

## Original Paper

# Quality Oil for Deep Frying in Foods and Changes Acidity on Various Kind of Oils after Frying

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### **Abstract**

*Human eat a lot of highly acidic and oxidant foods. Acid chemicals and oxidants in food cause harmful to the health. Acid value, free fatty acid and polarities of the fried oil change during cooking for food. Statistical data of fried oils estimate and systematize on three recipes of food (Doughstick, Fish cake and Fried chicken). Their recipes are on the best of sensory evaluation. In each food recipes are selected from market and evaluated by traditional and popular merchant. In the sampling, the experimental model is planned by trial RBCD with factorial  $3 \times 2 \times 3$ . The use of three type oil, two level temperature and three sampling collector are treated on experiments with three recipes. They showed that palm olien oil can change a higher pH than soybean oil and rice bran oil by a statistically significant difference at 95% confidence level. Deep frying by high temperatures and short time have change a quality oil less than low temperatures and long time. Frying in larger quantities and a longer period can change the more acidity and polarities. Quality foods for flavor and healthy oil must no more high and low temperature in cooking.*

### **Keywords**

*Acid value (AV), Acidity, Fried oil and Food frying*

## **1. Introduction**

Cells and tissues of normal body is level pH 7.35. In normal function, the body has been completely absorbed the oxygen for metabolic processes. The body can prevent cancer including the growth of

pathogens, bacteria and fungi. If pH level is more acid the normal cells in the body is misbehaving by more oxygen. In normal tissues can hold oxygen up to 20 times of acidic conditions. If blood develops a more acidic condition the body will inevitably deposit the excess acid. As this cycle continues, the dead cells will then turn into acids. These areas will increase in acidity until some cells die. The body obtains and contains an acid into the cell body. Blood will equillibrate and maintain the acidity. Survivable cell can become the toxic cells. In long time, those cells will be the addition of more acid. Some cells will die by the age of it. Remaining cells become abnormal cells and hazardous toxic cells. If the growth does not stop cells becomes abnormal cells or cancer cells.

Cooking oil help penetrate heat into the food and distribute heat for cooking. The correct frying is necessary to keep the enough high heat and no overheat conduction. Oil heat conduction helps cook quickly. Food is brought in direct with hot oil. Frying is a complex process by heat, mass transfer and chemical reactions change. The food surface becomes golden yellow to dark brown in color and develops a pleasant fried food flavor in the frying process, the food is fried in a layer of oil and fried until completion. Heat turns the internal moisture of food into vapor. The food loss moisture and develop surface color, firm texture, flavor and aroma. The food surface becomes golden yellow to dark brown in color and develops a pleasant fried food flavor.

Extremely cooking is brown according to the time in the recipe. Cooking food with oil take good texture, taste and more appetizing. Food frying makes it palatable and desirable to consumer include texture, fried food flavor. Deep frying is cooked using oil as a medium heat. Cooking food by frying, oil is absorbed and penetrated in context food. The penetration of fried oil is enough to make the food taste better. If food is adsorbed more oil and became oily it will destroy the taste of food. The frying of food must have an understanding of the nature of the oil and type of fried materials. The frying temperature depends on the thickness and type of food. Regulating lies between 175 and 190 °C (345-375 °F). The heat cooks food extremely quickly.

Oil for cooking originate in several major sources. Ability of resistance the change and oxidation of oil in each method are differential reasons. Oil for deep frying, it should be a high smoke point so that high temperature and more long time make change less quality oil. Repeated frying with over high heat, the oil will change the physical and chemical properties by moisture in the food and oxygen from the air. New compounds are occurred such as free acid, polar compounds, polymers, carbonyls, ketones, etc. They may accumulate in the body and harm to the health of consumers. Chemicals in food are acidic in accrued process of cooking will affect the body by exposure with increasing of acidity. Control the pH balance and chemicals are able to resist life-threatening disease and reduce the risk of cancer.

## **2. Materials and Methods**

### *2.1 Experimental Design and Random Sampling for Deep-Fried Oils*

Management and preparation of food recipes to deep frying (Doughstick, Fish cake and Fried chicken) for study the fried oils.



**Figure 1. Raw Material of Oil and Oil for Deep Frying**

Experimental design use management as trial factorial  $3 \times 2 \times 3$  and 2 blocks in experiments by RBCD. Three types of fried oil are soybean, rice bran and palm olein with two levels of high (H) and low (L) temperature. Oil samples after frying are been sampling by batch at three period in sampling level of fried food weight.

#### *2.2 Pick up Oils from Three Food Cooking by Sampling between Deep Frying Processing*

Doughstick recipes are directly selected from a professional merchant. The best recipe is chosen by preference test and sensory evaluation. Standard recipes of dough flour are deep-fried in each oil by two level temperature and period time of frying (180 °C 2 minutes and 160 °C 4 minutes). Frying oil are collected by batch of weight of dough flour at 0.5, 1 and 1.5 kilogram in each interval of sampling.

Fish cake recipes are selected by finished product with spices from a market. They are sensory for the best of ingredient and favorite recipe. Deep-fried oils for Fish cake 7.5 kg, are collected by batch at the end of the weight at 1, 5 and 7.5 kg respectively. Two levels of temperature and frying time are 150 °C for 3 minutes and 130 °C for 5 minutes.

Fried chicken recipes are chosen a testing by one of the most favorite. Marinated spicy chicken deep-fried on two levels of temperature and time as 175 °C 7 minutes and 155 °C 8 minutes. The frying oils of Fried chicken 5 kg. are collected by batch at weight 1, 3 and 5 kg respectively.

#### *2.3 Solvent Extraction on Oil after Process*

Solvent extraction for optimum, the food analysis with a convenient method of separating are made by extract the oil soluble components and other contaminates. Lipid and oil are soluble in three groups of organic solvent. Percentage of polar and nonpolar are 0%, 50% and 100%.

#### *2.4 Polar Compounds (Polar cpds) in Deep-Fried Processing*

Polar compounds are formed during deep frying as a function of process time and product exposure. Sample is filtered through silica column chromatography and eluted with hexane/diethyl ether. Solvent is evaporated and weighted for polar cpds (Gutierrez et al., 1988)

### *2.5 Studying Acid Value and the Quality Oil in Processing of Deep-Fried*

The standard analysis is a general method by AOAC reference. The chosen process for the more better is diethyl ether and ethanol solvent for oil extraction (Kardash & Yakov, 2005). This method is the most reliable to improvement and increase efficiently a high solubility. Quantitative analysis of acidity is acid value and free fatty acid. Sampling the fried oil of cooking process are evaluated on a type of oil, frying temperature, amount of sampling and kind of fried food. Sample oil (1-2 g) is weighted in flask with cover lid and poured a solvent mixture 25 ml of ethyl ether : ethanol (1 : 1). Soluble mixer is filled 1-2 drops of phenolphthalein indicator and titrated with 0.01 N potassium hydroxide in alcohol until the endpoint. Color of mix soluble change no color to pink. The volume of titration calculate as the acidity and compare against the equivalent gram (gm-E) of potassium hydroxide. Acid value and free fatty acid are evaluated on changes an acidity between cooking process.

### *2.6 Color and the Color Changes of Oils*

Measuring color is taken with the Data Color International Measurement model Color Tools. CIE value (Commission Internationale de l'Eclairage) display the color value in CIELAB system L\*(0 = black and 100 = white), a\*(-a\* = green and +a\* = red) and b\*(-b\* = blue and +b\* = yellow) at D65 10Deg (Light source Illuminant D).

### *2.7 Statistical Analysis*

Experimental designs are replicated two treatments in each value. Average values of different parameter by statistical analyses are expressed as the mean and standard deviation. Evaluation of significant difference among the mean values of analysis are conducted using statistical software as SPSS 15.0. Graph and T-test are performed on statistical analysis package of STATISTICA program at 95% confidence level. Identify differences among samples evaluate by Duncan New's Multiple Range Test at significant level  $P < 0.05$ .

## **3. Results and Discussions**

In the frying process of food is brought in direct with hot oil. The food surface becomes golden yellow to dark brown in color and develops a pleasant fried food flavor. Food frying make it palatable and desirable to consumer include texture and fried food flavor. Crispyness colour, flavor and texture are product characteristics of Thai fried foods. Frying is suitable on temperature and time. It make a high quality and identity of food such as appearance, taste and acceptance.



**Figure 2. Three Food Recipes (Doughstick, Fish Cake and Fried Chicken) of Deep Frying**

In three food recipes (Doughstick, Fish cake and Fried chicken) of deep frying by appropriate temperatures and short time have change a quality oil less than overheating and long time. Normally fried food should use an adequate temperature. Quality food for flavor and healthy oil must no more high and low temperature in cooking. The frying temperature depends on the thickness and type of food. Regulating the heat lies between 175 °C and 190 °C (345 °F and 375 °F). It cooks food *completely*. Heat of deep-frying is a complex process by mass transfer and chemical reactions change. Heat turns the internal moisture of food into vapor. The water vapor change bubbles around the food. The foods loss moisture and develop surface color, firm texture, flavor and aroma.

**Table 1. The Parameter of Oil after Deep-Frying for Three Food Recipes**

Parameter	Food Recipes of Deep-frying		
	Doughstick	Fish Cake	Fried Chicken
L	92.50±3.85 <sup>a</sup> – 92.77±5.14 <sup>a</sup>	90.95±3.91 <sup>a</sup> – 91.52±5.21 <sup>a</sup>	88.21±4.04 <sup>a</sup> – 88.77±5.38 <sup>a</sup>
a*	-1.60±0.20 <sup>a</sup> – -1.54±0.10 <sup>a</sup>	-0.55±0.20 <sup>b</sup> – -0.54±0.10 <sup>a</sup>	-8.76±0.10 <sup>a</sup> – -8.76±0.10 <sup>a</sup>
b*	21.14±2.42 <sup>a</sup> – 22.62±1.48 <sup>a</sup>	27.97±3.21 <sup>a</sup> ± 36.49±2.39 <sup>a</sup>	75.18±8.64 <sup>a</sup> – 78.52±5.15 <sup>a</sup>
Viscosity (Cp.)	61.62±1.74 <sup>a</sup> – 62.04±0.78 <sup>a</sup>	60.16±1.78 <sup>b</sup> – 61.18±0.77 <sup>a</sup>	60.63±1.77 <sup>a</sup> – 60.65±0.76 <sup>a</sup>
Acid value	0.81±0.01 <sup>a</sup> – 0.83±0.04 <sup>a</sup>	1.05±0.01 <sup>a</sup> – 1.10±0.06 <sup>a</sup>	0.53±0.05 <sup>a</sup> – 0.55±0.02 <sup>a</sup>
Polar cpds (%)	12.02±1.77 <sup>b</sup> – 12.65±0.78 <sup>a</sup>	11.67±1.71 <sup>a</sup> – 12.17±0.72 <sup>a</sup>	11.62±1.71 <sup>a</sup> – 11.83±0.75 <sup>a</sup>

*Note.* <sup>a,b</sup> are the vertical meanings in different alphabets and have significantly the differences at 0.05 level.

Table 1 shows the average parameter and standard deviation of fried oil by different temperature in three food recipes of deep-frying. Color oil after frying of Fried chicken has more dark than Fish cake and Doughstick. Viscosity and polar compounds are the highest for doughstick. Fish cake has a high

changing of pH and the highest amount of acid value in three food recipes.

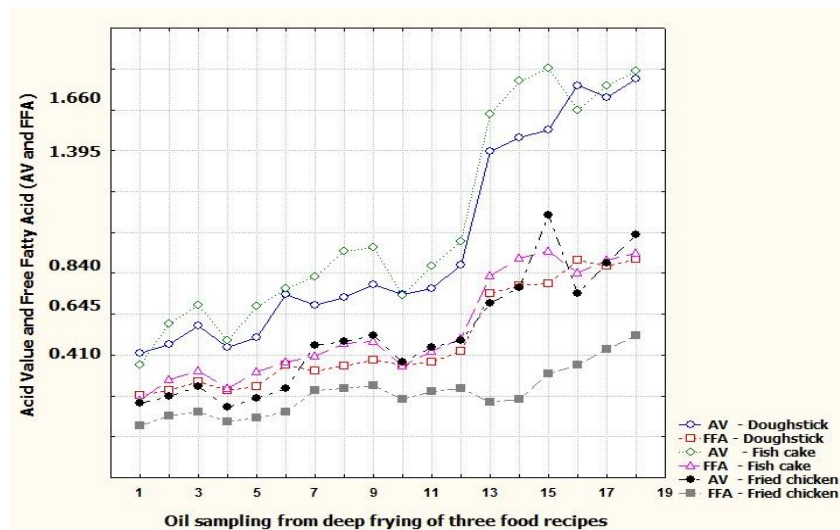
Acid value and free fatty acid obtained as a result of the breakdown of the total fried oil. Measurement of free acid in the fryer oil indicates the degradation. In the experiments, extraction technique with solvent is chosen one of the best of efficiency in all matrices. Conditions are fluctuation in control and comparison of extraction. Selection the best solubility of extract help decrease the interference of determining the total acidity in lipid contents of food. Normally the free fatty acid content in the fryer oil 0.25% to 0.4% for most snack food products and it allowed to go up > 0.5% in the fryer. If oils contain 2% free fatty acid the oil will begin to oxidize. Increasing of acidity during frying can evaluate as destroy oil and the broken bonds of molecule to free acid.

**Table 2. The Free Fatty Acid (FFA) of Fried Oil after Deep Frying by Different Temperature in Three Food Recipes**

Oil for Frying	Temperature Level	Intervals of Sampling	Deep-fried of Food Recipes		
			Doughstick	Fish Cake	Fried Chicken
			FFA $\pm$ SD	FFA $\pm$ SD	FFA $\pm$ SD
Rice bran oil	H	1	0.2050 $\pm$ 0.0021	0.1772 $\pm$ 0.0006	0.0552 $\pm$ 0.0005
		2	0.2250 $\pm$ 0.0021	0.27875 $\pm$ 0.0016	0.1006 $\pm$ 0.0002
		3	0.2700 $\pm$ 0.0028	0.3226 $\pm$ 0.0017	0.1230 $\pm$ 0.0002
	L	1	0.2250 $\pm$ 0.0007	0.2370 $\pm$ 0.0003	0.0723 $\pm$ 0.0001
		2	0.2450 $\pm$ 0.0007	0.3201 $\pm$ 0.0001	0.0945 $\pm$ 0.0001
		3	0.3500 $\pm$ 0.0008	0.3640 $\pm$ 0.0001	0.1196 $\pm$ 0.0002
Soy bean oil	H	1	0.3250 $\pm$ 0.0016	0.3947 $\pm$ 0.0012	0.2494 $\pm$ 0.0016
		2	0.3450 $\pm$ 0.0013	0.4563 $\pm$ 0.0012	0.2356 $\pm$ 0.0010
		3	0.3750 $\pm$ 0.0011	0.4647 $\pm$ 0.0007	0.2260 $\pm$ 0.0006
	L	1	0.3500 $\pm$ 0.0016	0.3486 $\pm$ 0.0021	0.2376 $\pm$ 0.0012
		2	0.3650 $\pm$ 0.0015	0.4203 $\pm$ 0.0013	0.2207 $\pm$ 0.0007
		3	0.4200 $\pm$ 0.0017	0.4802 $\pm$ 0.0009	0.1838 $\pm$ 0.0001
Plam oil	H	1	0.7500 $\pm$ 0.0017	0.7865 $\pm$ 0.0007	0.3085 $\pm$ 0.0036
		2	0.7400 $\pm$ 0.0014	0.8719 $\pm$ 0.0002	0.1819 $\pm$ 0.0020
		3	0.7000 $\pm$ 0.0008	0.9062 $\pm$ 0.0001	0.1685 $\pm$ 0.0019
	L	1	0.8650 $\pm$ 0.0009	0.8041 $\pm$ 0.0009	0.4963 $\pm$ 0.0002
		2	0.8700 $\pm$ 0.0013	0.8633 $\pm$ 0.0006	0.4261 $\pm$ 0.0003
		3	0.8350 $\pm$ 0.0009	0.8995 $\pm$ 0.0004	0.3535 $\pm$ 0.0002

*Note.* (H,L) mean the level high (H = 180-190 °C) and low (L = 150-160 °C) of temperature usage deep frying in each food.

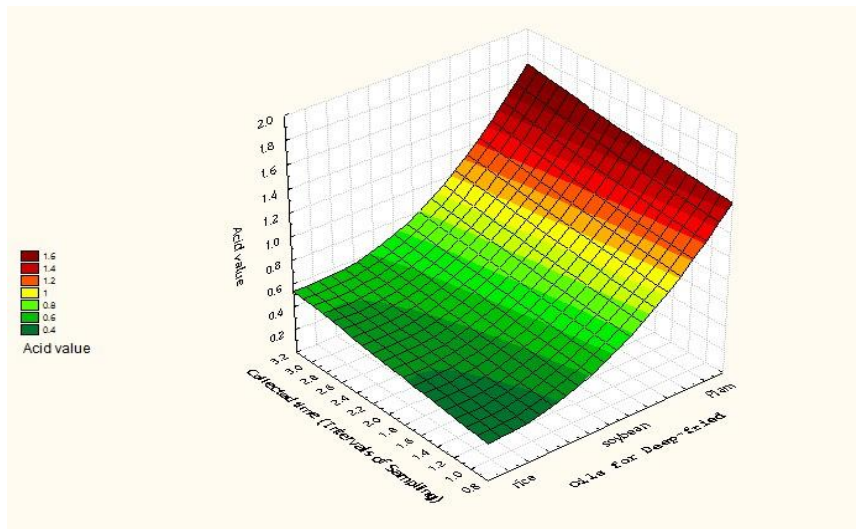
In a batch fryer, the oil is heated directly with an external heater. The food is fried in a layer of oil and fried until completion. Fried products are removed the excess oil through a drain device. Frying oils are collected by batch in three Intervals of sampling. They have free fatty acid (FFA)  $\pm$ SD by the kinds of oils in each deep-fried food on Table 2.



**Figure 3. Changing Acid Value (AV) and Free Fatty Acid (FFA) by Sampling the Deep Fried oil in Three Food Recipes**

Frying oil of Doughstick are been sampling with high and low temperature. Deep-frying of Doughstick must slowly penetrate heat so that crispiness and browning are spread out and change an equability. Frying of Doughstick at high temperature must use short time in order that fermented flour do not have a burn and hardness.

Changes the acidity of deep-fried oils are orderly made the descending as Doughstick, Fish cake and Fried chicken. The use of three type oils are deep-fried with foods at high temperature. Palm olein oil increase an acidity more than rice bran oil and soybean oil. Changing of AV and FFA are quickly when cooking deep-fried with more long time. They have range of acid value (max-min) and free fatty acid (FFA  $\pm$ SD) in table. AV and FFA of sampling oil in all of foods have significantly difference at  $\alpha=0.01$ . Graph show the acid value in three type of fried oils. Frying with the high temperature and short time of them have less the acid value and free fatty acid. Deep frying of Doughstick is both the more high temperature and the more quantity flour. It is different the ascending values of AV and FFA by a statistically significant difference at 95% confidence level. Frying oil for Doughstick by palm olein oil, soy bean oil and rice bran oil have mean and standard deviation of the acid value and free fatty acid as  $1.58 \pm 0.22$ ,  $0.72 \pm 0.22$ ,  $0.50 \pm 0.11$ , and  $0.79 \pm 0.11$ ,  $0.36 \pm 0.11$ ,  $0.25 \pm 0.05$  respectively. AV and FFA of palm olein oil are the highest average. Fried oil of Fish cake change the AV and FFA more than Doughstick and Fried chicken. Graph show the acid value (AV) and free fatty acid (FFA) in three kinds of fried oil. Palm olein oil change the acidity more than soy bean oil and rice bran oil respectively.



**Figure 4. Increasing the Acid Value of Three Oils at Different Collected Time in Deep Frying**

Three sampling of frying oil in two level temperature show increasing of acid value by more long time. The deep frying in a great amount of fried foods can made change more acidity. The three sampling of deep frying oil by low and high temperature for all foods increase the acidity respectively. The mean average in each weight period of sampling oil have difference significantly at = 0.05.

The maximum level for acid value of edible fat and oil were established by the administration of public health at 0.6 (Unit of AV = mg KOH/1 g oil for refined fat and oil). The oil degradation cause loss a nutritional value and the destruction of essential fatty acid. Consuming of the deteriorated oil get acid components and toxic products. Normally ratio of alkaline-acid food for consumption should be about four to one, or eighty percent as alkaline foods and twenty percent as acid foods for a healthy body. Experts recommend health by balance body with acid and alkaline foods. The evaluation on the acidity of fat and oil should develop and control a quality of cooking oils for consumer health.

#### 4. Conclusions

Fat and oil are a nutrition and a high source of energy in five main foods. They release nine calories per gram and dissolve a necessary vitamins. Oils which help distribute heat in cooking of fried food make increase browning, crispy and flavor food. The use of fat and oil for cooking food take effect to healthiness and unhealthiness. Acid value was used to assessment the degradation of frying oil. It is often a measure of the break down of triacylglycerols into free fatty acids and other free acid, including new compounds such as free acid, polar compounds, carbonyls, ketones, etc. The amount of free acids and volatiles are related to the quality of fried food.



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