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Analyzing the bleaching effects of activated carbon produced from natural coal on soyabean oil and Goya olive oil

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Abstract

Many contaminants, such as phosphatides, mucins, free fatty acids, dyes, and compounds that impact the color and odor, are present in crude fats and oils in variable concentrations. The standard chemical refining process removes these contaminants at numerous stages, including activation, carbonization, filtration, absorption, degumming, neutralization, and bleaching. While degumming is done to remove phosphatides so that hydratable phosphatides can be precipitated by adding water to the oil, non-hydrated phosphatides must be eliminated by adding acids, activation is done to open up the pore structure of the activated carbon. Additionally, free fatty acids are eliminated through neutralization with alkali hydroxides, producing soaps that can be eliminated, and undesirable colored impurities are eliminated through bleaching with an adsorptive reagent. Subsequently, the unwanted compounds are adsorbed and can be eliminated along with the adsorbent through filtration. Then, bleaching is done to get rid of color and unwelcome volatile and odiferous elements because bleaching removes numerous antioxidants. The equilibrium concentration, values for Ce/qc, b, and slopes for soybean oil and goya olive oil were calculated using the Langmuir isotherm equation. $\mathbf{C_e/Q_c = 1.C_e/Q^o + 1/bQ^o}$, Ce = equilibrium concentration, Q_c = percent absorption, $1/Q^o$ = slope, Q^o = adsorption capacity, and b = Langmuir constant. The results of % absorption obtained for soyabean oil are as follows; 86.90, 85.90, 86.90, 79.70, 78.40 and 29.60 while the results % absorption obtained for goya olive oil are 86.10, 84.10, 82.90, 81.80, 77.70, and 77.50 respectively. Based on their near range of adsorption capacities, it was concluded that activated coal was successful in bleaching both soyabean oil and goya olive oil. However, the activated coal had a little higher adsorption capacity on goya olive oil than soya bean oil.

Keywords: Activated carbon; Bleaching; Natural coal; Soya bean oil; Goya olive oil

1. Introduction

The antioxidants included in soyabean oil, such as tocophenols, flavonoids, ascorbic acids, carotenoids, and phytosterols, allow for the efficient recovery of color bodies and phosphatides when they are treated with surface-amorphous silica composition with an acid support. The ability to remove chlorophyll, as well as red and yellow color, is found to be substantially enhanced by the presence of a strong acid in the pores of the silica adsorbent. By applying the acid treatment described here, amorphous silica maintains its natural ability to adsorb phospholipids. The composition uses amorphous silica on which acid has been supported so that the smallest amount of acid is obtained in the silica pores **(Pryor et al; 1985)**. The following steps are included in a method for treating crude soyabean oil that contains calcium and magnesium and is extracted from soyabeans mechanically: mixing the crude oil with water or an acidic aqueous solution to create gums of hydratable phospholipids; separating the gums from the crude oil to obtain first treated soyabean oil; and thoroughly mixing the first treated oil with a basic aqueous solution to create soap stock that contains calcium and magnesium. Long-term storage of unsold olive oils causes them to undergo hydrolysis, which results in a high degree of acidity and a decrease in the product's value. Just bare minimum maintenance is required

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during the storage time to sustain the changes in oil quality. Recovering the economic worth of olive oil as a food product and/or lowering the disposal of the older unsold oil products in the economics of oil production are both facilitated by the deacidification process, which is one of the refining procedures to reduce free fatty acids (FFAs). Free fatty acids (FFAs) in deteriorated vegetable oils have been reduced using a variety of techniques, such as physical refining based on distillation and chemical refining using sodium hydroxide. Free fatty acids (FFAs) have also been shown to be lowered utilizing a membrane cell and various substances, including ethanol and methanol **(Cvengros; 1995)**. These methods could be successful in lowering free fatty acids (FFAs), but they also require a lot of energy and money to run**.** With these methods, both useful and undesirable non-glyceride components are lost **(Gotor and Rhazi; 2016)**. So, it is possible to realize the use of charcoal or activated carbon to prevent the use of such chemicals in the deactification of olive oil. Many investigations have reported the capacity of charcoal for adsorption **(Hille and Den ouden, 2005; ou et al; 2007; Melville et al; 1980)**. The capacity of charcoal to adsorb unwanted elements from a solution has led to its application. Activated carbon or charcoal made from natural coal is particularly affordable, accessible, and widely used in a variety of applications **(Asada et al., 2002; Kuti et al., 2008)**, making it a practical purification method even though chemical refining is a highly energy-intensive process that uses both purchased energy and by-product streams from the refining processes **(Geankopolis et al; 2018)**. This study used the Langmuir Isotherm method to examine how soybean oil and goya olive oil responded to the bleaching effects of activated carbon generated from natural coal.

2. Material and methods

2.1. Carbonization/Activation process

The sample (natural coal) that was taken from the coal site at Emene in Enugu State was ground to pass through a 3mm sieve and was retained in a 1.5 mm sieve. The raw material sample weighed 537.87 g. 100 ml of 35% phosphoric acid were added to 200 g of natural coal after it had been weighed out. In order for the activation ingredient to function correctly, the mixture was well mixed using a glass rod and left for 24 hours. After 24 hours, the mixture was drained and dried for roughly 4 hours in a machine working between 60 °C and 80°C. At a temperature of roughly 500 ^{0}C, the sample was carbonized in a muffle furnace (2 hrs). After allowing the sample to cool, distilled water was used to wash it until the pH of the water was neutral or nearly neutral. The sample was dried at 105 °C for 4 hours, and then it was crushed and sieved once more to achieve tiny particles for adsorption purposes. It was then stored in an airtight container for 24 hours.

2.2. Filtration Process

Filter paper was used to filter the sample (natural coal) after it had been diluted with distilled water. To gauge the filtrate's level of acidity or alkalinity, litmus paper was used as a test. Once a pH level of 5 to 6 was reached, the filtration process was performed a further six times. As a result, the remaining activated carbon was gathered, dumped on a drying pan, and placed in an oven to dry at 105 °C for four hours.

2.3. Absorption process

To examine the variations in their absorbance, the activated carbon from natural coal was put through a distinct absorption method. Against 10mls of the affluent in each case, six distinct grams of 0.5g, 1.0 g, 1.5 g, 2.0 g, 2.5 g, and 3.0 g were absorbed.

2.4. Degumming

Degumming was carried out using 500 ml of hot water heated to 100 ^{0}C, 500 ml of oil (soya bean oil and goya olive oil respectively), and a separating funnel. The operation was repeated until clear water was visible behind the oil layer.

2.5. Neutralization

Soya oil and goya olive oil which had been 60 percent degummed, were neutralized separately at 800 °C for about 10 minutes, after which 10 ml of 0.1 M NaOH and 6 g of NaCl were added to the oils. As soon as NaOH is added to the oil, it starts to catalyze, creating soap (triglyceride). To remove the soap, more hot water was added to the oils. This process was continued until the oils were free of soap.

2.6. Bleaching process

Measured amounts of 0.5 g, 1.0 g, 1.5 g, 2.0 g, 2.5 g, and 3.0 g of activated carbon were added to 10 ml of the neutralized oils and vigorously agitated before being added to the beaker and boiling for 30 minutes (the essence of the activated carbon was to adsorb the colour). After heating, cotton wool was used to filter the oil into a conical flask.

2.7. Readings using Ultra Violet (UV) spectrophotometer

The absorbance and concentration of a sample are measured using a UV spectrophotometer. Before use, the UV spectrophotometer was turned on and left running for around 30 minutes while the oils (soyabean oil and goya olive) were added to a 5 cm covet and a buffer solution was added to another covet. The two oil samples' absorbance and concentration were measured after 30 minutes. When the buffer solution (Acetone) and oil samples were added to the covet, the reading code was changed to 10 %, and water-proof material was used to cover the covet to stop light from penetrating the oil samples. The water-proof substance was subsequently removed once the reading code was changed to 0 %. The handle of the UV spectrophotometer was raised to read the absorbance, and the mode was activated to read the concentration.

2.8. Adsorption Isotherm and Langmuir Equation

In contrast to adsorption, which is the accumulation of solute molecules at a solid's surface, adsorption capacity is the concentration of a fluid component (in the gas or liquid phase) on the surface of a solid. The Langmuir isotherm was used to predict the adsorption capacity of the oil samples (soyabean oil and goya olive oil) utilized in this study. An isotherm of adsorption is a graph that illustrates the variation in the amount of adsorbate adsorbed on the surface of the adsorbent with the change in pressure at constant temperature. $\mathbf{C_e/Q_c = 1.Ce/Q^o + 1/bQ^o}$ is provided as the Langmuir isotherm equation where C_e = equilibrium concentration, Q_c = percent absorption, $1/Q^0$ = slope, Q^0 = adsorption capacity, and b = Langmuir constant.

2.9. Analysis

2.9.1. Percentage Absorption of soya bean oil and goya olive oil using activated coal

The % absorption for the two samples of oil (soyabean oil and goya olive oil) were calculated using the formula; qc = C_o – C_e/ C_o X 100/1, where C_o and C_e are absorption before adsorption and absorption after adsorption thus; the % absorption for soya bean oil and goya olive oil adsorbed by activated coal were calculated and recorded in tables 1, 2 and 3 respectively.

3. Results and discussion

The table 1 below shows the result of absorbance, % absorption and concentration of soya bean oil and goya olive oil adsorbed by activated carbon produced from natural coal (activated coal) using ultra violet (UV) spectrophotometer thus; the lower the weight of concentration, the higher the absorbance while table 2 also showed the values obtained from concentration/%absorption for soya bean oil and goya olive oil and table 3 presents the results obtained from slopes, intercepts and Langmuir constants for both sample oils respectively, which is an indication that activated coal is more effective at bleaching goya olive oil than it is at bleaching soya bean oil.

Table 1 Table of values for activated carbon obtained from natural coal

Weight of Concentration Of adsorbents (g)	Soya bean oil			Goya olive oil		
	Absorbance	Conc. (Mg/l)	% Absorption	Absorbance	Conc. (Mg/l)	% Absorption
3.0	0.10	10.20	86.90	0.10	10.10	86.10
2.5	0.11	10.90	85.90	0.12	11.50	84.10
2.0	0.10	10.10	86.90	0.12	12.40	82.90
1.5	0.16	15.70	79.70	0.13	13.20	81.80
1.0	0.17	16.80	78.40	0.16	16.20	77.70
0.5	0.55	54.60	29.60	0.16	16.30	77.50

Table 2 Table of values obtained from weight of concentration/% absorption (C_e/q_c)

Activated Coal	
Soya bean oil	**Goya olive oil**
0.035	0.035
0.029	0.030
0.023	0.024
0.019	0.018
0.013	0.013
0.017	0.001

Table 3 Table of results obtained from Slope, Intercept, and Langmuir constant (b) for soyabean oil and goya olive oil adsorbed by activated coal

Activated coal			
Samples of oil	**Slope($1/Q^0$)**	**Intercept ($1/bQ^o$)**	**Langmuir constant (b)**
Soyabean oil	0.01	0.004	0.4
Goya olive oil	0.01	0.006	0.6

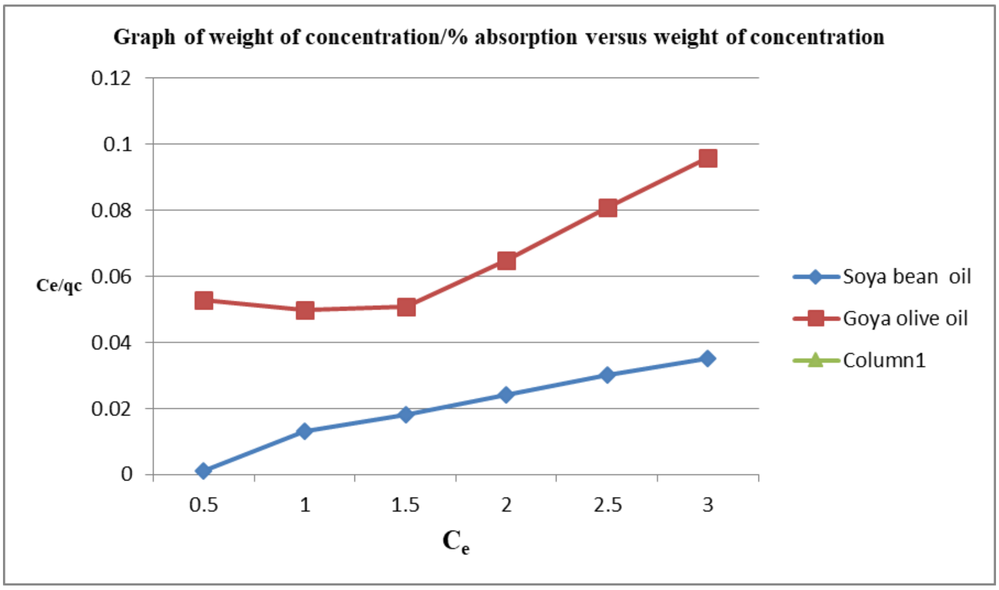

Figure 1 Graph of weight of concentration/% absorption versus weight of concentration for soyabean oil and goya olive oil adsorbed by activated coal using Langmuir equation; $C_e/q_c = 1.C_e/Q^o + 1/bQ$

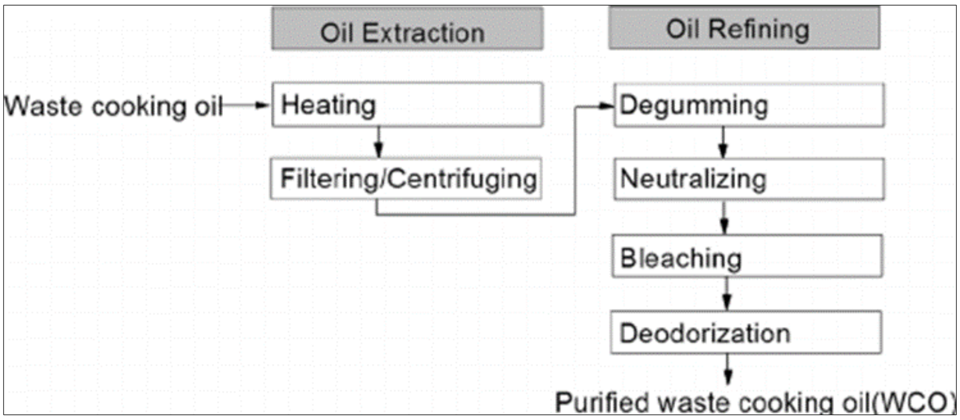

Figure 2 Diagrammatical representation of steps involved in refining edible oil

4. Conclusion

The effectiveness of activated coal in bleaching soya bean oil and goya olive oil was validated by this study. Additionally, it was found from the results table and graph that goya olive oil has a little bit higher capacity for adsorption than soya bean oil, which also suggests that goya olive oil has a little bit higher purity percentage than soya bean oil. As a result, according to the experiment that was conducted and the data provided, activated coal is more effective at bleaching goya olive oil than it is at bleaching soya bean oil.

Recommendation

Further research work should be carried out on the adsorption capacity of soya bean oil and goya olive oil using activated carbon produced from other carbonaceous materials such as sawdust (wood).

Compliance with ethical standards

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Disclosure of conflict of interest

The authors of this research work declare that there is no conflict of interest.

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