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Rheology of pumpkin seed oil

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Abstract
The rheology of vegetable oils is essential for the evaluation of their physicochemical properties, stability and processability in the food, cosmetic and pharmaceutical industries. The oil extracted from pumpkin seeds (Cucurbita pepo L.) presents a profile rich in unsaturated fatty acids, phytosterols and natural antioxidants, which gives it nutritional and functional value. The study of rheological properties provides important information on the behavior of the oil at different temperatures and shear rates, contributing to the optimization of the extraction, refining and formulation processes of the finished products. The results indicate that pumpkin oil behaves predominantly as a Newtonian fluid in the studied temperature and shear rate ranges, with viscosity decreasing with increasing temperature, a phenomenon typical of most vegetable oils. These characteristics recommend it as a valuable raw material for the development of functional, healthy and sustainable products.

Keywords: Seeds, pumpkin, rheology

Introduction

Vegetable oils are valuable raw materials, widely used in the food, cosmetic and pharmaceutical industries, due to their high content of essential fatty acids, vitamins and bioactive compounds. Their physicochemical properties, including rheological behavior, directly influence the quality, stability and processability of the oil in various technological applications.

Pumpkin seeds (*Cucurbita pepo L.*) are an important source of vegetable oil, recognized for its balanced profile of unsaturated fatty acids, phytosterols and natural antioxidants. This oil has high potential for food and cosmetic applications due to its nutritional value and associated functional properties.

Rheology, the science that studies the flow and deformation of materials, is essential for the characterization of vegetable oils. Determination of viscosity, temperature dependence and behavior at different shear rates provides relevant information for the optimization of technological processes, such as oil extraction, refining, blending or packaging. Through rheological analysis, the stability of the oil and the predictability of its behavior in industrial applications can be assessed, contributing to the development of functional and sustainable products.

Thus, the rheological study of pumpkin seed oil provides a solid scientific basis for the optimal utilization of this natural resource and for the expansion of its use in various industrial fields [1, 5].

Material and methods

For the study of pumpkin seed oil, a rotational rheometer with torque and speed control Anton Paar MCR series was used. Minimum torque < 1 µN•m, speed/shear rate range 10^{-3} – 10^{4} s^{-1}, precise temperature control ±0.1 °C. Integrated thermostatic liquid bath source compatible with the geometry used.



Fig 1: Anton Paar MCR rheometer

Results and discussion

Figure 2 represents the dependence of dynamic viscosity on temperature for pumpkin seed oil.

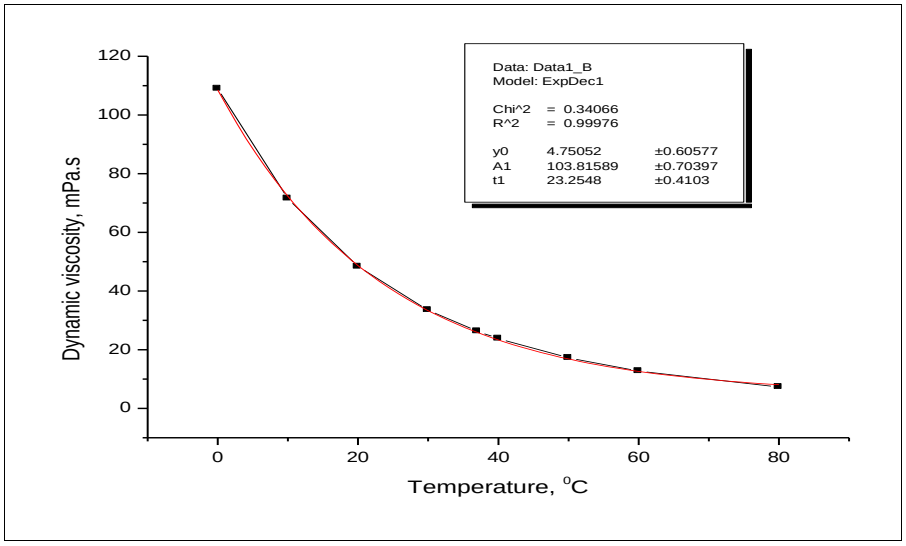

Fig 2: Temperature dependence of dynamic viscosity for pumpkin seed oil.

Typical behavior of viscous liquids: the dynamic viscosity (μ) of pumpkin seed oil decreases exponentially with increasing temperature, according to an Andrade/Arrhenius-type relationship. At low temperatures (0–10 °C), the oil is very viscous: ~70–110 mPa•s, so it flows poorly. At room temperature (20–25 °C), μ decreases to ~40–50 mPa•s. At 37 °C, μ ≈ 25–35 mPa•s. At high temperatures (60–80 °C), μ decreases significantly, to ~7–13 mPa•s, approaching the values of common heated vegetable oils. The decrease in viscosity is pronounced between 0–40 °C, after which the decrease becomes slower as the temperature increases.

At low temperatures, pumping, mixing or spraying the oil becomes difficult due to its high viscosity.

At moderate-high temperatures (above 50 °C), the oil becomes much more fluid, which favors industrial applications (e.g. extraction, biodiesel, food processing).

This behavior is similar to other vegetable oils, but the amplitude depends on the fatty acid composition and phospholipid/impurity content.

In short: the dynamic viscosity of pumpkin seed oil decreases exponentially with increasing temperature, from high values at low temperatures (above 100 mPa s at 0 °C) to values of the order of 7–10 mPa s at 80 °C [6, 12].

Figure 3 shows the dependence of shear stress on shear rate for pumpkin seed oil at various temperatures.

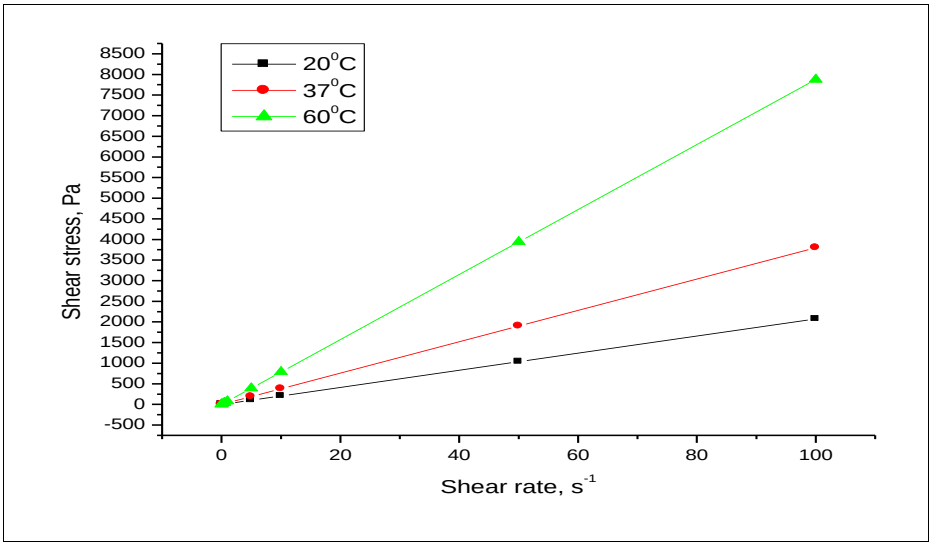

Fig 3: Shear stress versus shear rate for pumpkin seed oil at various temperatures.

For virgin pumpkin seed oil (regular vegetable oil, without particles or additives), the most reasonable starting model is **Newtonian:** so τ increases linearly with $\dot{\gamma}$, the slope being the dynamic viscosity μ (Pa•s). This is true for most vegetable oils at laboratory temperatures and over a wide range of $\dot{\gamma}$.

μ decreases sharply with increasing temperature → for the same shear rate, τ decreases as temperature increases.

Numerical example (previously estimated μ values)

- at 20 °C μ ≈ 0.0483 Pa•s → τ($\dot{\gamma}$ =100 s^{-1}) ≈ 4.83 Pa

- at 37 °C μ ≈ 0.0263 Pa•s → τ($\dot{\gamma}$ =100 s^{-1}) ≈ 2.63 Pa

- at 60 °C μ ≈ 0.0127 Pa•s → τ($\dot{\gamma}$ =100 s^{-1}) ≈ 1.27 Pa

At small $\dot{\gamma}$ (e.g. <1 s^{-1}) τ is small, but proportional to $\dot{\gamma}$; at large $\dot{\gamma}$ (e.g. in pumps, injections, atomization) τ becomes significant.

The direct result: at low temperatures much higher forces/tensions are needed for the same deformation rate (pumping, mixing).

Crude oils, with particles, phospholipids, impurities or in emulsions may exhibit: shear-thinning, yield stress or rheological hysteresis. If the oil is cold-pressed, unrefined or contains solids, verify experimentally; do not assume pure Newtonian [13, 15].

Figure 4 shows the dependence of dynamic viscosity on shear rate for pumpkin seed oil at 20^0C.

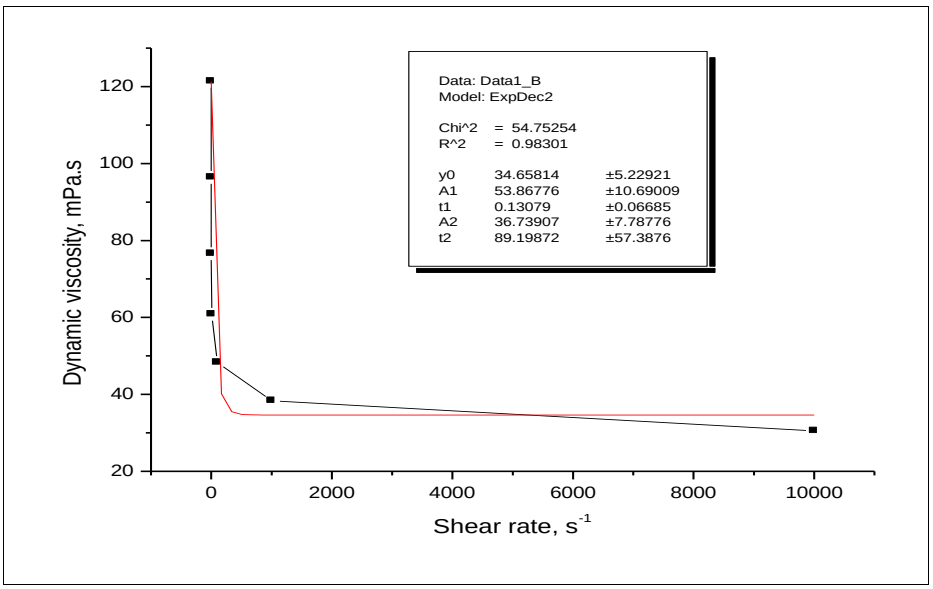

Fig 4: Dependence of dynamic viscosity on shear rate for pumpkin seed oil at 20^0C.

Newtonian reference behavior (most likely for pure vegetable oils): μ is practically independent of $\dot{\gamma}$ at usual conditions; the relationship τ = μ•$\dot{\gamma}$ is linear. For initial designs use constant values of μ at the working temperature (e.g.: 48.3 mPa•s at 20 °C, 26.3 mPa•s at 37 °C, 12.7 mPa•s at 60 °C — previous estimates).

If the oil is unrefined, contains solids/impurities, phospholipids or is in the form of an emulsion, shear-thinning (μ decreases when $\dot{\gamma}$ increases) or even yield stress may occur.

Independent of the model (Newtonian or non-Newtonian), increasing temperature reduces μ, so for the same $\dot{\gamma}$ the stress τ decreases significantly [16, 20].

Conclusions

The study of the rheological properties of pumpkin seed oil revealed that it behaves predominantly as a Newtonian fluid in the temperature and shear rate ranges analyzed. Its viscosity decreases with increasing temperature, which is characteristic of most vegetable oils, and indicates increased molecular mobility and reduced intermolecular interactions.

This predictability and rheological stability facilitates the industrial processing of the oil, including pumping, mixing and formulation of food or cosmetic products. The results obtained emphasize the fact that pumpkin seed oil is a valuable raw material, with stable and predictable rheological behavior, comparable to other common vegetable oils, and recommends its use in the development of functional and sustainable products.

Reference

1. Subagio A, Morita N. Food Chemistry,2003:81:97–102.
2. Dupont J, White PJ, Carpenter MP, Schaefer EJ, Meydani SN, Elson CE, *et al.* Journal of the American College of Nutrition,1990:9(5):438–470.
3. Veljković VB, Biberdžić MO, Banković-Ilić IB, Djalović IG, Tasić MB, Nježić ZB, Stamenković OS. Renewable and Sustainable Energy Reviews,2018:91:531–548.
4. Beadle JB, Just DE, Morgan RE, Reiners RA. Journal of the American Oil Chemists' Society,1965:42(2):90–95.
5. Strocchi A. Journal of Food Science,1982:47(1):36–39.
6. Stanciu I. Rheological behaviour of biodegradable lubricant. Journal of Science and Arts,2019:3(48):703–708.
7. Stanciu I. Rheological investigation of soybean oil from soya beans. Journal of Science and Arts,2019:4(49):938–988.
8. Stanciu I. Modeling the temperature dependence of dynamic viscosity for rapeseed oil. Journal of Science and Arts,2011:1:55–58.
9. Meneghetti SMP, Meneghetti MR, Wolf CR, Silva EC, Lima GE, Coimbra MDA, *et al.* Journal of the American Oil Chemists' Society,2006:83(9):819–822.
10. Stanciu I. Journal of Science and Arts,2018:18(2):453–458.
11. Sheibani A, Ghotbaddini-Bahraman N, Sadeghi F. Oriental Journal of Chemistry,2014:30(3):1205–1209.
12. Stanciu I. Some methods for determining the viscosity index of hydraulic oil. Indian Journal of Science & Technology,2023:16(4):254–258.
13. Stanciu I. Rheological behavior of corn oil at different viscosity and shear rate. Oriental Journal of Chemistry,2023:39(2):335–339.

14. Stanciu I. Rheological characteristics of corn oil used in biodegradable lubricant. Oriental Journal of Chemistry,2023:39(3):592–595.
15. Stanciu I. Effect of temperature on rheology of corn (Zea mays) oil. Oriental Journal of Chemistry,2023:39(4):1068–1070.
16. Stanciu I. Study rheological behavior of rapeseed oils compared to mineral oil. Oriental Journal of Chemistry,2021:37(1):247–249.
17. Stanciu I. Influence of temperature on the rheological behavior of orange honey. Oriental Journal of Chemistry,2021:37(2):440–443.
18. Hunsom M, Saila P, Chaiyakam P, Kositnan W. International Journal of Renewable Energy Research,2013:3(2).
19. Catterick J, Thornton P. Advances in Inorganic Chemistry and Radiochemistry. Emeleus HJ, Sharpe AG, editors. Academic Press,1977:20.
20. Oliveira FF. Physical-chemical characterization of pine oil samples and study on surfactants systems action in antimicrobial activity of active phenolic. PhD thesis, University of São Paulo,2008.