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Brief communication

Rheograms Describing the Evolution of Dynamic Viscosity as a Function of Shear rate and Shear Stress for Vegetable oils

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ABSTRACT

The proposed rheological study for six vegetable oils which are: olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil shows their non-Newtonian behavior. With the help of the Rheotest viscometer I determined the shear stress and then the dynamic viscosity. The analysis of the rheograms shows a decrease in the dynamic viscosity with the temperature and shear rate for the four studied vegetable oils.

Keywords: Vegetable oil, Rheology, Equations.

INTRODUCTION

The rheology of vegetable oils and the factors that influence their viscosity are studied by specialists, the theoretical and experimental data being useful in solving design issues that involve the use of these oils, either as lubricants, fuels or working fluids, to comply with environmental and health regulations. but also as an alternative to depleted petroleum products[1-4]. The purpose of this study is to study the rheological properties of the following vegetable oils: olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil.

The following rheological properties have been determined for these self-formulated lubricants:

- The rheological model of the lubricant, ie the legality of variation of the friction stresses depending on the shear speed;
- Variation of η with γ as well as variation of η with τ at various temperatures the following oils: olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil[5].

The dynamic viscosity and properties of olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil are influenced by the concentration, temperature and pressure at which they were studied. The dynamic viscosity dependence of the shear rate is linearly approximate for the six studied oils[6-10].

In this study it has been investigated the variation of viscosity with shear stress, variation of

viscosity with shear rate and variations shear stress with shear rate for olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil.

MATERIAL AND METHODS

The determination of the shear stress and the dynamic viscosity was carried out with a Haake VT 550 viscometer and a water bath was used to increase the temperature of the studied oil. The oil samples were studied at all shear rates and temperatures between 30 and 90^{0}C.

RESULTS AND DISCUSSION

Figure 1 present the dynamic viscosity variation with shear rate at temperatures (40-100^{0}C). It is noted that the dynamic viscosity linear with shear rate for all vegetable oils. It is noted that the dynamic viscosity varied linearly with shear rate for the six studied vegetable oils.

The following conclusions can be drawn from the graphical representation of the dynamic viscosity of the shear rate:

- For olive oil at high shear rates 80-120s^{-1} has a linear dependence of dynamic viscosity with shear rate, and at low shear rates has an exponential dependence.
- For coconut oil it has a linear dependence of the dynamic viscosity of the shear rate for the whole range.
- For almond oil which has a linear dependence of the dynamic viscosity of the shear rate for the whole range.
- For sesame oil which has a linear dependence of the dynamic viscosity of the shear rate for the whole range.
- For cottonseed oil which has a linear dependence of the dynamic viscosity of the shear rate for the whole range.
- For sunflower oil which has a linear dependence of the dynamic viscosity of the shear rate for the whole range.

The analyzed vegetable oils were derived from the following vegetable materials, flower seeds (sunflower, cotton), pod seeds (sesame seeds), whole fruits (olives) and nuts (coconut, almonds). Fig. 1 shows the rheograms of representative vegetable oils at different temperatures with the lowest (sunflower oil) and highest (olive oil) shear rates. From the presented figure it is observed that by the graphical representation of the dynamic viscosity with shear rate in the temperature range close to 30-90^{0}C all the oils have a linear dependence are therefore non-Newtonian fluids.[10-12]

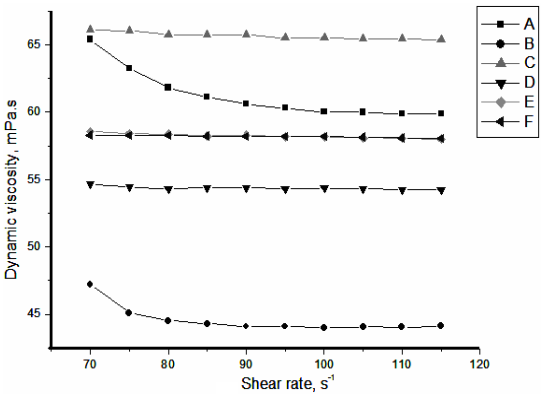

Fig. 1. Dependence η versus γ for: A-olive oil, B-coconut oil, C-almond oil, D-sesame oil, E-cottonseed oil F-sunflower oil

Figure 2 shows the rheograms of the olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil. The dependence of the shear rate on the shear stress is linearly close.

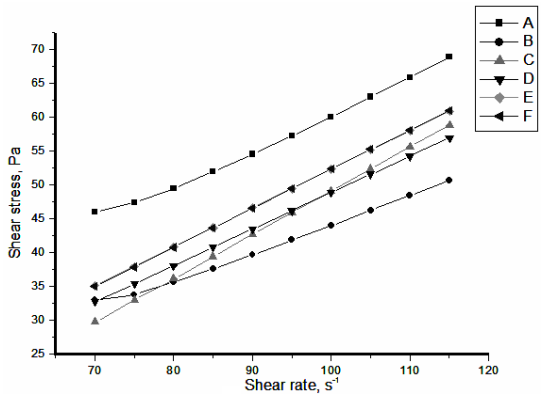

Fig. 2. Dependence shear stress versus shear rate for: A-olive oil, B-coconut oil, C-almond oil, D-sesame oil, E-cottonseed oil F-sunflower oil

Figures 3 and 4 show the dependence of the η on the τ for olive and coconut oils at various temperatures. The graphs show a decrease in dynamic viscosity with shear stress for the two oils mentioned above. At high shear stresses the dynamic viscosity of the two studied oils is close to constant, and at low shear stresses the dynamic viscosity decreases exponentially.

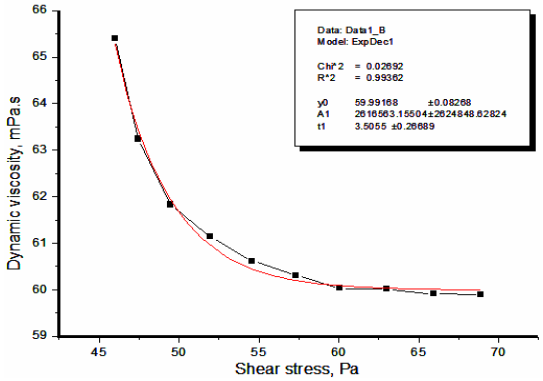

Fig. 3. Dependence dynamic viscosity versus shear stress for olive oil

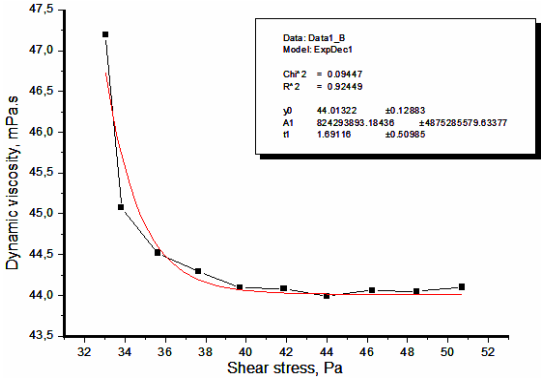

Fig. 4. Dependence dynamic viscosity versus shear stress for coconut oil

CONCLUSION

In this article we have studied olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil mechanically processed oils. The result show a decrease in the viscosity of the oil with temperature and shear rate due to the orientation of the oil molecules in the direction of shear. The studied oils: olive oil, coconut oil, almond oil, sesame oil, cottonseed oil and sunflower oil which have a non-Newtonian pseudoplastic behavior. At high shear stresses the dynamic viscosity of the two studied oils is close to constant. At low shear stresses the dynamic viscosity decreases exponentially.

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Conflict of interest

The author declare that we have no conflict of interest.

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