# The Recovery of Used Palm Cooking Oil Using Bagasse as Adsorbent

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***Abstract*** *- The use and reduce cooking oil is a common phenomena in our society. While some of this cooking oil is further refine most of it however and not subject to any filtration in the refining process medium such as carbon active, silica are commonly use. However the used of bagasse as adsorbent is not common. This is odd especially when structural component of bagasse which is made up of carbon material is suitable as adsorbent and the fact that, adsorbent bagasse further reduce solid waste disposal, and hence reducing one source of environmental pollution. This study was undertaken to explore the possibility of using bagasse as adsorbent. Specifically, bagasse is being experimented to reduce the harmful content such as FFA (Free Fatty Acid) and color density in used cooking oil. The variation of adsorbent weight and contact time are used in this research as parameters to determine the effective time and the amount of adsorbent that should be used in the oil refining process. From the experiment conducted, it can be established that bagasse when use as an adsorbent can reduce FFA to 82.14% which is lower the harmful limit. This result is obtained when using 7.5 gram of bagasse for 60 minutes contact time. Similarly, the color of oil is reduced to 75.67% which is significant and this is base on 10 gram of bagasse with 60 minutes of contact time.*

***Keywords:*** *Bagasse, Adsorbent, Recovery, Used Palm Cooking Oil, Free Fatty Acid, Color density.*

**Nomenclatures**

| | |
|---|---|
| FFA | Free Fatty Acid, in percentage, |
| m | Mass of the test portion, in grams, |
| N | Normality, |
| V | Volume of NaOH, in milliliters, |
| $\alpha$ | Contact time, in minute |
| $\beta$ | Weight of adsorbent, in grams. |

## 1. INTRODUCTION

The continue use and reuse of cooking oil (palm oil) is common in our society today. There are several reasons for this habit. The perception of some people that the food will be more delicious when fried using used oil, and also for economic reasons are most common. During the frying process, oil will experience degradation reactions caused by heat, air, and water, resulting in oxidation, hydrolysis and polymerization. Degradation reaction products contained in this oil will reduce the quality of the oil and cause adverse effects to humans (Bhattacharya, et al. 2008).

The parameters used in measuring the quality of used cooking oil in this research are the Free Fatty Acid (FFA), amount of hydrolysis and the color darker is effect from oxidation. Recycling used cooking oil using adsorbents, such as silica gel, magnesium oxide, aluminum hydroxide gel and activated clay, has been studied before (Lin & Reynolds, 1998;

Miyagi & Nakajima, 2003) for improving the quality parameter of used cooking oil.

This research attempt to explore the use of natural adsorbent made up of bagasse from sugarcane juice waste to recover the used cooking oil. Structural component of bagasse made up from carbon material makes bagasse suitable as adsorbent. From this study can be proven that the bagasse can be used as adsorbent after getting treatment, and can reduce the value of FFA and color density from used cooking oil (Pandey & Carney, 2008).

Recycling of disposed oils and waste products from sugarcane juice into purified frying oil and bagasse to be used as adsorbent are expected to reduce waste disposal problems that are consistent with the current discussion today and decrease the prospect of endangering the ecosystem.

## 2. METHODOLOGY

### 2.1 Design of experiment

In this study SAS (Statistical Analysis Software) is used to determine initial design and analysis of data. There are 2 factors used in this study that is weight and time. Both these factors affect to the used cooking oil refining process. For weight, the maximum weight used was 10 g and the minimum weight is 5 g. While for the time, the longest time is 60 minutes and the fastest is 10 minutes. By entering the weight factor and time, FFA and color as a variable, SAS will provide the experimental design with 13 run.

### 2.2 Materials and equipment

The materials used are derived from waste from sugarcane juice (bagasse) usually obtain from stall selling sugarcane juice. The used cooking oil on the other hand is based on cooking oil that has been condition by the researcher. Activation of bagasse will be using NaOH solution. The instrument used is a Whatman filter paper # 41, Thermometer, Rotavapor R-210 BUCHI Switzerland, Spectrophotometer Thermo scientific Genesys 20, Chemical laboratory support equipment Such as mixers, electric stove, Erlenmeyer, pipettes drops, balance sheet measures, and weights

### 2.3 Design of Experiment

This experiment involves two main stages, adsorbent bagasse making process and used cooking oil refining using bagasse adsorbent. The success of bagasse as an adsorbent can be seen by comparing the value of FFA and color density of the new cooking oil, used cooking oil and cooking oil after treatment with the bagasse adsorbent.

The Flowchart below illustrates the stages of research:

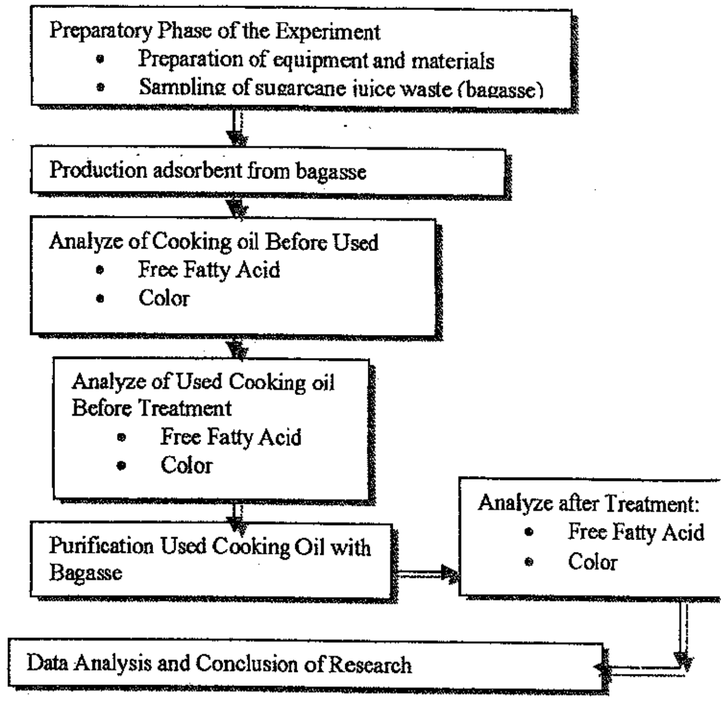


*Figure 1: Flow Chart of Experiment*

### 2.4 Preparation of bagasse adsorbent

There are several steps must be done before the activation of bagasse. Bagasse fibers must have been washed with water to remove sand, soil or other regulators. After that bagasse fibers that have been dried milled with a grinder into powder and sifted to obtain a diameter of < 600 μm.

To activate bagasse, heat the bagasse at 200 °C for 120 minutes in oven. Activated the heated bagasse with NaOH solution and then heated again for another 1.5 hours. Filter the mixture and then to heat them again at 200 °C for 90 minutes.

### 2.5 Preparation of Used Cooking Oil

Cooking oil that has been used for frying will experience color change, turbidity, and odor, which means reduce of quality (Richard D. O'Brien, 2009). In this research, the used cooking oil which will be purified has been used in 3 times of frying, to fry potatoes, chicken and dried fish. Cooking oil that has been used for cooking three different foods have become very murky, dark colored and has the smell terrible. The most extreme cooking oil changes occurred after the cooking oil used to fry the fish dry.

## 2.6 Purification Used Cooking Oil.

There are 2 factors that affect the oil refining process in this research, the weight and contact time. Weight is, how much we used bagasse adsorbent for the purification, and the contact time is, how long it taken to mixing adsorbent with used cooking oil.Method of oil purification with adsorbent according to Yustinah, 2009 research is described in the flowchart below.

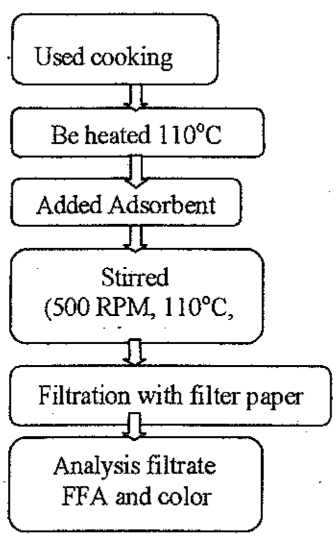


*Figure 2: Flow Chart of Used Oil Purification Process*

## 2.7 Determination of FFA.

About 28.2 g well mixed oil add with 50 ml hot ethyl alcohol and 1 % phenolphthalein. The mixture was titrated with 0.1 N NaOH with vigorous shaking until a permanent faint pink appeared and persisted at least for 1 minute (AOCS, 2009). The FFA content is calculated as percentage of oleic acid by using Equation 1.

$$\% FFA = (V \times N \times 28.2) / m \quad ...... \quad (1)$$

Where, m is the mass of the test portion, in grams, N the normality of NaOH, and V the volume of NaOH consumed, in milliliters.

## 2.8 Color

Determination of color differences using the reading level is shown by a spectrophotometer thermo scientific genesys 20, absorbance at 570 nm.

## 3. RESULTS AND DISCUSSION

This research used natural adsorbents which are made by bagasse from the waste of sugarcane juice to recover the used cooking oil. Bagasse is a waste from utilization of sugarcane. Constituent structures of bagasse derive from carbon material that makes bagasse suitable to be an adsorbent (Budiono, 2009). From the 177 grams of bagasse was activated to produce 66.39 grams. This is a severe reduction of 62.5% due to the heating process. 150 ml used cooking oil was mixed with various weight of adsorbent which is predetermined and then continued with the purifying process at various contact time as determined.

Based on established experimental design, FFA values obtained are:

Table 1: FFA Value and Percentage of Reduce

| No | Time | Weight | ml Naoh | FFA (%) | % reduce |
|---|---|---|---|---|---|
| 1 | New Cooking oil | | 0.2 | 0.0182 | control |
| 2 | Used Cooking oil | | 1.4 | 0.1271 | - |
| 3 | 10 | 5 | 0.6 | 0.0545 | 57.1 |
| 4 | 10 | 10 | 0.6 | 0.0545 | 57.1 |
| 5 | 60 | 5 | 0.35 | 0.0318 | 75.0 |
| 6 | 60 | 10 | 0.3 | 0.0272 | 78.6 |
| 7 | 10 | 7.5 | 0.5 | 0.0454 | 64.3 |
| 8 | 60 | 7.5 | 0.25 | 0.0227 | 82.1 |
| 9 | 35 | 5 | 0.5 | 0.0454 | 64.3 |
| 10 | 35 | 10 | 0.5 | 0.0454 | 64.3 |
| 11 | 35 | 7.5 | 0.4 | 0.0363 | 71.4 |
| 12 | 35 | 7.5 | 0.45 | 0.0409 | 67.9 |
| 13 | 35 | 7.5 | 0.4 | 0.0363 | 71.4 |
| 14 | 35 | 7.5 | 0.45 | 0.0409 | 67.8 |
| 15 | 35 | 7.5 | 0.4 | 0.0363 | 71.4 |

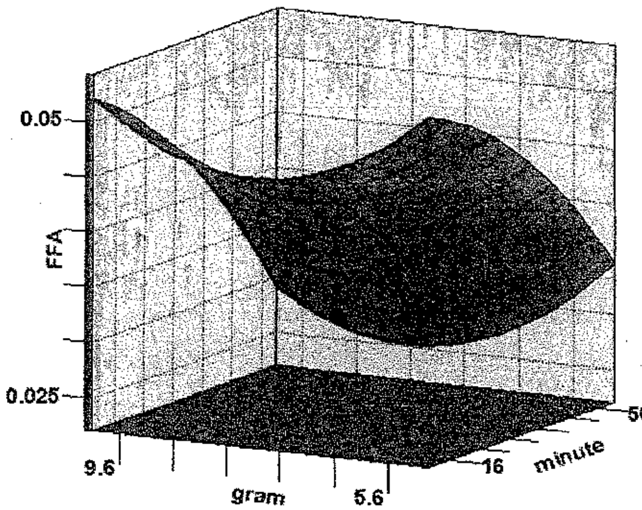


*Figure 3: The Relationship between weight, time and FFA*

Through the chart above, can be seen the relationship of weight adsorbent, with the length of contact time. At the same weight with different time variations, the curve that forms a smooth arch, which progressively decreases. This means that the longer the contact time is used, then the FFA obtained tend to be smaller. This shows that the length of time factor, affecting the level of impairment of FFA. In this study, the longest contact time is 60 minutes, which showed the highest FFA impairment compared with other times.

On the other hand at the same time variation, with the use of different adsorbent weight, found a curve which tends to curve toward the center. In general, the curve shows the use of more adsorbent bagasse not necessarily able to reduce the value of FFA.

Through variation of the existing weight of 5, 7.5, and 10 g, can be seen from the weight 5-7.5 g, a decline in the value of FFA significantly, while the weight 7.5-10 g value obtained by the more elevated FFA. This shows there is weight effective for bagasse adsorbent to be able to recover the used cooking oil better; use an adsorbent which more and more is not necessarily able to reduce the FFA is higher. This is because there are number of saturation use of adsorbent, where the saturation rate was the turning point limits adsorbent to adsorb completely.

The maximum standards for FFA value in the cooking oil released by PORAM (Palm Oil Refiners Association of Malaysia) for RBD (Refined, Bleached, Deodorization) Palm Oil is 0.1%. Base on this standard, treated used cooking oil at various condition resulted in the allowable limits. The highest percentage reduction of FFA is obtained at 60-minute contact time and 7.5 grams adsorbent used, producing a reduction to 82. 144%.

The experiment also proof that weights variation of bagasse used is of no significant. This is as per the table below.

Table 2: ANOVA for FFA

| No | Source | Pr>F |
|---|---|---|
| 1 | Time | <0.0001 |
| 2 | Weight | 0.3888 |
| 3 | Time x Weight | 0.2976 |

The Optimization Result of FFA supported by SAS, states that the titration reading be in units smaller than 0.05 ml. This will produce accurate results and prove the significance of data. However, results obtained in the study are based on units of 0.05, which reduces the accuracy, and this is due to the limited equipment available.

### 3.1 Predictive Models

From the data obtained. If time is $\alpha$, $\beta$ is weight so the value of FFA is:

FFA= $0.1134 + 0.000073\alpha - 0.017886\beta - 6.01\ E\text{-}6\alpha^2 - 0.000018\ \alpha\ \beta + 0.001215\ \beta^2$... (2)

### 3.2 Color

Changes in the color of cooking oil are perceived as indicating poor-quality product, regardless of the reason or effect upon performance (Richard D. O'Brien, 2009). Used cooking oil have golden brown color and cloudy before treatment. Used of weight variation and time gives a different effect on each sample. The data obtained from the measurement of color density through absorbance spectrophotometer readings are:

Table 3: Level of Color Density

| No | Time | Weight | Absorbance | % reduce |
|---|---|---|---|---|
| 1 | New Cooking oil | | Blank | Blank |
| 2 | Used Cooking oil | | 0.037 | .- |
| 3 | 10 | 5 | 0.017 | 54.054 |
| 4 | 10 | 10 | 0.019 | 48.649 |
| 5 | 60 | 5 | 0.017 | 54.054 |
| 6 | 60 | 10 | 0.009 | 75.676 |
| 7 | 10 | 7.5 | 0.016 | 56.757 |
| 8 | 60 | 7.5 | 0.01 | 72.973 |
| 9 | 35 | 5 | 0.017 | 54.054 |
| 10 | 35 | 10 | 0.013 | 64.865 |
| 11 | 35 | 7.5 | 0.013 | 64.865 |
| 12 | 35 | 7.5 | 0.014 | 62.162 |
| 13 | 35 | 7.5 | 0.013 | 64.865 |
| 14 | 35 | 7.5 | 0.012 | 67.568 |
| 15 | 35 | 7.5 | 0.013 | 64.865 |

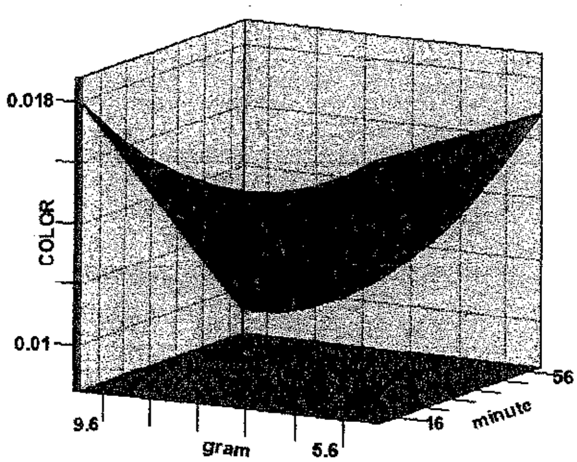


*Figure 4: The Relationship between weight, time and color*

Through the above curve can be seen a decreasing trend graph, with increase in the value of weight and time. This shows the more of weight adsorbent used, the value of color density could decrease, as well as the longer the contact time is used then the color density will be lower. This means the addition of weight and contact time affect the level of color density decreased.

Base on the analysis as illustrated above, it can be seen that the highest reduction of color density is when 10 grams of bagasse is used with a contact time of 60 minutes. Base on ANOVA analysis it can be established that the result obtain are significant. This means that there is effect of weight variation and time on the recovery process used cooking oil.

Table 4: ANOVA for Color

| No | Source | Pr>F |
|---|---|---|
| 1 | Time | < 0.0001 |
| 2 | Weight | 0.0002 |
| 3 | Time x Weight | < 0.0001 |

### 3.3 Predictive Model for Color Density

From the data obtained, if the time is $\alpha$, $\beta$ is weight. The color density can be obtained from equation 3:

$$Color = 0.032233 + 0.000193\alpha - 0.004867\beta - 0.00004\alpha\beta + 0.000373\beta^2 \ldots\ldots\ldots (3)$$

## 4. CONCLUSION

Adsorbent made from bagasse is potential in the process recovery of used cooking oil. The bagasse adsorbent can decrease FFA up to 82.14% and reduce the color density up to 75.67%. From 150 ml of used cooking oil sample, time effective for treatment to reduce FFA and color density is about 60 minutes. The effective weight of bagasse which has been used for the reduction of FFA is 7.5 g, while the reduction of color density level requires 10 g of bagasse adsorbent.

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