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Modeling The Viscosity of the Vegetable Oils of Argan, Avocado, Olive, Rapeseed and Sunflower.

Rajaa Rochdi[1]*, Meriem Rochdi[2], asmaa kafih[1], Nabil Rochdi[3], Imane Hassanain[1], and Mohamed Alaoui El Belghiti[1]

[1]Equipe physico-chimie des matériaux, nanomatériaux et environnement, Département de Chimie, Université Mohammed V, Faculté des Sciences, Avenue Ibn Batouta, BP 1014 Rabat.
[2]Environnement & Energies Renouvelables. Université Ibn Tofaïl, Faculté des Sciences, Département de Biologie. BP : 133, 14000 Kenitra, Maroc.
[3]Equipe spectroscopie imagerie atomique des matériaux, Département de Physique/ Nanotechnologie, Université Cadi Ayyad, Faculté des Sciences Semlalia, Avenue Prince Moulay Abdellah B.P 2390-4000 Marrakech

ABSTRACT

In this study we compare the viscosity of different vegetable oils studied, argan oil, avocado oil, olive oil, rapeseed oil and sunflower oil. The temperature dependence of Kinematic viscosity of the different vegetable oils studied is described using the Arrhenius-type equation. We plotted the curves of Logarithm of viscosity versus 1/T for each sample. The activation energy E_a and the infinite-temperature viscosity (η_∞) were determined from these plots for each oil, the correlation coefficients varied between 0.942 and 0.994.
Keywords: Activation energy, Arrhenius-type relationship, Temperature, Viscosity.

Corresponding author

INTRODUCTION

The recent energy situation and environmental concerns (limiting emissions of greenhouse gases) lead some socio-economic actors, especially from the world of agriculture and para agricultural, became interested in the use of pure plant oils, for energy uses, such as automobile fuel (biofuel), stationary engines (pumps, generators), burning (heating of buildings, greenhouses...) or industrial applications (lubricants, non-toxic solvents, paints, inks...).

Vegetable oils are increasingly used in pharmacy, cosmetics etc... Therefore, several studies have been conducted to assess the quality of the oil on the basis of their physical properties: viscosity, refractive index, resistivity electrical etc. Pace, Risman, Bengtsson and El-Al Shami [1] suggested that the electrical properties could be used as indicators of the status and quality of vegetable oils. Several researchers have worked on the chemical and physical properties of vegetable oils [2, 3, 4, 5].

The variation of the viscosity of used oils with the temperature is analysed by applying the Arrhenius equation:

$$\nu = A\exp(E_a/RT) \qquad (1)$$

Where ν is the kinematic viscosity, A is the pre-exponential factor (m^2/s), E_a is the activation energy (J/mol); R is the gas constant (J/mol/K) and T is the temperature (K). The value of A can be approximated as the infinite-temperature viscosity (ν_∞), which is exact in the limit of the infinite temperature.

The, equation (1) can be rewritten in the following form:

$$\ln(\nu) = \ln(A) + (E_a/RT) \qquad (2)$$

The objective of this work is to fit our results by the Arrhenius equation, and to determine from this modeling, the physicochemical characteristics of the studied oil.

MATERIALS AND METHODS

Materials:

The viscosity is measured by the Osswald viscometer shown in figure 1.

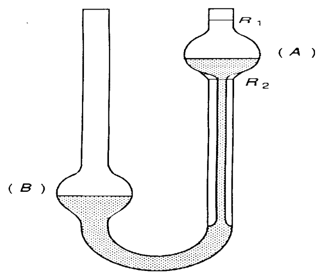

Figure 1: Osswald viscosimeter

Methods:

Measure of the viscosity of vegetebale oils:

Measuring the flow time of a volume V of fluid through a capillary tube. The viscosity is proportional to the flow of time :

$$\nu = K \cdot \Delta t$$

The constant K of the apparatus is given by the manufacturer of the viscometer.

RESULTS AND DISCUSSIONS

We studied the variation of the kinematic viscosity with the temperature of the different vegetable oils: Argan oil, olive oil, avocado oil, rapeseed oil and sunflower oil, the obtained results are shown in figures 2, 3, 4, 5, 6 and 7 show the dependence of Nepirean-logarithm of viscosity versus temperature of the vegetable oil studied. From these figures, it can be observed that the kinematic viscosity of the vegetable oil decreases with increasing temperature. We can compute the values of the activation energy Ea and pre-exponential factor ($\nu \infty$) from the slope and y-intercept of this straight line respectively. In table 1, we have reported the important
parameters deduced from the data of this study.

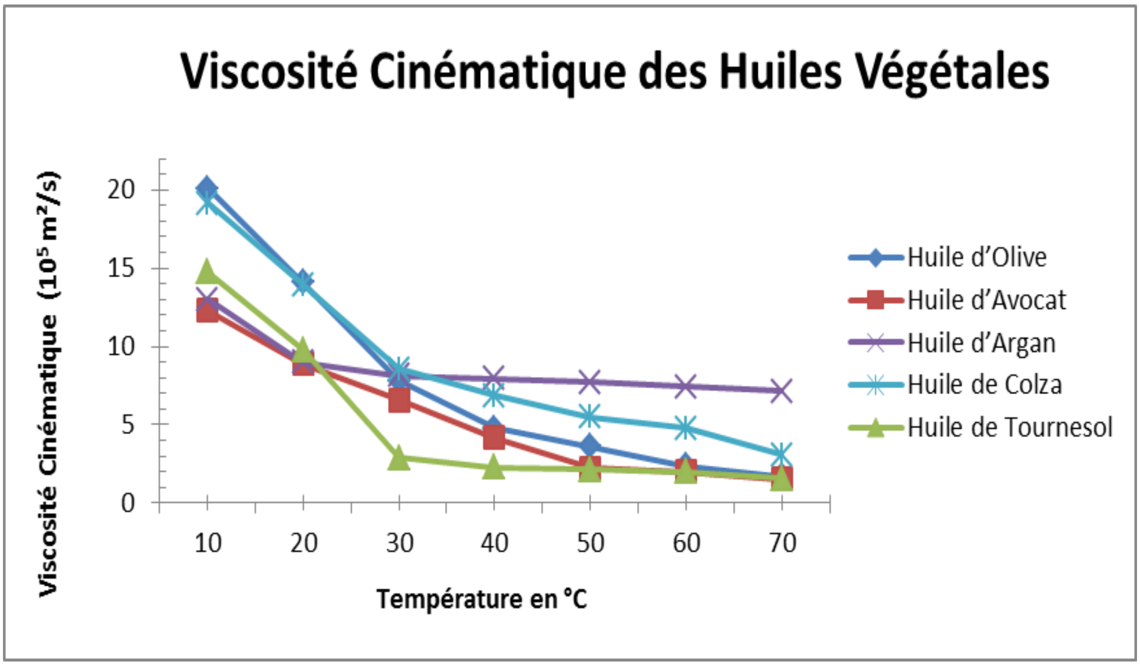

Figure 2: Kinematic viscosity of the different vegetable oils

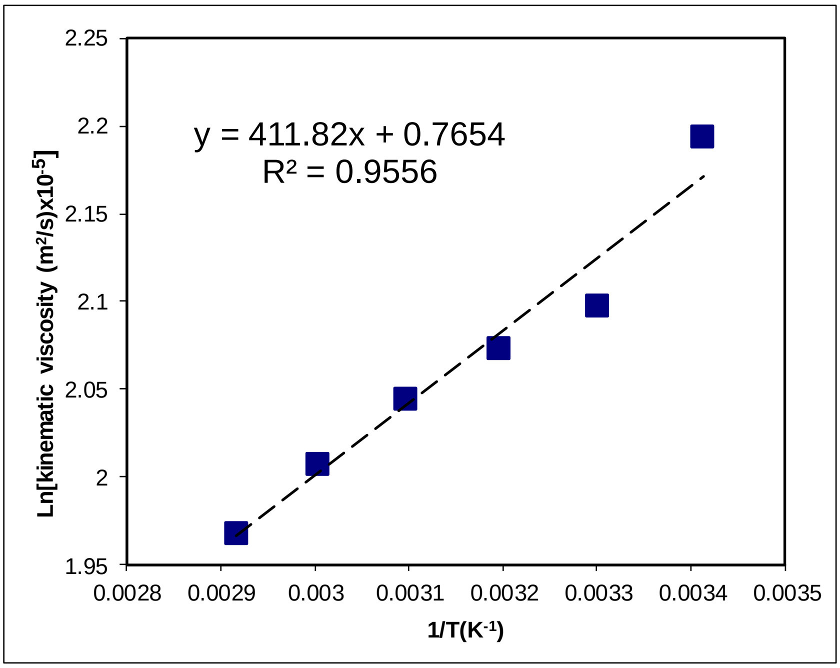

Figure 3: Dependence of Ln (viscosity) versus 1/T of argan oil.

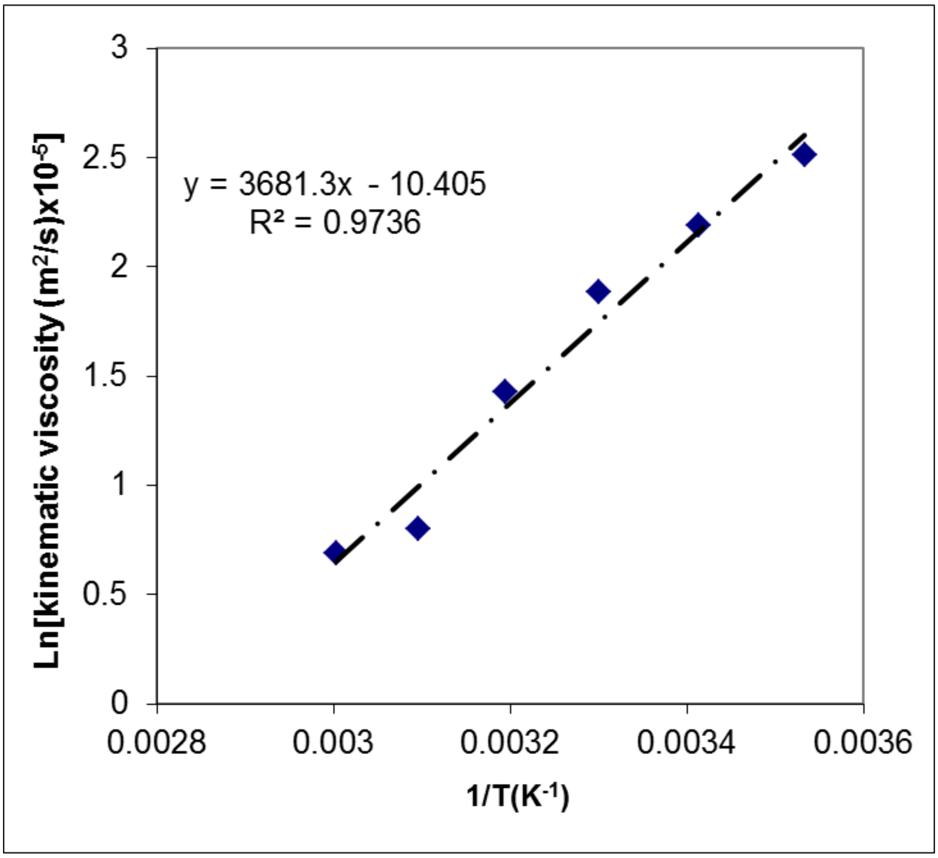

Figure 4: Dependence of Ln(viscosity) versus 1/T of avocado oil.

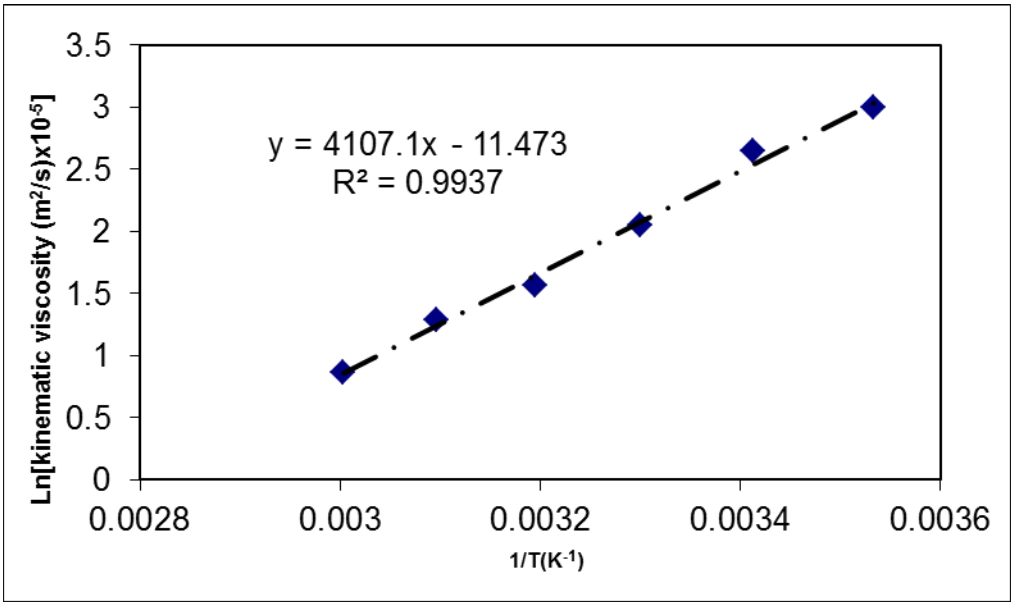

Figure 5: Dependence of Ln(viscosity) versus 1/T of olive oil.

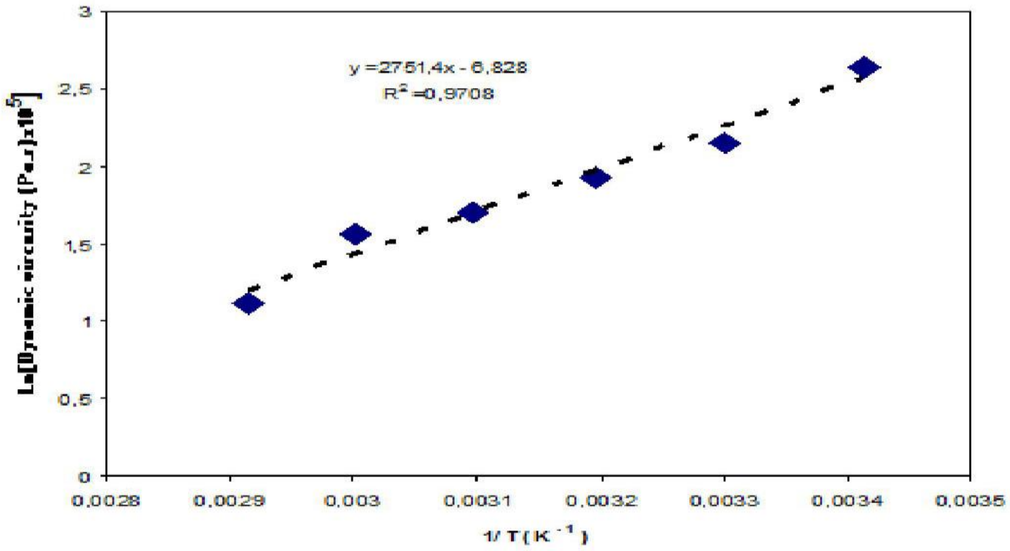

Figure 6: Dependence of Ln(viscosity) versus 1/T of rapeseed oil.

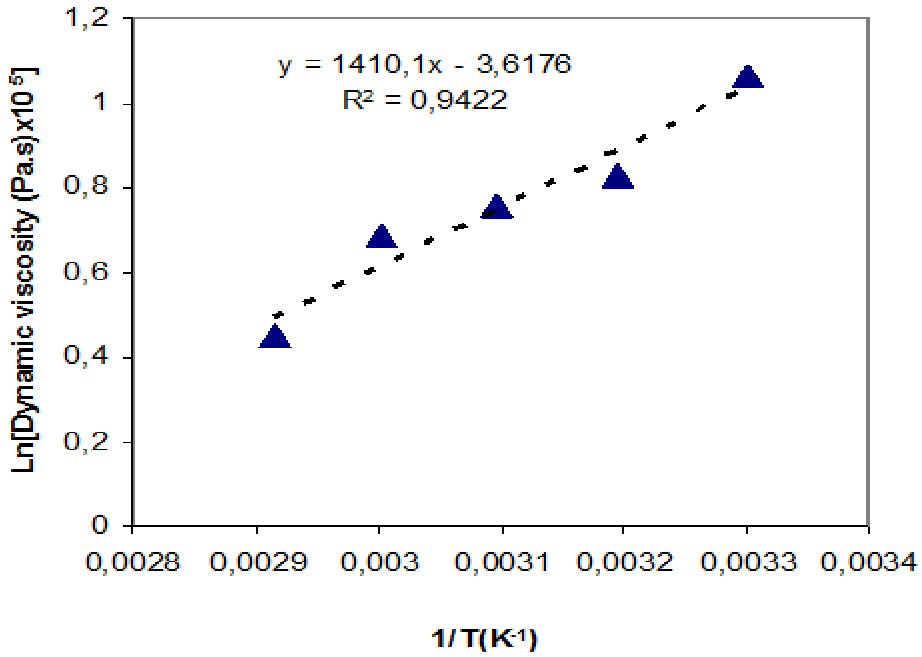

Figure 7: Dependence of Ln(viscosity) versus 1/T of sunflower oil.

Table 1: Important parameters of the ln(viscosity) versus temperature fit

Samples	ν_∞ (m²/s)x10⁶	E_a(KJ/mole)	R^2
Argan oil	0.21	3.4	0.956
Avocado oil	0.30	30.6	0.974
Olive oil	0.11	34.1	0.994
Rapeseed oil	0.01	22.86	0.971
Sunflower oil	0.27	11.72	0.942

The results show that the infinite-temperature viscosity **(ν_∞)** of the avocado oil is larger than that of the other oils, while the activation energy **(E_a)** of the olive oil is the largest one.

(ν_∞) avocado oil > (ν_∞) sunflower oil > (ν_∞) argan oil > (ν_∞) olive oil > (ν_∞) rapeseed oil
(E_a) olive oil > (E_a)avocado oil > (E_a) rapeseed oil > (E_a) unflower oil > (E_a) argan oil

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CONCLUSION

The kinematic viscosities of the different vegetable oils: argan oil, avocado oil, olive oil, rapeseed oil, sunflower oil, decreased with the temperature, experimentally and as pre-dicted by the Arrhenius equation.

The activation energy, as well as the pre-exponential term was obtained. These results can be used as a way to characterize the oil quality. These values depend on the nature of the oil.

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