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Der Pharma Chemica, 2015, 7(12):146-151
(http://derpharmachemica.com/archive.html)

ISSN 0975-413X
CODEN (USA): PCHHAX

Comparative study of the kinematic viscosity versus temperature for vegetable oils : Argan, Avocado, Olive , Rapeseed, Sunflower, Linseed, Almond and Diesel fuel

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ABSTRACT

In this study we compare the viscosity of different vegetable oils studied. The temperature dependence of Kinematic viscosity of vegetable oils: argan oil, avocado oil, olive oil , Rapeseed oil, Sunflower oil, Linseed oil, Almond oil and Diesel fuel is described using an 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 0.998.*

Keywords: viscosity, Arrhenius-type relationship, temperature, activation energy.

INTRODUCTION

Vegetable oils are generally very low toxics and have excellent biodegradability, these oils can be also perceived to be alternatives to mineral oils as base oils for industrial lubricants due to growing environmental concerns. These qualities are due in particular to a low resistance to oxidation and hydrolysis. They are also important alternatives as fossil fuels replacement [1-3]

Viscosity means the resistance of one part of the fluid to move relative to another one.Viscosity is one of the most important physical properties of a liquid system; the change of viscosity is linked to physicochemical oil properties [4-6]. Furthermore, it is also a factor that determines the global quality and stability of a vegetable oil. From the physicochemical point of view, several studies [7] have been carried out on the viscosity of oils, this parameter can changes with temperature, pressure, and concentration of fluids; all these changes can be modelled by some theorical equations.

The variation of the viscosity of used oils with the temperature is analyzed 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 infinite temperature [8].

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 Arrhenius equation, and determine from this modeling, the physicochemical characteristics of the oil studied.

MATERIALS AND METHODS

2.1 Materials:
The viscosity is measured by a viscometer Osswald [9]**:**

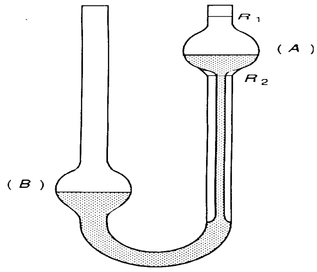

Figure 1 Osswald viscosimeter

2.2 **Methods:**
Measurement of the kinematic viscosity of vegetable oils:
Measuring the time of a flow of a volume V of fluid through a capillary tube. The kinematic viscosity is proportional to the flow time:

$$(\nu = k \ \Delta t) \qquad (3)$$

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

RESULTS AND DISCUSSION

In the present work, we determined the viscosities of some vegetable oils in the temperature range from 283K to 333K. Figures 2, 3, 4, 5, 6, 7, 8, 9 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 E_a and pre-exponential factor (ν_∞) 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.

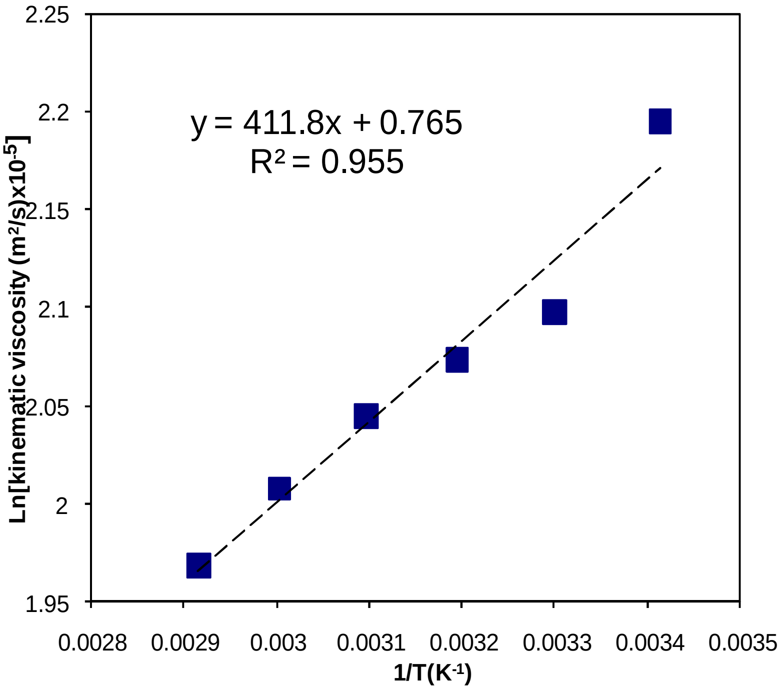

Fig. 2 Dependence of Ln(viscosity) versus 1/T of argan oil

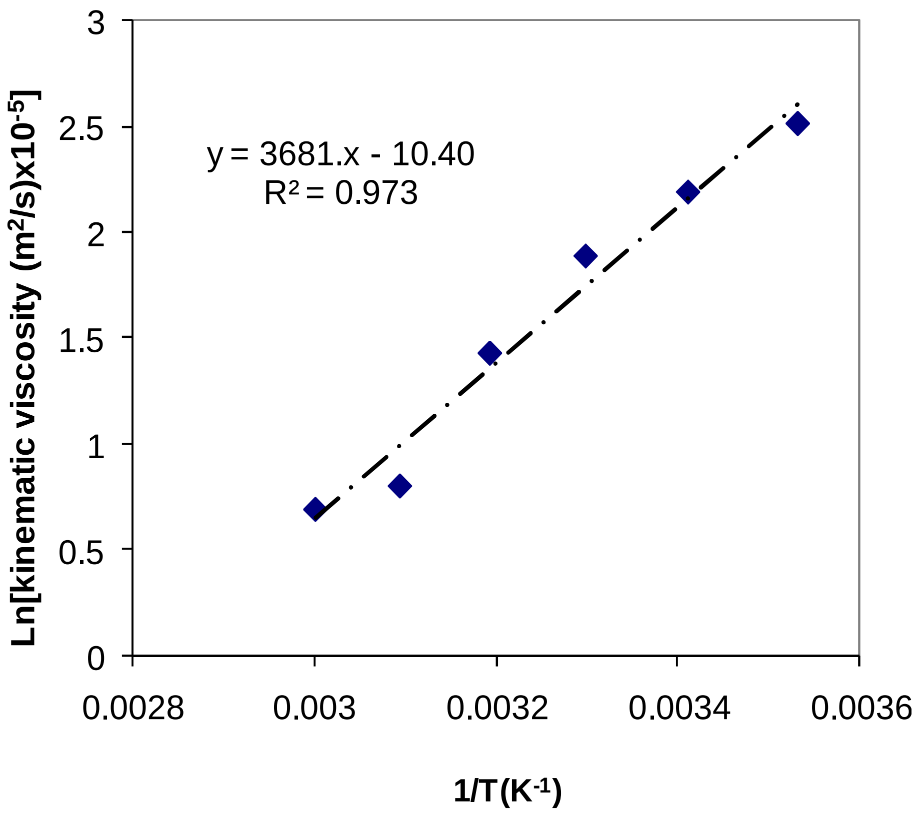

Fig. 3 Dependence of Ln(viscosity) versus 1/T of avocado oil

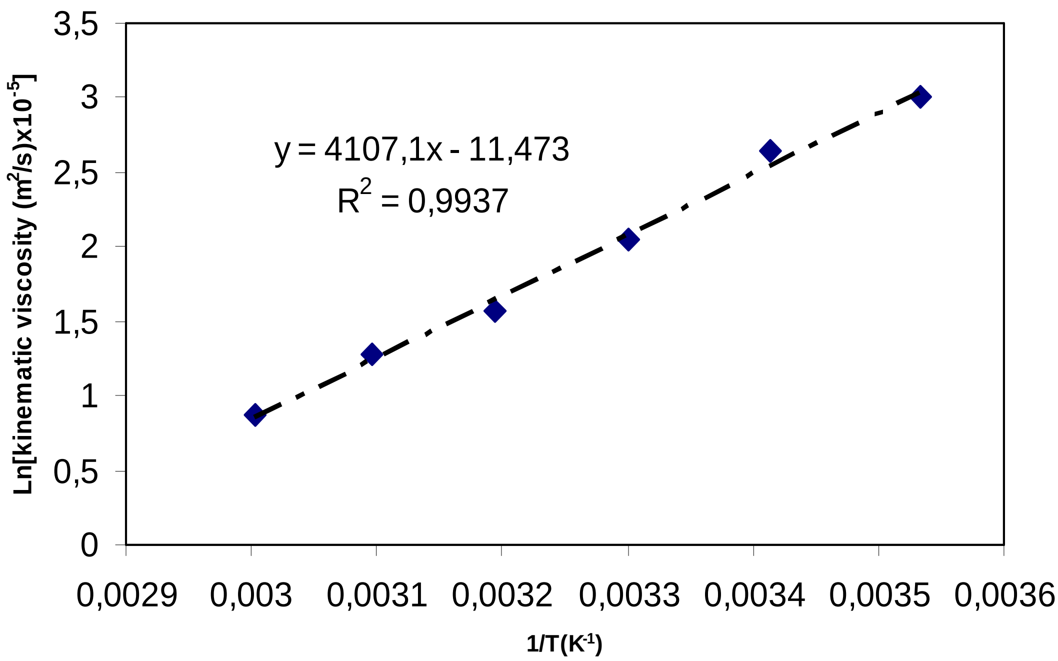

Fig. 4 Dependence of Ln(viscosity) versus 1/T of olive oil

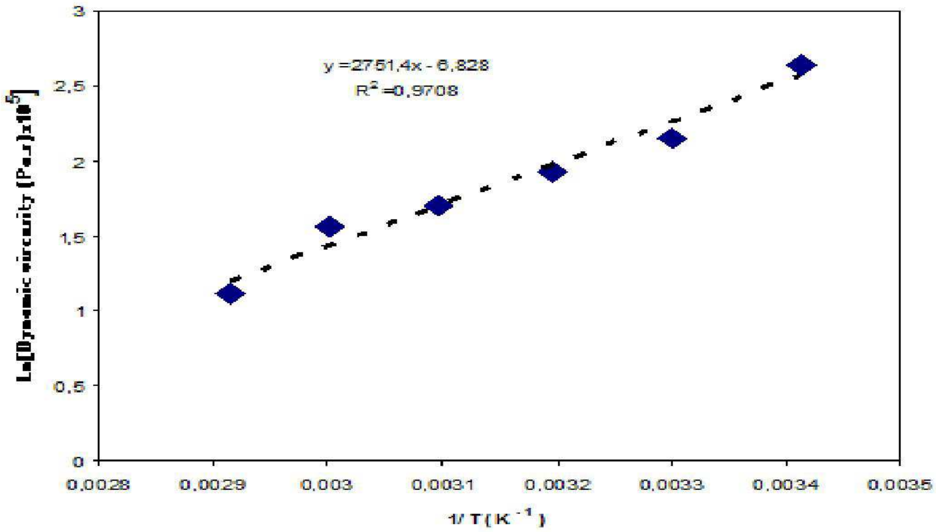

Fig. 5 Dependence of Ln(viscosity) versus 1/T rapeseed of oil

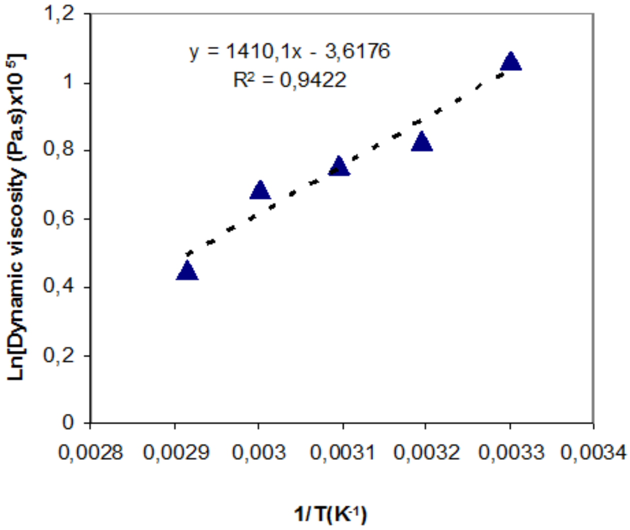

Fig. 6 Dependence of Ln(viscosity) versus 1/T of sunflower oil

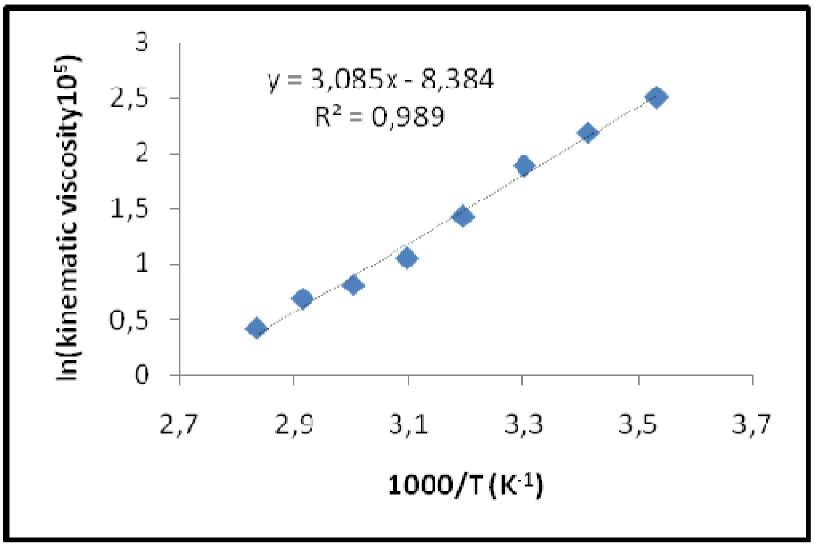

Fig 7. Dependence of ln(viscosity) versus 1/T for Linseed vegetable oil

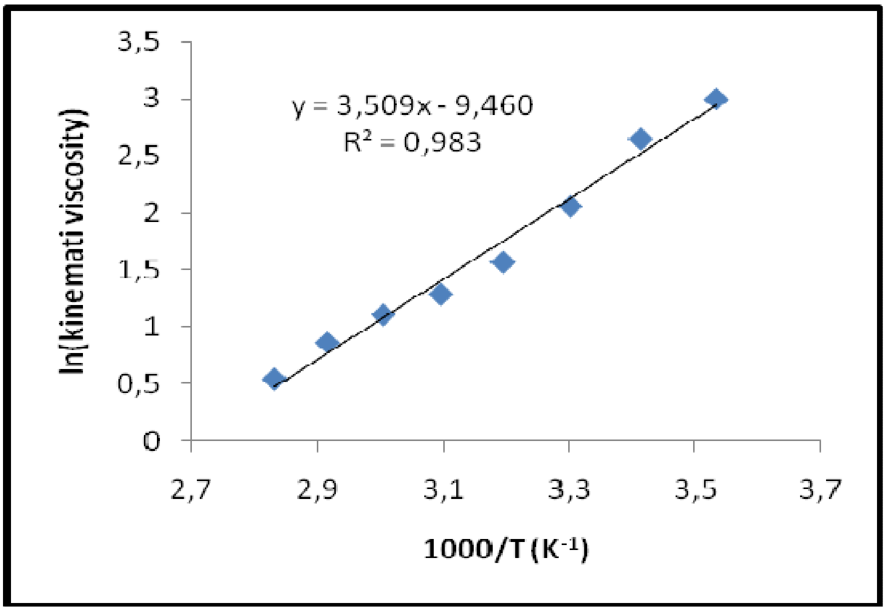

Fig 8. Dependence of $\log_e$(kinematic viscosity) versus 1/T for almond vegetable oil

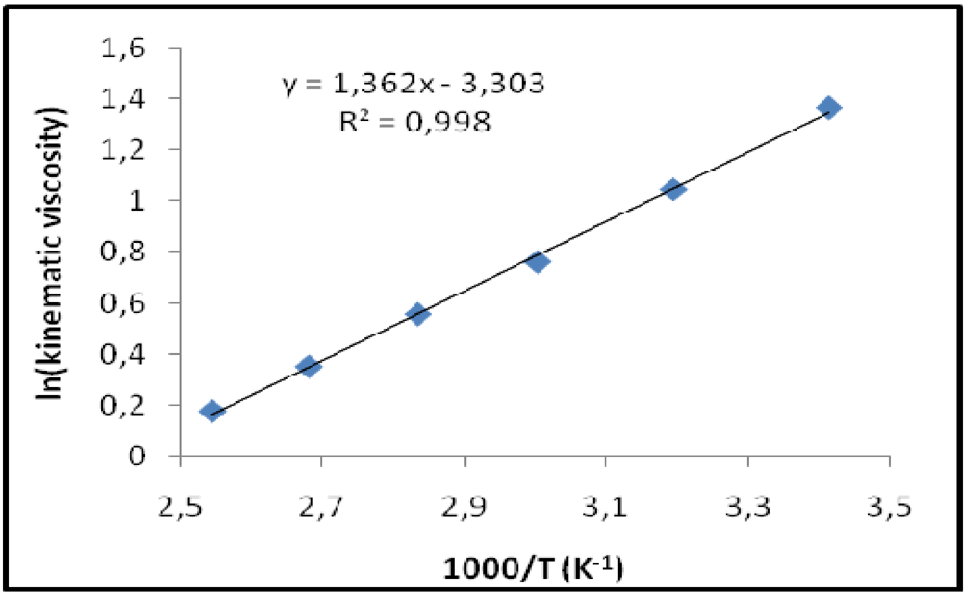

Fig 9 Dependence of $\log_e$(kinematic viscosity) versus 1/T for diesel oil

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

sample	ν_∞ (m^2/s)x10^6	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
Colza oil	0.01	22.86	0.971
Sunflower oil	0.27	11.72	0.942
Linseed oil	0.002	25.64	0.989
Almond oil	0.001	29.16	0.983
Diesel fuel	0.37	11.32	0.998
Linseed oil	0.002	25.64	0.989

CONCLUSION

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

(ν_∞)Diesel> (ν_∞)avocado> (ν_∞) sunflower > (ν_∞)argan > (ν_∞)olive> (ν_∞). rapeseed > (ν_∞). linseed, > (ν_∞). almond (E_a)olive > (E_a)avocado >(E_a) almond >(E_a) linseed >(E_a) linseed >(E_a) unflower > (E_a) Diesel >(E_a) argan

CONCLUSION

-The kinematic viscosities of vegetable oils, argan, avocado, olive oil ,Rapeseed oil sunflower oil, Linseed oil, Almond oil and Diesel fuel decreased with temperature, experimentally and as pre-dicted by an Arrhenius equation. The activation energy, as well as the pre-exponential term was obtained. These results can be used as a way of characterizing the oil quality. These values depend on oil nature.

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