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Thermal and Optical investigation of Corn and Cottonseed as Frying Oils

Tamador S. Saeed[a] and Omer I. Eid[b,c]

[a] Sudanese Standards and Metrology Organization, P O Box 3573 Khartoum, Sudan: tamadorsalih@gmail.com.
[b] Current: Northern Border University, Faculty of Science and Arts, P O Box 1321, Rafha, Saudi Arabia.
[c] Permanent: Department of Physics, Faculty of Science, University of Khartoum, P O Box 321, (11115) Khartoum, Sudan: oieid@uofk.edu, omereid@gmail.com

Abstract

The purpose of this study is to examine the heating effect on some food oils, we have selected two of the commonly used in cooking and frying in Sudan, namely; the *Corn* and the *Cottonseed*. For this purpose we studied the change occurred in some of the physical properties. These are: the refractive index, viscosity, density and the specific heat capacity According to the results obtained a slight change was noticed in the refractive index and the density of the oils, while there was a remarkable increase in the coefficient of viscosity. The measurements were repeatedly recorded before and after boiling the oils in a period of five days for. The results revealed that boiling of the oils change their physical properties.

Keywords: Frying oils, Corn, Cottonseed, Fatty acids, Cholesterol, Refractive Index, Boiling, Viscosity, Density, Specific Heat Capacity.

Introduction

Frying oils have been a hot issue in literature; the topic was approached by many researchers [1 - 3]. Most of the common oils are originally extracted from seeds, classified as liquid fats. Oils are very rich source of energy. When oils are exposed to high temperatures the omega3 fatty acids are affected and therefore damage the oils. The main elements of the fatty acids are: Carbon (C), Hydrogen (H) and Oxygen (O) arranged as a carbon chain skeleton with a carboxyl group (-COOH) at one end [4, 5]. The *corn* oil extracted from corn seed is rich in double unsaturated fatty acid. *Corn* oil is odorless, has very little taste, and has a high smoke point, which makes it suitable for frying [6]. *Cottonseed* oil, extracted from cotton seeds, is used in some margarine; It must be refined to remove gossypol. Several commercial products available contain cottonseed oil.

Experimental Work

The physical properties of the sample oils that examined in this study include the index of refraction, the density, the viscosity and the specific heat capacity. Our aim is to test the variations of these properties with heating at boiling temperature. The refractive indices of the oils were obtained by using the traveling microscope method [7]. The density (kg/m3) is measured using standard method. The viscosity is calculated by means of a viscometer. The specific heat capacity is measured by using a simple electrical method where Newton's law of cooling was applied.

Results and Discussion

The physical properties of the *corn* and the *cottonseed* as frying oils considered in this research work are the index of refraction (n), the specific heat capacity (C), the kinematics viscosity (η), the density (ρ) and the boiling point (B.P). The data of these properties within the specified period of time are recorded in Tables (1) and (2), respectively.

Table 1 The measured physical properties of the *corn* oil.

Days	n	ρ (kg/m^3)	η ($Dyne.s/cm^2$)	B.P (^oC)	C (J/kg.K)
*First	1.40 ±0.03	0.885	0.516 ±0.004		3103
First	1.46 ±0.04	0.937	0.577 ±0.002	230.0	3251
Second	1.50 ±0.04	0.922	0.640 ±0.001	188.1	3152
Third	1.46 ±0.04	0.929	0.697 ±0.001	189.5	3217
Fourth	1.51 ±0.01	0.921	0.678 ±0.004	193.4	4647
Fifth	1.30 ±0.01	0.919	0.702 ±0.001	170.5	5399

* Refers to the first day before heating the oil.

Table 2 The measured physical properties of the *cottonseed* oil.

Days	n	ρ (kg/m^3)	η ($Dyne.s/cm^2$)	B.P (^oC)	C (J/kg.K)
*First	1.44 ±0.1	0.883	0.693 ±0.002		3136
First	1.53 ±0.08	0.932	0.703 ±0.002	215.0	3867
Second	1.48 ±0.05	0.930	0.793 ±0.002	199.9	4129
Third	1.35 ±0.02	0.897	0.776 ±0.001	173.8	5037
Fourth	1.45 ±0.06	0.934	0.904 ±0.004	212.0	5149
Fifth	1.47 ±0.05	0.917	0.972 ±0.001	186.0	5927

Corn oil

Measurements of the index of refraction (n) have been carried out for five days, in the first day the measurements were performed at room temperature, and repeated for four days after heating the oils to their boiling temperatures. The results revealed a change in the value of (n) as a result of heating. The difference between the minimum and the maximum values is (0.21 ± 0.1) as given in the second column of Table 1.
The refractive index of the corn oil varied between 1.30 and 1.51, see Table (1), the standard values for the corn oil provided by the Sudanese Standards & Metrology Organization (SSMO), [8], are 1.465 & 1.468, when measured at 20oC. The third column shows the density as measured in the given period of time, the values range between 0.885 kg/m3 and 0.937 kg/m3.
The kinematic viscosity (in cgs system of units) is shown in the fourth column. Note that the viscosity increased from (0.516 ±0.004) to (0.702 ± 0.001) Dyne.s/cm2 reaching 36% of the original value. The boiling temperature is

decreased from 230.0 °C to 170.5 °C. Finally the specific heat capacity has recorded a remarkable increase as shown in the table.

Cottonseed oil

The refractive index of the cottonseed is varied between 1.35 and 1.53, Table (2), while the standard values are 1.458 and 1.466 measured at 40oC. The change in the density ranges between 0.883 kg/m3 and 0.917 kg/m3. The kinematic viscosity is recorded in the fourth column.

The viscosity is also increased in accordance with the *corn* oil, from (0.693 ± 0.002) to (0.972 ± 0.001) Dyne.s/cm2 with 37% increase. The taken after the oil cooled down to room temperature. The measured viscosities for both oils were increased with the number of times at which the oil is heated.
There is no major change in the density of both oils. The oils that heated to high temperature for long and many times are susceptible to change in their physical properties. This leads to unhealthy compounds for human.

Conclusion

In this research work we examined the effect of heating on the *corn* and *cottonseed* oils that commonly used in cooking and frying in Sudan. We used simple physics experiments to measure thermal and optical properties of the oils subjected to high temperature. The results deduced from this research confirmed that cooking at high temperatures will alter the thermal and the optical properties of the oils, in a good chance of damage them as well. The recommendation drawn from this work is that; the oil must not be used more than one time in frying purposes, since some of their physical properties will be changed. The process of re-heating oils to their boiling temperatures will damage them

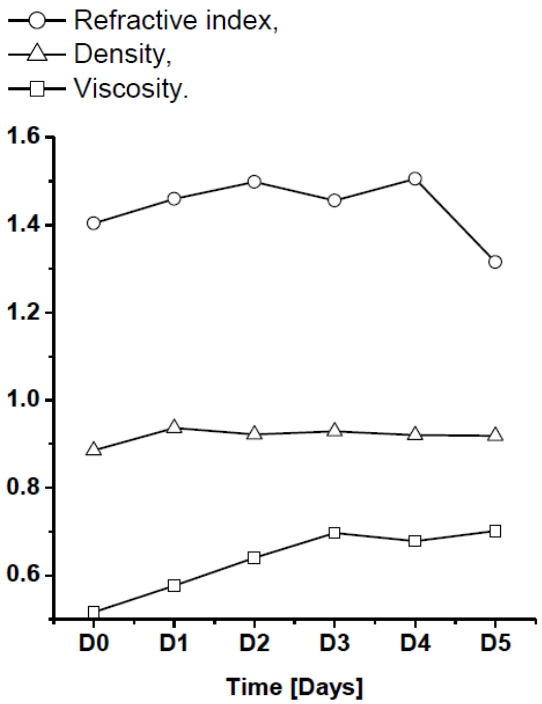

Fig. 1: The Corn oil before heating (D0) and after heating for five days (D1 - 5)

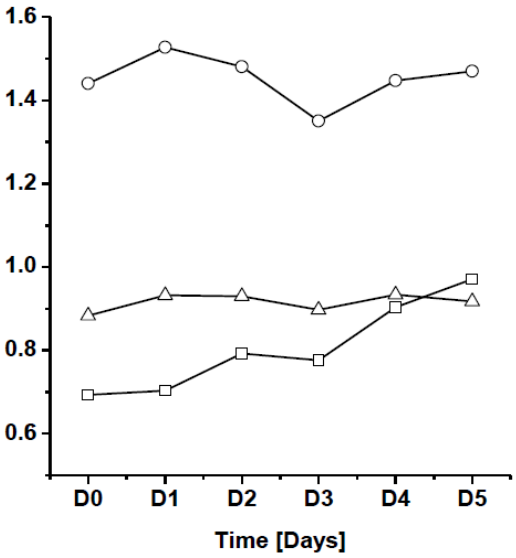

Fig. 2: The Cottonseed oil before heating (D0) and after heating for five days (D1 - 5)

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