Using of Activated *Jurdiga* for Bleaching of Sunflower Edible Oils

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Ayat M. Mustafa[1] and Elnur K. Abusabah[1]
Department of Food Engineering and Technology, Faculty of Engineering and Technology, University of Gezira.

ABSTRACT

Bleaching process is cost intensive process for the refining vegetable oils and this is due to the consumption of bleaching earth which is imported from abroad which contributes in raising the total operating cost of the process. The objective of this study is to investigate the possibility of using activated jurdiga to bleach edible oils to meet the local demand and lower production cost. Jurdiga was brought from Um-Shoka area in Sennar State, Sudan. The chemical composition of jurdiga was determined. The analysis of jurdiga revealed high total sodium carbonate equal to 24 % and sodium bicarbonate equal to 20%. Jurdiga was crushed and was activated by 5%, 5%, 10% and 20% of concentrated H_2SO_4 () . The bleaching efficiency of the produced activated jurdiga for bleaching of sunflower oil was investigated by adding various dosages of 1.5, 2.5, 3.5 and 4.5 grams of activated Jurdiga at temperatures of 80°C, 100°C and 120°C and compared with commercial fuller earth. The conditions that gave best results for the sulfuric acid activation and bleaching test was found to be 10% acid concentration, 4.5 grams of activated jurdiga at 120°C for 70 gram of oil. The bleaching efficiency of the activated jurdiga was 70 %. This result is compararable with commercial fuller earth which has 90% bleaching efficiency. Key words: Bleaching, Fuller earth, Activation, Jurdiga, Edible oils.

INTRODUCTION

Sudan produces edible oils from different oil seeds. Oilseeds crop rank second after cereals in area and total production. The country's oilseed production rests mainly on sesame (*Sesame indicum L.*), groundnut (*Arachishypogaea L.*) and cotton seed (*GossypiumhirsutumL.*), while sunflower has been introduced recently into the cropping sequence. Sunflower is a promising oilseed crop in Sudan (Mohamed, 2010). The main aim of the refining processes is to convert the crude oil to a quality edible oil by removing objectionable impurities to the desired levels in the most efficient manner. Bleaching treatment is a critical step and the conditions for bleaching depend on the type of crude oil and its quality. The main task of bleaching is the removal of color pigments and the decomposition of hydro-peroxides. This increases the shelf life and value of the product. Bleaching is carried out on dehydrated fat and oil by bringing them into contact under given conditions of temperature, time and pressure with powdered bleaching material (earth or carbon) which is applied after degumming and neutralization in the chemical refining. The process of bleaching is more appropriately referred to as adsorption treatment (Bernardini, 1983). Bleaching clays are used for bleaching process. Natural clays, activated earths, synthetic silicates and carbon black are the basic kinds of materials used in edible oil bleaching. Bleaching earths like bentonites, consist mainly of crystalline silicate of aluminum with various amounts of alkali metals and transition metals. Compared to naturally active clays, activated bleaching earths indicate higher activity. Therefore acid treatment is applied to natural clays to enhance its adsorptive properties. The activation is usually done with mineral acids (hydrochloric acid or sulfuric acid). The desired changes in the physicochemical properties of clay occurring as a result of acid activation depend considerably on the condition of acid activation such as acid concentration, the duration and temperature of the activation process. Acid activation is a complex process and involves a series of chemical reactions, resulting in strongly protonated clay mineral surface and increased specific surface area. Activation proceeds with partial dissolution of bentonites and includes an initial replacement of exchangeable cations by protons (H^{+}): the Al^{3+}, Fe^{3+}, and Mg^{2+} and cations are removed from octahedral and tetrahedral matrix and are replaced by H^{+}, with subsequent release of the structural cations as salts of the mineral acid which indicates the site of substitution. This attack alters the structure, chemical and physical properties of the clay while increasing the adsorption capacity (Ujeneza, 2014). The clay chosen for this investigation is commonly known as "Jurdiga" This clay is found in large quantities in Um-Shoka in Sennar State. Jurdiga is a fine granule with a low acidity and dark-brown color. It is chemically composed of sodium carbonate and other salts, characterizing it as a base. This clay is used in digestivedisorders and poor digestion and in cases of excess acidity. The fact that this clay adsorbs gasses indicates the possibility of its use as an adsorbent agent for bleaching of oils and therefore, the scope of this project is finally defined as investigating the bleaching properties of "*Jurdiga*" after activation.

The general objective of this search work is to use activated jurdiga for bleaching of edible oil and the specific objectives are to determine the chemical composition of local earth " Jurdiga", to investigate the best activation conditions for jurdiga and to investigate the best conditions of the activated earth dosages, and temperatures for oil bleaching.

MATERIALS AND METHODS :

Sample of "*Jurdiga*"was obtained from Um-Shoka area in Sennar State, Sudan. Unbleached Sunflower oil from Arab Sudanese Vegetable oil factory, Sudan on May 2017 was used in the following experiments. Also concentrated sulfuric acid was used**.**

Equipment:

Piston and mortar, sensitive balance, sieve (150m), heater, thermometer(300), pH-meter, rotary vacuum evaporator, water bath, oil bath, vacuum pump, funnel, filter paper (Double Rings), lovibond tintometer PFX995 and some glassware were used throughout the study.

Chemical Composition of Jurdiga:

The chemical analysis of jurdiga was determined experimentally in Agricultural Research Corporation WadMadani, Sudan.

The analysis done for following salts and metal ions :

$NaCO_3$ and $NaHCO_3$using titration, Na^{2+}, $K^+$and Ca^{2+} using flame photometer, Fe^{3+}using colorimetric method and $Si^{4+}$and Na^{3+}using atomic adsorption.

Perpration of Activaed *Jurdiga:*

Some amount of jurdiga was crushed with piston and mortar to obtain fine particles enough to pass through a sieve (150 µm). Then various concentrations of 0% (blank solution), 5%, 10% and 20% of H_2SO_4 were prepared. Samples each of 70 gram were mixed with 300 ml of $H_2SO_4$of various concentrations as mentioned above. Then suspensions were heated at 105℃ for 3 hours under continuous stirring. The temperature and time were fixed for all experiments. After that the suspensions were washed with water to eliminate any traces of acid . The pH was determined by pH -meter and adjusted at 4. Acid suspensions were filtered using filter paper and dried at 105℃ for 2 hours. The activated jurdiga were crushed and sieved again to 150 m. The dried powders were labeled and stored for future use (Erten, 2004).

Bleaching Experiment:

The bleaching procedure was to place 70 gram of unbleached sunflower oil into a 250 ml round–bottom rotary evaporator flask. The oil was heated at 80 ℃ before adding the bleaching powder. Then 1.5, 2.5, 3.5 and 4.5 grams of activated jurdiga were added to the hot oil. Vacuum was applied and temperature was raised to 80 ℃. The oil and activated jurdiga were stirred at 185 rpm in the rotary drum for 30 minutes at these conditions. After that the used jurdiga was separated from the bleached oil by two methods namely filtration and centrifugation. The same experiment was conducted with higher temperatures of 100℃ and 120℃. The color of the bleached oil was determined by using Lovibond Tintometer PFX995.

Filtration of Bleaching Powder:

The suspension was filtered at the end of experiment using Buchner funnel with double rings filter paper chart of medium filter speed.

Centrifugation of Bleaching Powder:

In addition to separation of suspension by filtration, also others experiments were tried to separate the bleaching powder from the oil suspension by centrifugation. A simple bowl centrifuge with 3000 rpm for 10 min was used

The bleaching efficiency (E) was calculated according to the following equation (1):

$$E= \frac{\text{Red of unbleached oil} - \text{Red of bleached oil}}{\text{Red of unbleached oil}} * 100 \ldots\ldots\ldots\ldots\ldots (1)$$

RESULT AND DISCUSSION:

The analysis of Jurdiga gave the following results shown in table (1)

Table (1) Chemical Composition of Jurdiga :

Component	%
$NaCO_3$	24
$Na\ HCO_3$	20
Na_2O	6
CaO	21
MgO	12
SiO_2	2.1
K_2O	5.2
Al_2O_3	0.3
Fe_2O_3	7

The Lovibond Tintometer readings of the color of the crude oil and bleaching efficiency of oil treated with standard fuller earth was found to be 90% as shown in table (2).

Table (2): The Color of the Sunflower Crude Oil:

Sample	Red	Yellow	Blue	E (%)
Crude	9.1	72.9	3.1	
Oil from drier	4.4	72.9	0.0	
Standard fuller earth	0.9	12	0.0	90

Tables (3) show the results of bleaching sunflower oil by activated jurdiga of concentrations of 0%, 5%, 10%, 20% of sulfuric acid and different dosages of activated jurdiga of 1.5, 2.5, 3.5, 4.5 grams to separate and at different temperature of 80°C, 100°C, 120°C respectively.

Table (3): Bleaching at 80^0C, 100^0C and 120^0C (Separation of Bleaching Powder by Filtration)

Acid Concentration %	Dose (g)	Bleaching test at 80^0C (Separation of Bleaching Powder by Filtration)				Bleaching Test at 100^0C (Separation of Bleaching Powder by Filtration				Bleaching Test at 120^0C (Separation of Bleaching Powder by Filtration			
		Red	Yellow	Blue	E(%)	Red	Yellow	Blue	E(%)	Red	Yellow	Blue	E(%)
	1.5	4.1	72.1	2.1	6.0	3.8	70	0.0	13.6	3.5	71.4	1.4	20.4
	2.5	3.9	70	0.0	11.4	3	70.4	0.4	31.8	2.9	70	0.0	34.1
	3.5	3.2	70	0.0	27.2	3	70	0.0	31.8	2.3	70	0.0	47.7
	4.5	2.8	70	0.00	36.3	2.7	70	0.0	38.6	2.2	70	0.0	50
	1.5	3.4	70	0.0	15.9	3.3	71.7	1.7	25	3.2	71.7	1.7	27.4
	2.5	3.1	70	0.0	29.5	3	70	0.0	31.8	2.7	57	0.0	38.6
	3.5	2.8	70	0.0	36.3	2.5	51	0.0	43.1	2.2	23	0.0	50
	4.5	2.5	70	0.0	43.1	2.1	34.9	0.0	52.2	2.1	10	0.0	52.2

	1.5	2.6	70.6	0.6	40.9	2.7	70.3	0.3	38.6	2.6	70	0.0	40.9
	2.5	2.3	51.5	0.5	47.7	2.3	70	0.0	47.7	1.9	34	0.0	56.8
	3.5	2	32	0.0	54.5	1.9	16	0.0	56.8	1.7	27	0.0	61.3
	4.5	1.7	16	0.0	61.3	1.5	18	0.2	65.9	1.3	12	0.0	70.4
	1.5	2.8	70	0.0	36.3	2.4	70.4	1.4	45.4	2.5	70	0.0	43.1
	2.5	2.7	70	1.3	38.6	2.4	70.3	0.0	45.4	2.1	70	0.0	52.2
	3.5	2.5	71.4	1.4	43.2	2.1	70	0.0	52.2	2.1	70	0.0	52.2
	4.5	2.3	70	0.0	47.7	2.1	69	0.2	52.2	2.1	70	0.0	52.2

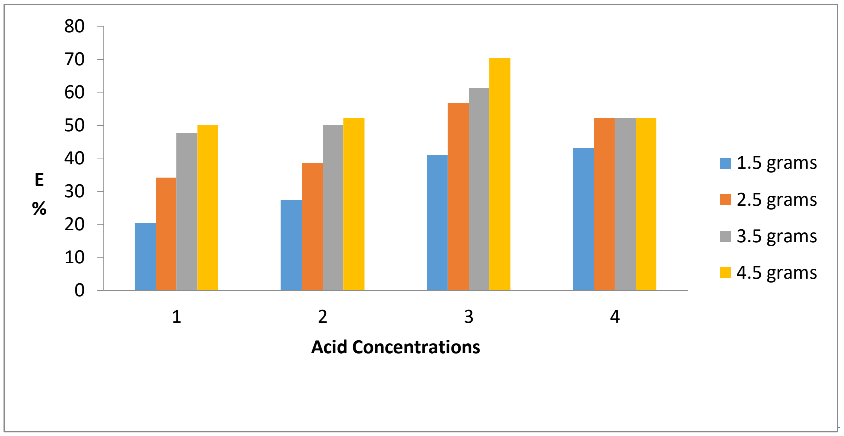
Table (5) :Bleaching Test at 80°C, 100°C and 120°C (Separation of Bleaching Powder by Centrifugation)

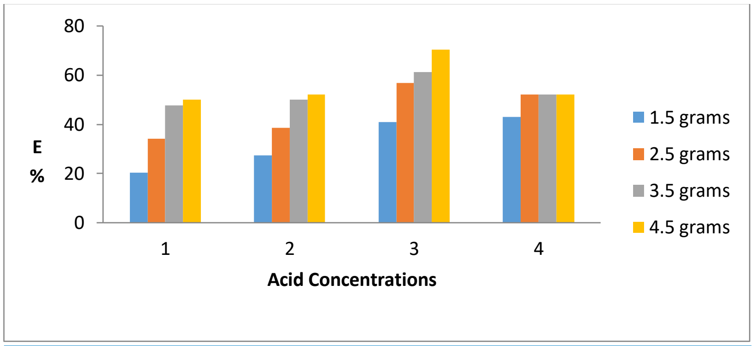
...ing Test at 80°C ...ation of Bleaching ... by Centrifugation)			Bleaching Test at 100°C (Separation of Bleaching Powder by Centrifugation)				Bleaching Test at 120°C (Separation of Bleaching Powder by Centrifugation))			
...ellow	Blue	E(%)	Red	Yellow	Blue	E(%)	Red	Yellow	Blue	E(%)
70	0.0	9.09	3.8	70	0.0	13.6	3.2	70	0.0	27.7
70	0.0	13.6	3.0	70	0.0	31.8	2.6	70	0.0	40.9
70	0.0	27.2	2.8	70	0.0	36.6	2.6	70	0.0	40.9
70	0.0	31.8	2.5	70	0.0	43.0	2.3	70	0.0	47.7

70	0.0	18.1	3.4	70	0.0	15.9	3.0	70	0.0	31.8
70	0.0	31.8	3.0	70	0.0	31.8	2.7	70	0.0	38.6
70	0.0	36.3	2.5	70	0.0	43.1	2.4	70	0.0	45.4
70	0.0	47.7	2.0	70	0.0	43.1	2.0	70	0.0	54.4
70	0.0	45.4	2.4	70	0.0	45.4	2.0	70	0.0	54.4
47	0.0	47.7	2.3	39	0.0	47.7	1.8	34	0.0	59.09
32	0.0	50.0	2.0	16	0.0	54.5	1.7	30	0.0	61.3
18	0.0	61.3	1.5	18	0.0	65.9	1.2	13	0.0	72.7
70	0.0	31.8	2.6	70	0.0	40.9	2.4	70	0.0	45.4
70	0.0	38.6	2.4	70	0.0	45.4	2.1	70	0.0	52.2
70	0.0	34.09	2.2	70	0.0	50.0	2.0	70	0.0	54.4
70	0.0	47.7	2.1	70	0.0	52.2	2.0	70	0.0	54.4

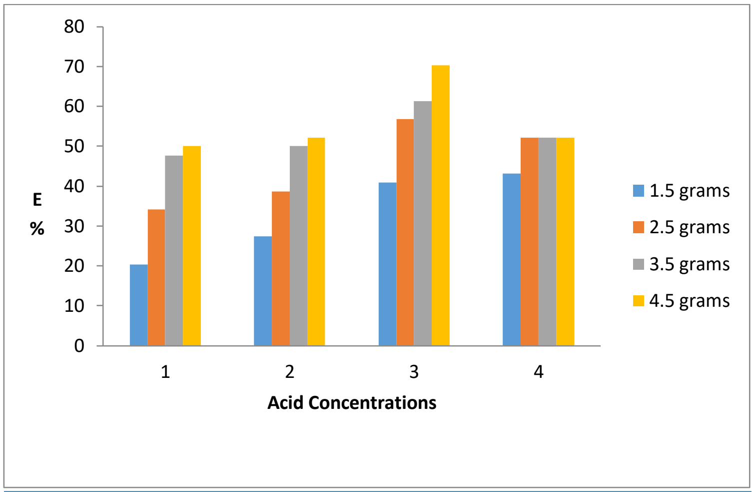
Effect of Dosage on Bleaching Efficiency:

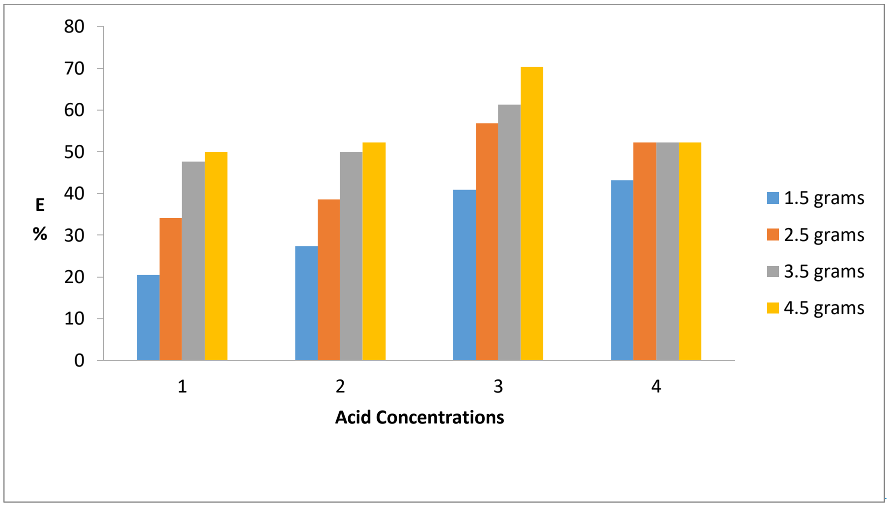
The dosage of activated jurdiga was varied from 1.5 grams to 4.5 grams. Figures 1, 2 and 3 show the effect of dosage with different acid concentration in bleaching efficiency. From the figures it was observed that increasing the dosage, increased the bleaching efficiency. This can be attributed to the increase in active site available for adsorption. The results clearly indicate that the bleaching efficiency increases to high values at dosage of 4.5gram at all tried temperatures of 80°C and 100°C. However at temperature of 120°C and 20% acid concentration it was observed that the efficiency increased from 43.1% to 52.2% by increasing the dose from 1.5 gram to 2.5 gram, further increase in dose has no significant effect on it and the efficiency remained constant. This could be explained by the fact that adsorption equilibrium has been reached between the adsorbent/ oil mixtures, thereby preventing further pigment removal by the excess adsorbent dosage.



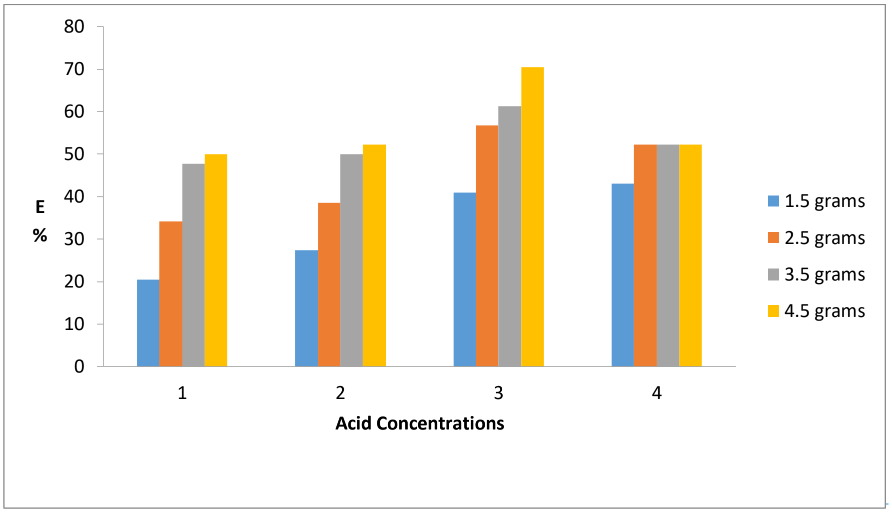


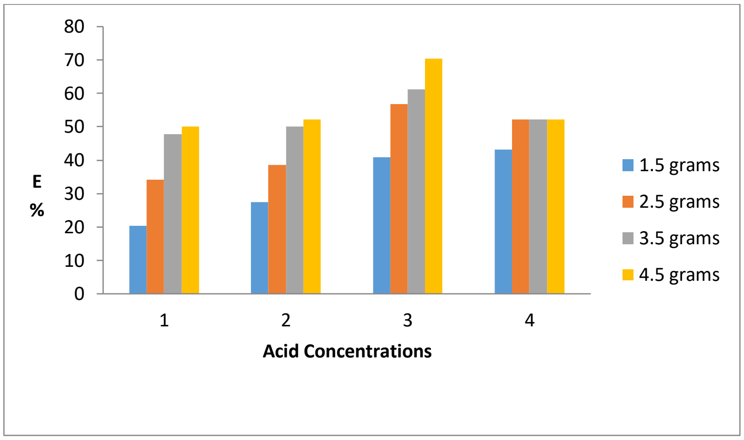
Fig(1): Effect of dose and acid concentration in bleaching efficiency at 80°C





Fig(2): Effect of dose and acid concentration in bleaching efficiency at 100°C.





Fig(3): Effect of dose and acid concentration in bleaching efficiency at 120°C.

Effect of Acid Concentration on Bleaching Efficiency:

The effect of acid concentration on bleaching efficiency is shown in figures 1, 2 and 3. It is clear from the figure that the bleaching efficiency increased with the concentration of acid used up to 10%. Above this concentration, the efficiency decreased. This initial increase in bleaching efficiency with increasing the acid concentration was probably due to the formation of active sites on the surface of jurdiga. The subsequent decline in bleaching efficiency can be explained as a result of destruction of the jurdiga structure by the excess acid.

The Effect of Acid Concentration and Dosage at Different Temperatures:

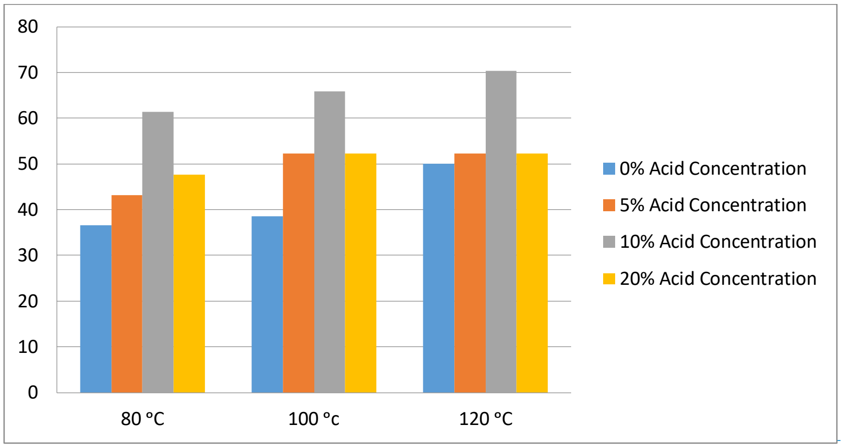
Table 4 shows that the best acid concentration for activation of jurdiga, to get higher bleaching efficiency of (70%), is 10% H_2SO_4 with addition of 4.5 grams at 120°C.These results were compared with commercial fuller earth, from table 5.3,shows commercial fuller earth has higher efficiency than the activated jurdiga. The variation in bleaching performance may be due to variation in chemical composition of jurdiga and commercial fuller earth. Commercial fuller earth contains higher content of silicate and aluminum which enhances it is adsorptive properties.

Table(4): The Effect of Acid Concentration and Dosage for Different Temperatures

Acid Concentration (%)	Temperature (°C)			Bleaching Efficiency (%)		
	80	100	120	80	100	120
0	4.5	4.5	4.5	36.6	38.6	50
5	4.5	4.5	4.5	43.1	52.2	52.2
10	4.5	4.5	4.5	61.3	65.9	70.4
20	4.5	3.5	2.5	47.7	52.2	52.2

Effect of Temperature on Bleaching Efficiency:

Figure 4 show the effect of temperature on bleaching efficiency. From the figures the efficiency increased with increasing the temperature. The results clearly indicate that the bleaching efficiency increases to an optimum value (E=70.4) at 120°C. This is most probably because increase in temperature activates the molecules, and increases their kinetic energy, thereby promoting access to more adsorption. Oil viscosity decreases with increasing temperature resulting in better dispersion of bleaching earth particles, improved clay/oil interactions , and less resistance to the flow (Brooks, *et al*, 2013).



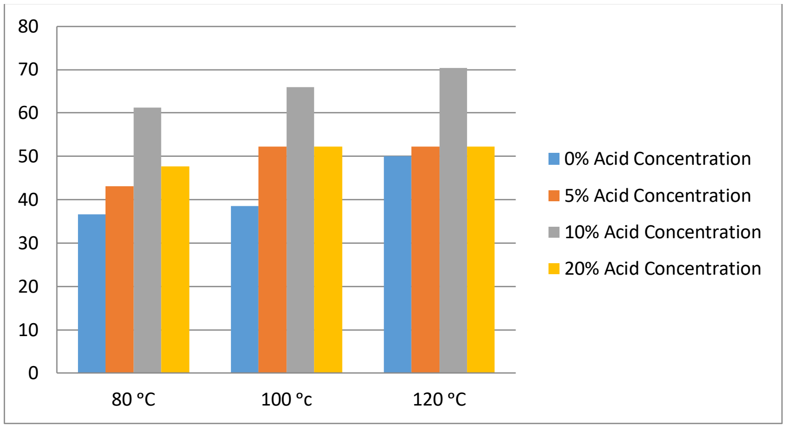


Figure 4. Effect of bleaching temperature in bleaching efficiency with 20 % acid concentration

Separation of Bleaching Powder by Centrifugation:

Separation of bleaching powder by centrifugation was carried out to completely separate powder, because in some experiment the powder dropout with oil and this may be due to filtration. Table 5 Show the result. The results clearly showed that the lovibond units of blue iszero, and this indicates that the powder was completely separated by centrifugation. By comparing the results of separation of bleaching powder by centrifugation with the result of separation of bleaching powder by filtration, it is observed that there was no significant difference in the bleaching efficiency, other than the absence of the blue in lovibond units.

CONCLUSION

The potential of activating jurdiga from Um- Shoka, Sennar State used as adsorbent for bleaching of crude sunflower oil brought from Arab Sudanese Vegetable Oil Co. Ltd, Sudan was investigated in this study. Acid activation has been found to affect the bleaching efficiency of jurdiga for the bleaching of sunflower oil. Upon activation, the bleaching performance of activated jurdiga was observed to increase by increasing the concentration of acid up to 10%.Above this concentration, the efficiency decreased and this can be explained by destruction of the jurdiga structure by the excess acid. When investigation of the effect of the various parameters on bleaching, such as, adsorbent dosage and temperature it was found that increasing the dose and temperature increased the bleaching efficiency and the optimal dose and temperature were 4.5 grams of activated jurdiga and 120°C respectively. The separation of used bleaching powder by centrifugation was carried out to completely separate powder and it was found that the blue unit of the lovibond tinometer was found zero this mean that the jurdiga particles were completely removed.

REFERENCES

Bernardini, E. (1983). *Vegetable Oils and Fats Processing*. Publishing Home, Roma. pp:101-223.

Brook, D. D, Berbesi, R and Hodgson, A.S (2013). Optimization of Bleaching Process. Eds; AOCS Lioid Library.

Erten, Y. (2004). Use of Domestic Minerals for Vegetable Oil Bleaching. M.Sc. Thesis, Izmir Institute of Technology Izmir, Turkey.

Mohamed, M.Y. (2010). Development and Stability of some Sunflower Hybrids under Irrigated Conditions. Oilseed Crops Research Center, Agricultural Research Corporation, pp. 135-144, (2010).

Ujeneza, E. (2014). Optimization of Acid Activation and Bleaching Performance of Local Bentonite Clay. M.Sc. Thesis, University of Nairobi, Kenya

استخدام الجردقة المنشطة لقصر لون زيت طعام زهرة الشمس

قسم هندسة وتكنولوجيا الأغذية

كلية الهندسة والتكنولوجيا

جامعة الجزيرة

الملخص

تعتبر عملية قصر لون الزيوت النباتية عملية ذات تكلفة عالية عند تكريرها، وذلك يرجع لاستهلاك مسحوق قصر لون الزيوت المستورد من الخارج مما يساهم في رفع تكلفة التشغيل الكلية لعملية قصر لون الزيوت. . تهدف هذه الدراسة للاستفادة من الجردقة في عملية قصر لون زيوت الطعام بدلا من مسحوق قصر لون زيت الطعام التجارية المستورد من الخارج لإستيفاء الطلب الداخلي وتقليل تكلفة الإنتاج. أحضرت الجردقة من منطقة أم شوك ولاية سنار/ السودان. حددت المكونات الكيميائية للجردقة . كشف التحليل عن محتوى عال من كربونات الصوديوم 24 % وبيكربونات الصوديوم 20%. تم تحضير حامض الكبريتيك بتركيز 0% و 5% و 10% و20% . تم إجراء دراسة معمليه حول تنشيط الجردقة باستخدام حامض الكبريتيك. كما تم دراسة كفاءة قصر اللون للجردقه المنشطة والمنتجة لقصر لون زيت زهرة الشمس بإضافة جرعات مختلفة هي 1.5 و 2.5 و 3.5 و 4.5 جرام في درجات حراره

مختلفة هي 80، 100 و 120 درجة مئوية. وجد أن أفضل ظرف للتنشيط باستخدام الحامض ولقصر اللون كالآتي: الحامض تركيز %10 و 4.5 جرامات من الجردقة المنشطة في درجة حرارة 120 مئوية. أعطت الجردقة المنشطة المنتجة كفاءة %70 في قصر لون زيت زهرة الشمس . هذه النتيجة تمت مقارنتها مع المسحوق المستورد المستخدم لقصر لون الزيوت والتي لها كفاءة %90 في قصر لون زيت زهرة الشمس.

كلمات مفتاحيه: قصر اللون , تراب قصر اللون , تنشيط , جردقه .