Stabilizing Cooking Oil by Mangosteen (Garcinia mangostana L.) Peel Crude Extract

Sri Rahayu, Supriyatin, Yulilina, Dinda Nurul Nabila

Abstract— Increase use of cooking oil with decrease source available has made the price going rise. This had made people use cooking oil repeatedly. Repeated use of cooking oil will break the oil structure and create harmful effect. Disruption on oil structure cannot be hindered but it can be slower by adding stabilizing agent. The purpose of this study was to assess the role of mangosteen in stabilizing cooking oil. Preliminary descriptive study was done against flavonoid content and DPPH radicals scavenging activity of some antioxidant plant. Samples used were mangosteen peel, celery leaves, tea leaves and citrus fruit. Experimental method of mangosteen activity used was CRD (completely randomized design) with 3x4 factors. Factors applied was solvent type (chloroform, aquadest, ethanol) and extract concentration (0 µg/ml, 90 µg/ml, 100 µg/ml, and 110 µg/ml). Each procedure was repeated 5 times. Parameter measured was free fatty acid number (FFA) and oil turbidity. Data was analyzed with two ways Anava followed by DMRT. Preliminary results showed that the highest levels of flavonoid were found in mangosteen peel (72 g/kg) followed by celery (37.9 g/kg), citrus fruit (25,5 g/kg) and tea leaves powder (13,9 g/kg). DPPH radicals scavenging activity ranging from 71,1 % of mangosteen peel, 48,2% of the celery, 13,2% of citrus fruit and 11,2% of tea leaves powder. Preliminary result confirmed the best use of antioxidant from mangosteen compare to others. Experimental result showed that 110 µg/ml aquadest was the best combination to give lowest FFA value (1.24%). 90 µg/ml whilst, oil turbidity didn't show differences under treatment given. Ethanol was found give highest FFA value (5.11%). It can be concluded that mangosteen peel is able to stabilize cooking oil and solvent with extract combination give impact on free fatty acid number of cooking oil.

Index Terms— mangosteen peel, cooking oil, free fatty acid

I. INTRODUCTION

Need of cooking oil in food process has undergoes dramatic increased every year. Higher use wasn't significantly stabilized by availability of the oil. This underlined the reason of expensive price on cooking oil. Economic condition was then acted as the reason of repeated use on cooking oil.

Repeated use of cooking oil will lower the oil quality. Quality of cooking oil can be assessed by physical parameters such as color, smell and viscosity. Chemical value of free fatty acid and peroxidation number would also be used as the information of cooking oil. Higher value on free fatty acid number of cooking oil showed decreased quality of the oil (1). Oxidation is one of the process responsible in increasing the number of free fatty acid on cooking oil (2). This process occurred due to contact of oil with heat, free oxygen, catalyst such as iron and zinc. Destruction process of cooking oil as the result of heating on high temperature (200-250°C) will cause toxicity and create many diseases (3). Antioxidant added on cooking oil will be able to stabilize and slower the oxidation process and prevent free radical formation on cooking oil (4).

Some researchers have been done efforts in minimizing bad impact on repeated use of cooking oil. Study on the use of turmeric acid has revealed its effect in minimizing oxidation (5). Previous study on the application of noni fruit combined with adsorbent has been proven to minimize the destruction of cooking oil (6). Noni fruit and turmeric acid used on previous study was acted as antioxidant in minimizing oxidation process. Other study on plant local antioxidant plant suggested that mangosteen gave the best result in scavenging DPPH (1,1-diphenyl-2 picryl hydrazil) radicals due to xhantones found in this plant (7). The findings give interest of the study in investigating the benefit of mangosteen peel extract in stabilizing cooking oil. Hopefully the result will give better value on cooking oil quality compared to other plant which has ever been used before.

II. EXPERIMENTAL DETAILS

Study was conducted in Biochemistry and organic chemistry laboratory, Faculty of Mathematics and Natural Sciences, State University of Jakarta. Preliminary study was done by descriptive methods on flavonoid content and DPPH (1,1-diphenyl-2 picryl hydrazil) scavenging ability. Sample used in preliminary study were mangsoteen peel, celery leaves, tea leaves and citrus fruit. Experimental Design used was Complete Randomized Design (CRD) with 3x4 factorial. Factors applied were solvent type (Chloroform, aquadest, ethanol) and extract concentration µg/ml, 90 µg/ml, 100 µg/ml, and 110 µg/ml). Oil without extract was used as positive control. Each was 5 times repeated. Parameters measured were oil turbidity and FFA (Free Fatty Acid) number.

Total flavonoid content

2 ml Aluminum triklorida ($AlCl_3$) 2 % on methanol was mix with extract solution (1 mg/ml). The compound was then incubated in room temperature for 10 minutes, and absorbance was measured with spectrophotometer on 415 nm. Measurement was done duplicate. Flavooid content was determined by equation below:

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Total flavonoid (g/kg routine) = Absorbance – 0,0556/ 0,0144.

DPPH Scavenging Activity

Antioxidant activity of the samples was measure with stabile free radicals 1,1-diphenyl-2 picryl hydrazil (DPPH) (8). 2 ml of free radical DPPH in methanol on 0,05 mg/ml concentration was added with 1 ml of plants extract on cuvette. The compound was then shake and incubated on room temperature for 30 minutes. Absorbance was then measure with spectrophotometer on 517 nm. DPPH radical concentration was counted by equation below:

Scavenging effect of DPPH (%) = $(A_0 - A_1)/A_0$ x 100

Where A_0 was absorbance of negative control without extract and A_1 was absorbance of sample.

Mangosteen application on cooking oil

Mangosteen under different concentration and solvent type were immersed in cooking oil for 24 hours. Cooking oil was then used to fry catfish(6). Cooking oil was then measured for turbidity and FFA number.

Oil Turbidity Measurement

Oil clarity was measured with spectrophotometer on 448nm (9). Absorbance value showed the oil turbidity and quality of the oil.

FFA Measurement

Samples (28,2 ± 0,2 g) added with alcohol (50 ml) and phenolphthalein (PP) indicator (2 ml) were titrated with 0,1 N NaOH. Pink color looks of the solute was observed after it was stabile 30 second. Measurement was done with the equation below

$$\%FFA = \frac{mlNAOHxOilWeight}{SampleWeightx100} x100$$

Statistical Analysis

Parameters measured were free fatty acid number and oil turbidity. Statistical used was two ways ANOVA (α=0,05). Further study was done with DMRT (*Duncan Multiple Range Test*) to evaluate effect between each treatment.

III. RESULT AND DISCUSSION

Flavonoid Content of Some Antioxidant Plants

Based on the result it was known that all plants used in the research contain flavonoid at different level with highest level in mangosteen. Mangosteen was widely studied as it has higher concentration of phenolic and tannins especially on the young fruit (10). Other research suggested that mangosteen peel can be used as source of antioxidant or food products due to its flavonoid and non-toxic properties (11). Other finding exhibits that celery also has flavonoids at lower level compare to mangosteen Research done by Yao (12) investigated that celery has high level of phenolic compound with apigenin as the major flavonoid. The other two plants, citrus fruit and tea leaves have been known for decades as the source of antioxidant. Research done by Rekha (13) concluded that citrus has antioxidant capacity directly related to not only ascorbic acid but also high total phenolic contents, one of them is flavonoid. Quantitate results obtained that the highest levels of flavonoid were found in mangosteen peel (72 g/kg) followed by celery (37.9 g/kg), citrus fruit (25,5 g/kg) and tea leaves powder (13,9 g/kg) (Fig 1).

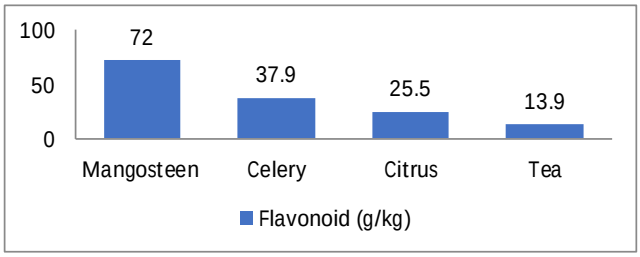

FIGURE 1. Flavonoid content of some antioxidant plants

One of the most common antioxidant compounds that found in plant tissues is flavonoid. Almost all plants have polyphenolic compound found from leafy vegetable, fruits, herbs, spices seeds, and beverages. Some endemic plants even have greater flavonoid content than others. Flavonoid can be found in every organs of plants, so it will be found on each plant extracts Flavonoids is the group of polyphenol compound known to be able to work against free radicals (oxygen reactive compound) such as superoxide anion and radical hydroxyl, inhibitors for enzyme hydrolysis and oxidative, and worked as anti-inflammation (14). Flavonoid is secondary metabolite compound which is found in plant, except algae. Common flavonoids found in higher plants (angiospermae) are flavone and flavonols content with C- and O-glycoside, isoflavones C- and O-glycosides, flavanones C- and o-glycosides, chalcones with C- and O-glycosides, and dehydrochacones, proanthocyanidines and anthocyanin, aurones O-glycosides, and dihydroflavonols O-glycoside. Flavones, flavonols, flavanones, isoflavones, and chalcones also often found in the form of glycol. Flavonoid is constituted of two aromatic rings that able or unable to form the third ring with the arrangement of C6-C3-C6 (15).

DPPH Radicals Activity of Some Antioxidant Plants

Many methods can be used to clarify antioxidant activity on plants. Previous research investigated antioxidant property of 30 plants using DPPH, ABTS radical scavenging assay, ORAC, SOD AND FRAP assay. DPPH was choses as it was widely known technique to assess antioxidant due to it simplest process. The absorbance of the solution added with DPPH was then measured after defined period (16). This research measured antioxidant activity of some local plants in Indonesia using DPPH radicals scavenging activity. Result showed that the radical activity of plants used were ranging from 71,1 % of mangosteen peel, 48,2% of the celery, 13,2% of citrus fruit and 11,2% of tea leaves powder (Fig 2).

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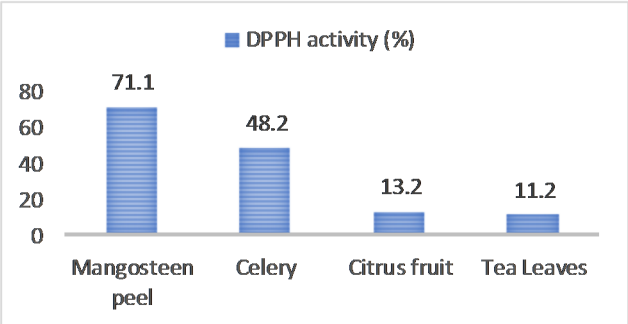

FIGURE 2. DPPH Radicals Activity of Some Antioxidant Plants

Mangosteen peel extract demonstrate the ability to neutralize DPPH in a high activity compare to celery, citrus fruit and tea leaves. It was seen that all plants were able to neutralize the radicals given for 30 minutes incubation period. Free electron in DPPH will easily react with substance to whom it donates the hydrogen. DPPH coupled with substance will decrease absorbance value of the free radicals. (17). The reason underlying this process is the phenolic content owned by antioxidant plant. Most phenolic substance can prevent peroxidation process. Metal from peroxidation result will bind to phenol with OH group and act as chelator (14). Numerous studies have found high correlation between antioxidant activity and phenol content (8). Our preliminary study also revealed that total flavonoid content of plants has significance influence on DPPH radicals scavenging activity which showed the antioxidant activity of the plant.

Free Fatty Acid (FFA) Number

The lowest FFA in cooking oil was observed in extract with aquadest (MA) of 110µg / ml. Whilst, control showed result on an average of 1.24%. This was different in extract with aquadest (MA) with a concentration of 90 µg / ml which was the largest number of free fatty acid or close to control with an average of 1.54%.

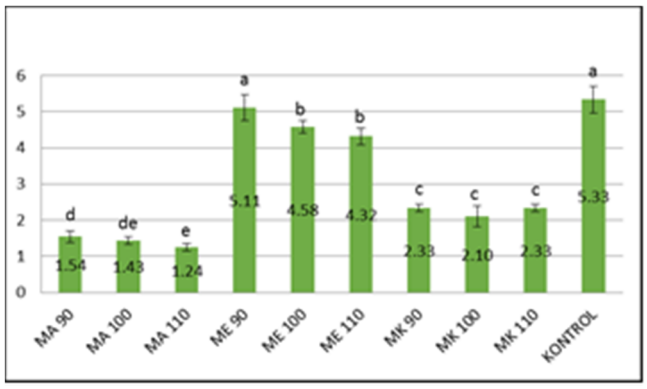

FIGURE 3. Duncan Result on Free Fatty Acid of Cooking Oil

Figure 3 describe that MA 110 µg / ml was the best combination of solvent and concentration type to slower the increase of FFA value on cooking oil because it has the smallest value compared to others. ME (Extract on Ethanol). The worst combination of concentration in inhibiting FFA number found in 90µg / ml (5.11%). The FFA value of this treatment group was almost equal to the positive control (5.33%) and there was no significant difference. Nevertheless, the result indicated that all treatments can slower the increase in the number of free fatty acids compare to control. Mangosteen fruit used as raw material in this study was Garcinia mangostana l.. which was originated from Leuwiliang district, Bogor. Mangosteen used here was one of the superior mangosteen fruit that was launched by IPB (Bogor Agricultural University) in 2010. The same level of fruit maturity was used to ensure uniformity. Usually ripe of mangosteen fruit has a lifespan of about 120-125 days. The maturity level of the selected mangosteen fruit was the index of maturity 6 with the characteristics of the color of the purple fruit skin, the fruit is ripe, the fruit is suitable for the needs of the domestic market, and ready to eat.

Mangosteen peel in the form of extract was added to the cooking oil with a combination of solvent type and the concentration of the extract that has been established. This was done by calculating the number of FFA and clarity on cooking oil. FFA usually uses as indicator of oil damage due to oxidation and hydrolysis processes and free radicals' reaction (18). Frying time as well as food composition fried will also increase the value Moreover, water also take part in oil damage by presence of water, carbohydrates and protein content in food (19).

FFA number as the hydrolysis result of triglycerides is easily oxidized and create oil rancidity. Titration method is applicable in measuring the FFA value. The process was done by evaluating color changes from colorless to pink or purple due to phenolphthalein compound. In this study, the oleic acid as the most unsaturated FFA ingredient in palm oil was decided to be used as calculation base.

Maximizing the antioxidant effect on cooking oil was done by adding in as early as possible before cooking. It creates slower oxidation at uniform speed of the frying process (20). As the result, FFA formation will be lower and the damage of cooking oil will also be minimum.

Cooking Oil Turbidity

Turbidity was used as indicator of oil clarity. The control showed result of 0.65 whereas in the treated cooking oil it showed different results. The absorbance value of cooking oil at MA 90µg / ml was 0.72, MA 100µg / ml was 0.71, MA 110µg / ml was 0.68. The absorbance value of cooking oil at ME 90µg / ml was 0.75, ME 100µg / ml is 0.79, ME 110µg / ml was 0.81. The absorbance value of cooking oil at MK 90µg / ml was 0.82, MK 100µg / ml was 0.87, 110.0 MK / ml was 0.77. The lowest absorbance value of cooking oil was found at MA (Extract with aquadest) 110µg / ml of 0.682 and the highest absorbance value was MK (Extract with chloroform) 90µg / ml with 0.832.

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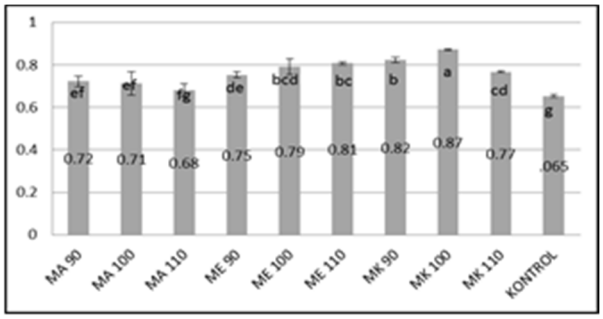

Fig 4. Duncan test on oil Turbidity

The color of oil becomes one of the determinants of the frying process. Oil should not be reused if the color has changed permanently compared to its original color (21). On the results of tests that have been done, the results obtained that the heating process well indicates that the more heat the greater the value of cooking oil absorbance.

Combination of solvent type and concentration of extract also showed the same result. Absorbance values show random results. It can be seen that absorbance value of oil after treatment was higher than control. This may be due to reason that extract added to oil will change the color even under invisible sight. Based on theory the more heating was done, the greatest absorbance will be gained as result of thermal polymerization (22).

Thermal polymerization is a process of oil polymerization that occurs due to heat either in the presence of oxygen or not. Heat can break the molecules of oil or fatty acids. Components that have been interrupted can then react to each other and bind to form a large molecule. The formation of this polymer molecule will cause the color of cooking oil to decrease its clarity (23).

IV. CONCLUSSION

It can be inferred from the study that there was influence of concentration of mangosteen peel crude extract and solvent type to FF number. The best combination of treatments was MA 110 µg / ml and treatment combinations did not positively affect the clarity of cooking oil.

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