Effect of Temulawak (curcuma zanthorrizha) Extracts Addition as Natural Antioxidant Against The Destruction of Palm Oil in Frying Process

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Abstract. Curcumin that is extracted from Temulawak (curcuma zanthorrizha) is a natural source of antioxidants. It can be added in palm oil to reduce the destruction caused of heat in frying process. The method used in this study was a completely randomized design (CRD) with a single factor, each repeated 3 times and to know the difference was used the DMRT test. The research was conducted in two stages. First stage is to determine the best concentration of curcumin added into palm cooking oil (0 ppm, 300 ppm, 600 ppm, 900 ppm, 1200 ppm) while the second stage is to test the stability of curcumin in palm cooking oil used to fry for four times of frying. The results of the study showed that the best curcumin extract addition is concentration of 1200 ppm, where the cooking oil has characteristics iodine value of 60.790 gr I2 / 100 gr, peroxide number 1.033 mEq / Kg, free fatty acid 0.076%, moisture content 0.061%, smoke point 193.33°C and antioxidant activity 62.469%. The results of the stability of curcumin extract on palm cooking oil during the fourth frying process were iodine value 60.509 gr I2 / 100 gr (0.36% decrease), peroxide number 1,798 mEq / Kg (59.39% increase), free fatty acid 0.096% (12.94% increase), moisture content 0.245% (218.18% increase), smoke point 174.0°C (6.70% decrease) and antioxidant activity (DPPH) 56.092% (6.93% decrease).

1. Introduction
The main damage to oil fat is the appearance of a rancid smell and taste called the rancidity process. This is caused by further oxidation of unsaturated fatty acids in oil fats [1]. Autodissociation starts with the formation of free radicals and then these radicals with O2 form an unstable active peroxide. The high value of peroxide will accelerate the process of rancidity of the oil fat [2]. Oxidation reactions in fats or oils can be inhibited by using antioxidants. According to [3], in recent years it has been reported that the use of synthetic antioxidants can cause adverse effects on human health, such as liver, lung, intestinal, and poisoning. On the other hand, nature provides an effective and relatively safe source of antioxidants such as flavonoids, vitamin C, beta carotene and Vitamin E. This encourages more research to be carried out on natural materials to become a source of antioxidants, one of the plants that contains antioxidant compounds is Temulawak (curcuma zanthorrizha). It is a rhizome plant that is widely found in Indonesia. Curcumin as bioactive compound can be extracted from Temulawak rhizome using ethanol by maceration method, based on [4]. According to research by [5], curcumin has an important group in the antioxidant process. The structure of curcumin consists of a hydroxy phenolic group of groups β diketone. The phenolic hydroxy group functions as a free radical catcher on the antioxidant mechanism.

The addition of antioxidants in the frying process also plays a role in the quality of cooking oil as a frying medium, the more frying the oil does, the more damaged due to the influence of high temperature when frying. According to research by [6], repeated heating of palm oil can oxidize oil so that it is darker in color. The heating of broken oil (heated - cooled - heated) for several days causes faster destruction and decomposition when the oil is reheated. According to [7], cooking oil which is used more than 4 times the
heating with frying temperature 170-180°C will be oxidized which is characterized by the higher number of peroxides and the darker the color of the frying oil.

2. Materials And Methods
The main ingredient of this research is the palm cooking oil, which is obtained from the grocery store in Surabaya, Temulawak (Curcuma zanthorrhiza) rhizome obtained from traditional markets in Surabaya. The shaman’s material from the research is Aquadest, Na2S2O3, NaOH 0.1 N, Potassium Iodide saturated, ethanol 80%, PV Solvent (Aetic acid: Chloroform 2:3), PP indicator, AMYC indicator, K2CR2O3 PA, Hexana glacial, HCL Concentrated PA, Potassium hydrogen Phtalate PA.

Curcumin extraction from Temulawak rhizome:
Wash Temulawak rhizome and peel parts of the skin, then destroy by shredded and extracted using an ethanol solvent 80% with a method of maceration for 4 hours with a ratio of comparison material: solvent 1:2. Separate the filtrate and residue from the extraction process by filtered using filter paper. Vaporize the solvent (evaporated) by heated with a temperature of 80°C

The method used in this study was a completely randomized design (CRD) with a single factor, each repeated 3 times and to know the difference was used the DMRT test. The research was conducted in two stages. First stage is to determine the best concentration of curcumin added into cooking oil (0 ppm, 300 ppm, 600 ppm, 900 ppm, 1200 ppm) and analyzed for Iodine value, peroxide number, free fatty acid, moisture content, smoke point and antioxidant activity. The second stage is to test the stability of curcumin in cooking oil used to fry for four times of frying.

3. Results And Discussion
3.1 Results of stage I analysis (best concentration determination)
In research stage I, conducted testing on the addition of curcumin extract in the various concentrations into palm cooking oil to determine the best concentration. Stage I result can be seen in table 1.

Table 1. The effect of concentration of curcumin extract on the chemical parameter of palm cooking oil

| Level of Curcumin extract | iod number (gr I2/100 gr) | Peroxide number (mEk/Kg) | FFA (%) | Water Content (%) | Smoke Point (°C) | Antioxidant Activity (%) |
|---------------------------|--------------------------|--------------------------|---------|------------------|-----------------|-------------------------|
| 0 ppm                     | 60,80a                   | 1,75a                    | 0,10a   | 0,058a           | 195,33a         | 57,08d                  |
| 300 ppm                   | 60,76a                   | 1,34b                    | 0,08b   | 0,056a           | 193,00a         | 58,04c                  |
| 600 ppm                   | 60,80a                   | 1,28b                    | 0,08b   | 0,061a           | 195,66a         | 58,76b                  |
| 900 ppm                   | 60,78a                   | 1,16c                    | 0,07c   | 0,067a           | 194,33a         | 60,74a                  |
| 1200 ppm                  | 60,79a                   | 1,03d                    | 0,07c   | 0,061a           | 193,33a         | 62,46a                  |

Table1. shows that the greater the concentration of curcumin extract does not have a significant effect on iodine value, moisture content and palm oil cooking point smoke. But it has a profound effect on peroxide, FFA and antioxidant activity. The higher the level of curcumin added, the smaller the yod value, peroxide number, FFA and smoke point, but the value increases in the parameters of water content and antioxidant activity. This is caused by the presence of curcumin compounds in palm cooking oil which function as antioxidants which have the ability to capture peroxide compounds in palm cooking oil, according to [8], curcumin extract contains phenolic OH groups which play a role in capturing free radical compounds by donating or giving one of their hydrogen ions (H+) to radical lipid peroxyls (LOO *). LOO * is the result
of HO * reaction in HO * attack lipid peroxidation process against PUFA (Poly Unsaturated Fatty Acid). Giving H * atoms by an antioxidant can stop further radical reactions. Besides that, the mechanism for reducing free fatty acids occurs because essential oils found in turmeric can bind water through the breakdown of ester bonds so that the hydrolysis reaction can be slowed [9]. The addition of curcumin as a natural antioxidant can increase antioxidant activity in oil by 9.46%.

3.2 Results Stage II Analysis (Test the stability of curcumin during frying process)

Furthermore, stability testing of curcumin was carried out by adding 1200 ppm curcumin to palm cooking oil and repeated frying four times. The results of the analysis of palm cooking oil are as follows:

3.2.1 Iodine value

Graph of the average value of iodized palm cooking oil by adding curcumin extract to the frying process can be seen in Figure 1 below.

![Figure 1](image1.png)

**Figure 1.** Effect of the addition of curcumin curcuma extract to the iodine value of bulk palm cooking oil in the frying process.

In Figure 1, shows that more and more frying process cause a decrease in the value of the palm cooking oil's iod, but statistically not distinct. When compared with the quality standard of bulk palm cooking oil, the value of Iod in the 4th frying process still meets the quality requirements of the bulk palm cooking oil, namely 60.0 mEk/kg

3.2.2 Peroxide Number

Graph of average value of the average palm cooking oil peroxide with the addition of rhizome curcumin extract Temulawak in the frying process can be seen in Figure 2.

![Figure 2](image2.png)

**Figure 2.** Effect of the concentration of curcumin curcumin extract on the peroxide number in the frying process.

Figure 2 shows that the higher the frying repeat, the higher the proxide value in bulk palm cooking oil. This is because the high heating process causes the oxidation reaction to accelerate. According to [10], the oxidation process can take place if there is contact between a number of oxygen with oil or fat which results in a rancid odor in oil and fat. The next oxidation is the breakdown of fatty acids accompanied by the conversion of hydroperoxide to aldehyde and ketones and free fatty acids. In the fourth frying number
peroxide obtained is 1.798 mEq / Kg and when compared with the Indonesian National Standard (10 mEk / kg), the peroxide number shows if bulk cooking oil is still feasible to use.

3.2.3 Free fatty acid levels
The graph of the average value of free fatty acid bulk palm oil with the addition of curcumin curcumin extract in the frying process can be seen in Figure 3.

Figure 3. Effect of curcumin curcumin extract on the levels of ALB bulk palm cooking oil in the frying process.

Figure 3 shows that the more repeated frying, the higher the level of free fatty acids in bulk palm cooking oil. Hydrolysis of palm cooking oil during frying occurs because of the absorption of water from fried media (potatoes / french fries) into palm cooking oil resulting in an increase in the levels of free fatty acids in palm cooking oil [11]. The 4th frying pan in this study found 0.080% free fatty acids. The value of free fatty acids in this study is still below the standard of Indonesian National Standard (0.3%) so that in the fourth frying pan the bulk palm oil is still suitable for use in the frying process.

3.2.4 Moisture content
Graph of the average value of bulk palm oil cooking water with the addition of curcumin curcumin extract in the frying process can be seen in Figure 4.

Figure 4. Effect of the concentration of curcumin curcumin extract on the moisture content of bulk palm cooking oil during frying.

Figure 4, shows the more repeated frying, the water content in bulk palm cooking oil increases. This is due to the fact that the fried material contains a number of water, resulting in an increase in the moisture content of bulk palm cooking oil in the frying process. This is supported by the research of [12] which states that the moisture content of cooking oil increases linearly with the number of repetitions of frying on sweet potato media. According to Indonesian National Standard, the standard content of palm cooking oil is <0.1%. When compared to the standard water content of bulk palm cooking oil in the 4th frying pan, it is not feasible to use.

3.2.5 Smoke Point
The graph of the average value of the smoke point value of bulk palm cooking oil with the addition of curcumin curcumin extract in the frying process can be seen in Figure 5.

![Figure 5](image1.png)

**Figure 5.** Effect of the concentration of curcumin curcumin extract on the smoke point of bulk palm cooking oil during frying

Figure 5 shows that the more frying repeat, the value of the smoke point (smoke point) of bulk palm cooking oil decreases. This is caused by repeated high-temperature heating processes which cause the smoke field to decrease because cooking oil polymers will degrade to form acrolein. The 170ºC smoke point is the minimum standard used to state that the oil has reached the damage limit. Heating oil will produce free fatty acids and its purity decreases so that the cooking oil smoke points will decrease with the heating process [13]. When compared to the standard palm oil cooking fume point on the fourth frying pan, bulk palm cooking oil with the addition of curcumin curcumin extract of 1200 ginger is still feasible to use.

### 3.2.6 Antioxidant Activity

Graph of the average value of antioxidant activity (DPPH) of bulk palm cooking oil with the addition of curcumin curcumin extract in the frying process can be seen in Figure 6.

![Figure 6](image2.png)

**Figure 6.** Effect of curcumin curcumin concentration on the antioxidant activity of bulk palm cooking oil during frying

Figure 6, shows that the more frying repeat, the antioxidant activity of bulk palm cooking oil decreases. This is due to the heating process. According to [14], long heating and using high temperatures can reduce antioxidant activity. during heating, curcuminoids were degraded and formed brownish ferulic and ferulloimethane acids [10].

### 4. Conclusion

Addition of curcumin extract of 1200 ppm was the best result in maintaining the quality of palm cooking oil with iodine value: 60.790 gr I2 / 100 gr, peroxide value 1.033 mEq / Kg, free fatty acid 0.076%, moisture content 0.061%, smoke point 193, 3330C and antioxidant activity (DPPH) 62.469%.

The stability of curcumin can be seen from the application of four repetitions of frying which decreased the value of iodine value by 0.36%, smoke point 6.70% and antioxidant activity which was significant at 6.93%; and an increase in peroxide value of 59.39%, FFA of 12.94%, and moisture content of 218.18%.

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