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Journal of Chemical and Pharmaceutical Research, 2015, 7(9S):59-65

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The purification of waste cooking oil based on lipid profiles measurements by using skin of *Salacca zalacca*

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ABSTRACT

The waste cooking oil is widely used in traditional market. The purification of waste cooking oil is very important to avoid a large number of disposable oil, environmental pollution and health risk of oil consumption. Two types of oils, Chicken/Fish-used Oil and Banana-used Oil, have been treated with the powder of skin of Salacca zalacca in a batch method. The optimum condition showed that 15 g of skin powder has reached at two weeks contact time and 3h shaking time. The results showed the skin powder of Salacca zalacca could improve the quality of waste cooking oil by reducing the MDA value and lipid profile (total cholesterol and LDL). FTIR indicated some functional groups which play the role of chemical interaction such as; C=O stretch of aldehydes, esters and saturated aliphatics; N−H bend of primary amines; N−O stretch of nitro compounds; and C−N stretch of aromatic amines.

Keywords: Waste-cooking oil, Skin of Salacca zalacca, Malondialdehydes (MDA), Total Cholesterol, LDL.

INTRODUCTION

World vegetable oil production has increased over the past decades, according to the United States Department of Agriculture, 168.85 million metric tons were produced globally at the end of 2013 - 2014 season [1]. Consumption of deep frying vegetable oils is also high, especially in developing countries such as Indonesia. Recent observation on the food stall in many traditional market, to reduce cost expenses, the oils are often to be used repeatedly for frying until discarded and replaced with fresh oil, thus named as waste cooking oil. When heated repeatedly, changes in physical appearance of the oil will occur such as increased viscosity and darkening in colour [2] which may alter the fatty acid composition of the oil. Heating causes the oil to undergo a series of chemical reactions like oxidation, hydrolysis and polymerization [3]. During this process, many oxidative products such as hydroperoxide and aldehydes are produced, which can be absorbed into the fried food [4]. Repeated heating of the oil also accelerates oxidative degradation of lipids, forming hazardous reactive oxygen species and depleting the natural antioxidant contents of the waste cooking oil. Long-term ingestion of foods prepared using waste cooking oil could severely compromise one's antioxidant defense network, leading to pathologies such as hypertension, diabetes and vascular inflammation [5]. Furthermore several studies also reported the increasing levels of total cholesterol, LDL, MDA, Tryglicerides and lowering the HDL content [6-8].

Recycling or purification of waste cooking oil by using adsorbents,such as silica gel, magnesium oxide, aluminium hydroxide gel and activated clay, has been studied for improving the quality parameter of waste cooking oil [9-10]. The indicators of poor oil quality include elevated Free Fatty Acids (FFA), change of color, low smoke point, low iodine value, total polar material, high foaming properties, increased viscosity [11] and peroxide value [12].

In this study we reported the potential ability of waste agricultural product, skin of *Salacca zalacca*, for reduction of total cholesterol, LDL and MDA values of two types of waste cooking oils which mentioned as Chicken/Fish-used Oil (C/Fu Oil) and Banana-used Oil (Bu Oil).

EXPERIMENTAL SECTION

Chemicals and Equipments

All chemicals used in this experiment are analytical grade and obtained from Merck (Germany). Distilled water obtained from laboratory made. A cruiser (Fritch, Germany), analytical balance (Kern & Sohn, GmbH), rotary shaker (Edmun Buhler 7400 Tubingen), , UV-Vis (Thermo Insight), FTIR (Nicolet iS10 with KBr) and SEM (Hitachi S-3400N) were used in this experiment, MICRO LAB 300 (MRK Diagnostic), Diagnostic Reagent (Diasys).

Waste Cooking Oils

Two types of waste cooking oils were used; (1) Chicken/Fished-used oil (C/Fu Oil) and (2) Banana-used oil (Bu Oil). The oils were obtained from `Pecel Lele` food stall in Padang City. The new oil was considered as a standard.

Powder of *Salacca* skin

The skin of *Salacca zalacca* was obtained from traditional market in Medan city, North Sumatra, Indonesia. After washed, *salacca* skin was dried at room temperature to form powder. The powder was sieved to 450 µm and dried at room temperature. The powder then ready to be used.

Batch Treatment

Powder of *salacca* skin in weight variations of 5 g, 10 g, 15 g and 20 g were soaked with 50 mL of waste cooking oil and stirred for 3 h, then stored at room temperature for two weeks. After filtration, the lipid profiles of two oils have been evaluated with spectrophotometric method (Abs 546 nm).

Lipid Profiles Analysis

The total cholesterol, LDL and MDA of waste cooking oils were determined as the following procedures;

Total Cholesterol

	Blank (µl)	Sample (µl)	Standard (µl)
Distilled water	10	-	-
Waste Cooking Oils	-	10	-
Standard (New Oil)	-	-	10
Reagent Chol	1000	1000	1000

Procedures :
Mixed homogenously, incubated 20 min at room temp or 10 min at 37 °C then measured with UV-vis Spect at 546 nm

LDL Measurement

	Blank (µl)	Sample (µl)	Standard (µl)
Distilled water	10	-	-
Waste Cooking Oils	-	10	-
Standard (New Oil)	-	-	10
Reagent LDL	1000	1000	1000

Procedures :
Mixed homogenously, incubated 20 min at room temp or 10 min at 37 °C then measured with UV-vis Spect at 546 nm
Filtrate preparation:
1. Mixed homogenously then incubated for 30 min.
2. Centrifuge at 2500 rpm for 15 min, then filtrate was separated.

MDA Level

	Blank (ml)	Sample (ml)	Standard (ml)
Distilled water	0.5	-	-
Waste Cooking Oils	-	0.5	-
Standard (New Oil)	-	-	0.5

Procedures :
1. Add 2.5 ml TCA 5%, mixed with vortex mixer
2. Centrifuge for 10 min at 2000 rpm
3. Take 1.5 ml filtrate and add with 1.5 mL Na.thiobarbituric acid, mixed with vortex mixer
4. Put in water bath at 100 °C for 30 min
5. Cooling at room temp and measured by UV-Vis Spect at 530 nm

Filtrate preparation:
1. Mixed homogenously then incubated for 30 min.
2. Centrifuge at 2500 rpm for 15 min, then filtrate was separated.

FTIR and SEM Analysis

To evaluate the functional groups which play the role of adsorption process, the powder of *salacca* skin has been analyzed by FTIR (Nicolet iS10 with KBr) and the surface morphology of *salacca* skin observed by SEM (Hitachi S-3400N) with such established method.

RESULTS AND DISCUSSION

Physical Quality Improvement

After batch treatment with powder of *salacca* skin, results showed a physical quality improvement which indicated by a dark brown (untreated oil) changed to a more yellowish and better in flavor (treated oil) as shown in figure 1. The preliminary screening showed that 5g to 15g of skin powder has reached optimum condition at 15g of weight, two weeks of contact time and 3h shaking time (data not shown). The physical quality of treated oil has suggested the potential ability of powder of *salacca* skin as biosorbent to improve the quality of waste cooking oils. This result also in aggreement with a previously reported that the ash powder of *salacca* seed could purify the waste cooking oil physically [13].

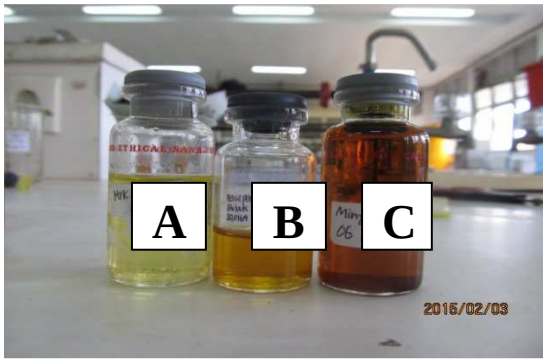

Figure 1. Physical Quality Improvement: A : New Oil, B : Treated Oil, C : Untreated Oil (waste cooking oil).

Effect on the Total Cholesterol

As shown in the figure 2.a the total cholesterol of C/Fu Oil was subsequently reduced by treatment of *salacca* skin powder, the optimum condition reached at 15 g of *salacca* skin powder where as total cholesterol reduced as 58%. Interestingly, figure 2.b showed the total cholesterol of Bu Oil was reduced 15% at 5 g of *salacca* skin powder, this result indicated that *salacca* skin may ineffective to reduce the total cholesterol at higher concentration. This might be due to physical interaction such as aggregation [14-15].

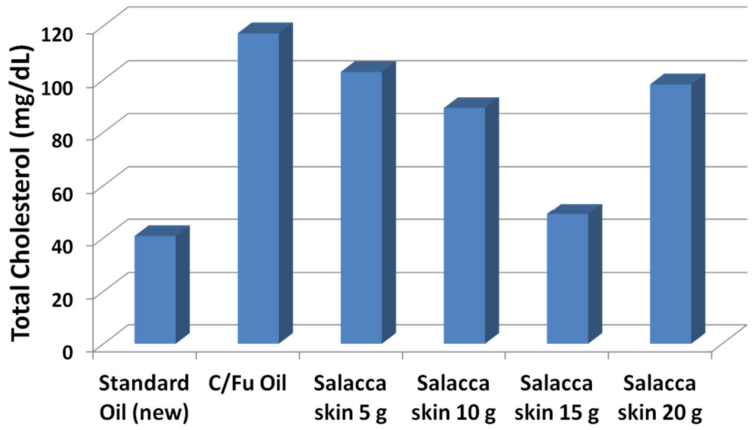

Figure 2.a. Effect on The Total Cholesterol (C/Fu Oil)

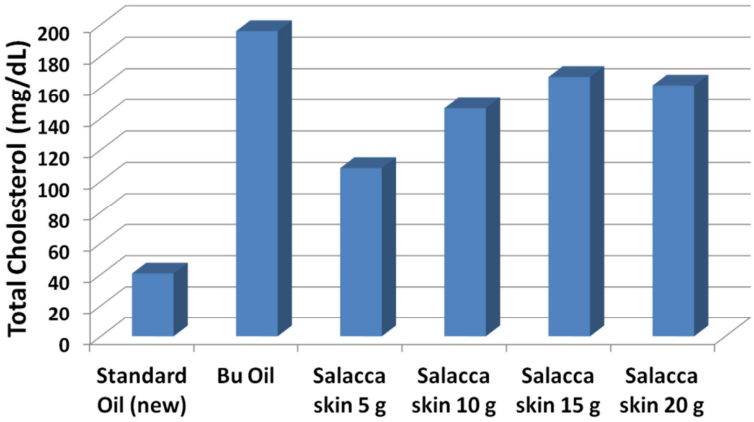

Figure 2.b. Effect on The Total Cholesterol (Bu Oil)

Effect on the LDL Values

The result in figure 3.a suggested that LDL values of C/Fu Oil was optimally reduced about 9% at 5g of *salacca* skin powder. Further, the figure 3.b also supported that *salacca* skin powder also might not effective to reduce the LDL values of Bu Oil at higher concentration, although the minimum LDL values of Bu Oil was reached at 10 g of *salacca* skin powder. This results might be due to interferences of polarity between the active sites of biosorbent and the secondary products of lipid peroxidation [3,5].

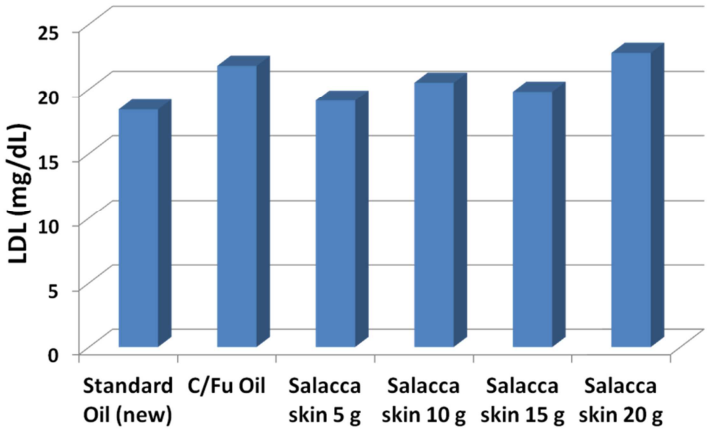

Figure 3.a. Effect on The LDL (C/Fu Oil)

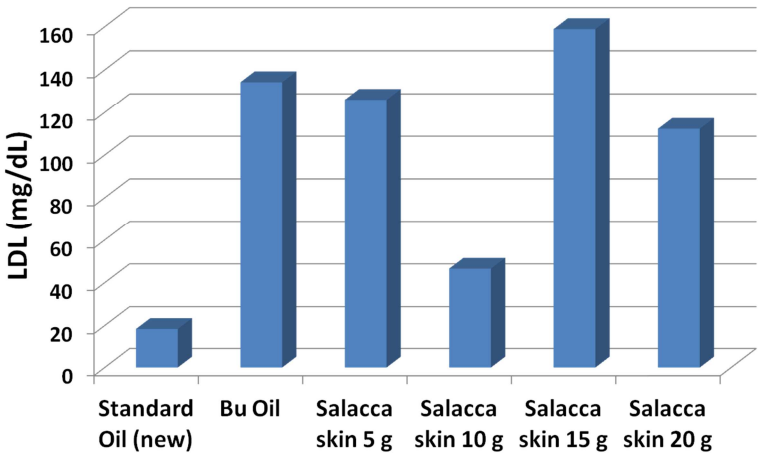

Figure 3.b. Effect on The LDL (Bu Oil)

Effect on the MDA Level

The measurement on MDA level showed a positive effect of treatment by *salacca* skin powder as shown in figure 4.a and 4.b. The MDA level of C/Fu Oil was reduced by the increasing of concentration. The optimum condition was reached at 15 g of salacca skin as the reduction of MDA levels of C/Fu Oil and Bu Oil are 15% and 6% respectively. This results also suggested that utilization of *salacca* skin could reduce the bad effect of MDA as the most abundant lipid peroxidation cytotoxins formed in foods [16].

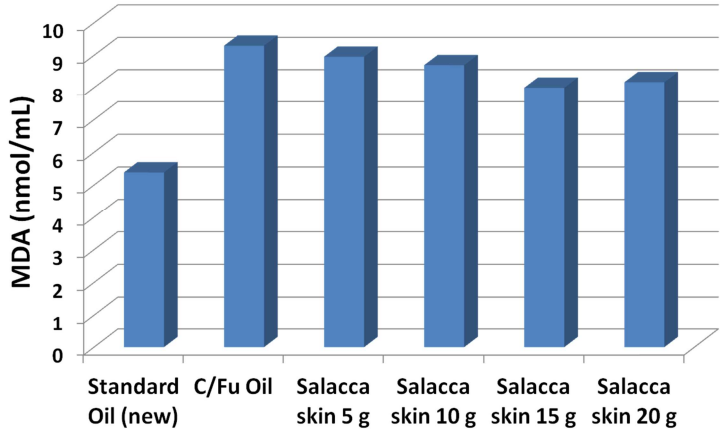

Figure 4.a. Effect on The MDA (C/Fu Oil)

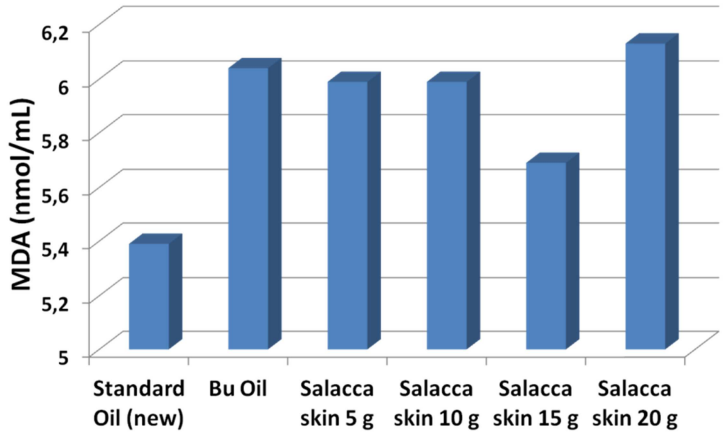

Figure 4.b. Effect on The MDA (Bu Oil)

FTIR Analysis

Based on FTIR spectra as shown in Figure 5.a and 5.b, we obtained the common peaks of hydroxil (−OH) and methyl ($-CH_3$) functional groups. FTIR also resulted some specific bands which might play the role of chemical interaction between oil compounds and active sites of *salacca* skin powder and such as; 1735.59 cm^{-1} indicated the C=O stretch of aldehydes, esters and saturated aliphatics; 1636.25cm^{-1} attributed to N−H bend of primary amines; 1513.10 cm^{-1} assigned to N−O stretch of nitro compounds; and 1258.00 cm^{-1} indicated the C−N stretch of aromatic amines.

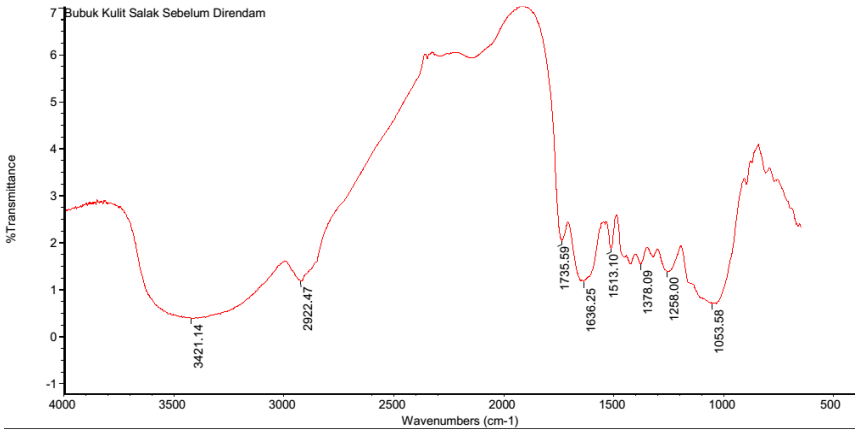

Figure 5.a. FTIR spectra of *salacca* skin before batch treatment

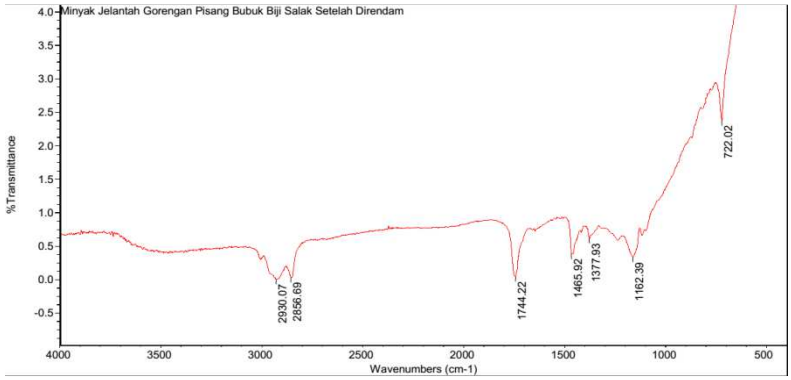

Figure 5.b. FTIR spectra of *salacca* skin after batch treatment

SEM Analysis

Based on the SEM images as shown in figure 6.a and 6.b, surface morphology was slightly changed due to immersion of *salacca* skin powder in batch treatment. The surface of *salacca* skin powder become more expanded, swelled and bigger pores.

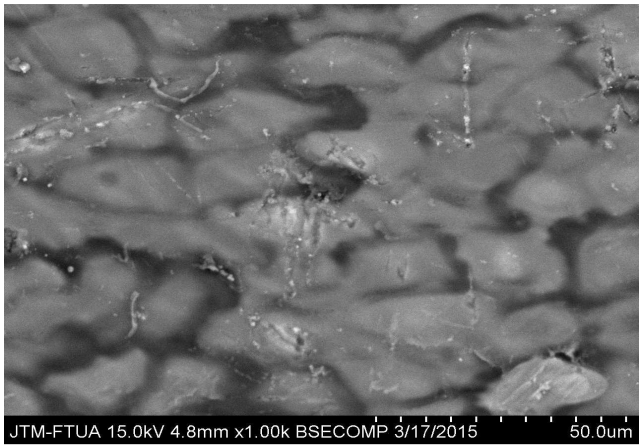

Figure 6.a. SEM images of *salacca* skin before batch treatment

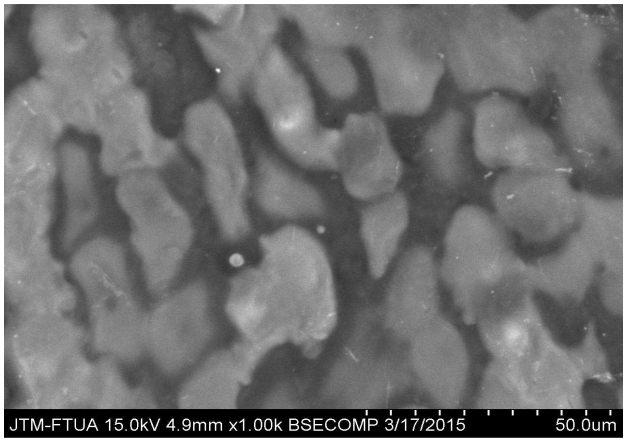

Figure 6.b. SEM images of *salacca* skin after batch treatment

CONCLUSION

Based on experimental data, we conclude that the powder of *salacca* skin has potential ability to reduce the values of total cholesterol, LDL and MDA of waste cooking oils after treatment. The utilization of abundant waste agricultural products such as *salacca* skin may improve the health quality of oil consumption and avoid a large number of disposable oil or environmental pollution.

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