplets on the substrate surface > 90°, then the material is hydrophobic. And if the contact angle more than 150°, the material is super hydrophobic [3], [7], [16]. The average value of the contact angle of the droplets on the glass surface with capsicol coating is lower than 90° and higher than 0°. It indicates that the capsicol coating on the glass surface is only wetted by the liquid (i.e., water) [1], [5]. These results can be a starting point to continue in the fabrication of hydrophobic glass based on plant extract.

4. Conclusion
The water-repellent properties of capsicol was studied using contact angle measurement. The best result obtained at 30 minutes of the drying time of capsicol coating. Drying time of the coating affect the values of contact angle and droplets diameter that was obtained. The average value of the contact angle on the glass surface that coated by capsicol was 46.77°, which higher than the bare glass and lower than the glass with commercial water repellent coating. The value was less than 90° and indicate the wetting process by water. The diameter of droplets on the glass with capsicol coating is lower and more rounded shape than the bare glass. The results give information that capsicol has water repellent properties.

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