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Rheological Behavior of Corn oil at Different Viscosity and Shear rates

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ABSTRACT

In this article I presented the rheological behavior of corn oil studied in the temperature range 40-100°C and shear rates between 3.3 and 1312.0 s^{-1}. The experiments showed the decrease of dynamic viscosity with temperature and shear rate. To study the dependence of dynamic viscosity on temperature, we applied two equations that perfectly describe the rheological behavior of corn oil. These equations are the Andrade equation and the Azian equation for which the correlation coefficients have values close to unity.

Keywords: Rheology, Corn oil, Viscosity, Shear rates

INTRODUCTION

Corn oil is transparent, with a neutral taste. The color and smell depend on the production method. Basic raw materials are mature embryos of corn kernels. Possible colors of corn oil are light yellow, bright yellow, dark red-brown.

Maize is a monotonous annual growth of up to 3 meters. A solid stem with nodes along the entire length is covered with dense linear leaves of a saturated green color. The fruit is a berry. Fruits are collected in gross domestic products (GDPs), covered with leaf-shaped overhangs[1-5].

The oil includes

Linoleic acid is necessary for the normal activities of the heart, normalizes insulin, stabilizes the activity of the nervous system, improves metabolism.

Oleic acid- Reduces cholesterol, supports the heart muscle.

Palmitic acid- It is necessary to ensure the process of energy accumulation. The most important element in the synthesis of stearic acid. A large amount of palmitic acid is harmful.

Stearic acid must ensure the process of energy accumulation

Acid archive- It is necessary to normalize the tone of the muscle frame and quick recovery after loads.

Vitamin A (retinol)- Reflected on the quality of vision, strengthens resistance to infections, restores skin turgor, and improves the functioning of the gastrointestinal tract.

Vitamin B1 (thiamine)- Improves brain activity, stimulates blood formation, opposes the development of depressive states.

Vitamin P (Rutin)- Contributes to the absorption of vitamin C, normalizes pressure and lipid processes in water, opposes body aging and oncological diseases.

Vitamin K (Philokinon)- Contributes to the healing opposes osteoporosis, stabilizes redox reactions, helps to remove poisons from the body.

Vitamin D necessary for the quality of the nervous system, ensures the strength of the musculoskeletal system and teeth.

Vitamin E (tocopherol)- mandatory for all systems, strong antioxidant, improves skin turgor.

Vitamin C. (Ascorbic acid)- necessary for normal homeostasis, stimulates the endocrine system, strengthens vessel walls, powerful antioxidant.

Magnesium it opposes the formation of stones in a bubble and bustard kidneys, strengthens the heart muscle and the nervous system[6-12].

Phosphorus- The need for normal metabolism, strong teeth and bones, stable kidney work, hearts.

Potassium Necessary for the strength of the heart muscle, normal water-lipid metabolism, good mood.

Copper- It is necessary for persistent immunity, normal bleeding.

The oil is removed from the grain embryos. Natural fruit oil from 32 to 37%.

Pressing (cold or hot), extraction, pressing and extraction.

When pressed, the grain mint is subjected to cold or hot pressure.

In the first case, the raw materials are not treated at high temperatures. As a result, the oil acquires the light color, natural taste and aroma of oilseeds.

In the second case dry fried for some time. This leads to a decrease in the viscosity of the oil, which provides a faster process of extracting the fatty substance from the raw materials.

To neutralize the negative effect of temperature on the oil and not reduce the percentage of production, steam the grain mint. Having a temperature of the raw material at 90^0C and increasing the humidity up to 12%, the mass is pressed under moderate pressure. At the same time, the mint process provides gives the majority contained in it.

The remaining part is removed under high pressure, applied after drying the raw materials and bring it to a temperature of 1200°C. The extracted secondary oil, has a pronounced smell, needs refining.

Corn wheat starch is used in the production of tablets, baby powder and glucose. Water in which corn kernels have been soaked, is demand in the production of antibiotics.

In extraction, grain mint is mixed with solvent fatty substance, for example, purified gasoline. The method allows obtaining oil, free of harmful components (resins, oxides, pigments). After extracting the gasoline oil, the latter is completely separated.

When processing mint from very suitable seeds, apply the combined processing of raw materials: pressing and extraction.

Corn oil has a lot of useful properties, so it is:

- Protects against the effects of free radicals due to the impact on the person of chemical substances, adverse emissions.
- Improves the activity of the gastrointestinal tract, the nervous, cardiovascular and endocrine systems.
- Copies inflammatory processes.
- They can be applied to the treatment of burns.
- Helps fight skin disorders.
- Improves the activity of the pancreas and gall bladder.

MATERIAL AND METHODS

Corn oil was studied in the temperature range 40-100°C

Rheological measurements were using a rotational viscometer Rheotest RV which can develop shear rates between 3.3 and 1312 s^{-1}, with two measuring ranges- I and II, and two speeds- a and b. Depending on the measurement range and rate, apparent viscosity, between 1 and 10 mPa•s can be measured using cylinder S_1.

The rheoviscosimeter measures a proportional value, by constant of cylinder with shear stress applied to the measurement system. To obtain the shear stress in mPa, the constant of cylinder is 114 for range I and 567 for range II. The shear speeds are between 3.3 and 120 s^{-1}.

RESULTS AND DISCUSSION

The rheogram (shear stress-shear rate dependence) for corn oil, represented in Fig. 1 was drawn with data from Table 1. The rheogram shows that viscosities-calculated at each point as the ratio of shear stress and shear rate-decrease with increasing shear rate, which means that this cream has a pseudoplastic behavior.

It can be seen from the table that the viscosity of corn oil decreases with increasing temperature and shear speed. At high shear speeds, the viscosity of the oil remains constant.

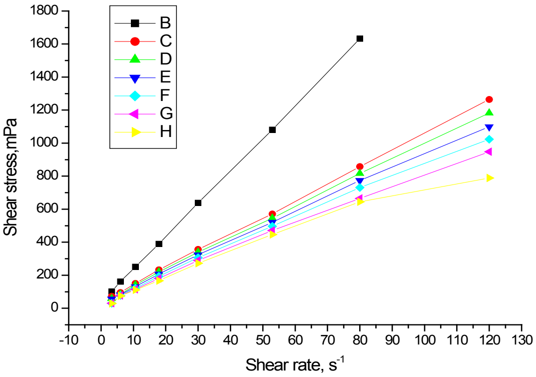

Fig. 1. The rheogram of corn oil at increasing the shearing rate and temperatures B-40°C, C-50°C, D-60°C, E-70°C, F-80°C, G-90°C and H-100°C

Table 1: The results of rheological measurements for corn oil at increased shear rates

Shear rate, s^{-1}	40°C Shear stress, Pa	50°C Shear stress, Pa	60°C Shear stress, Pa	70°C Shear stress, Pa	80°C Shear stress, Pa	90°C Shear stress, Pa	100°C Shear stress, Pa
3.3	101.6400	72.8310	58.7400	55.9350	30.6240	29.7660	28.7430
6	161.7000	95.1600	84.4800	81.3000	78.1200	76.7400	74.9400
10.6	251.4320	150.9440	140.7680	130.8040	120.8400	114.1620	110.9820
17.87	389.3873	233.2035	219.9797	206.7559	193.5321	180.3083	167.0845
30	638.7000	356.7000	339.9000	323.1000	306.3000	289.5000	272.4000
52.95	1081.2390	570.8010	545.9145	521.0280	496.1415	471.2550	445.8390
80	1632.000	858.4000	816.0000	773.6000	731.2000	664.8000	644.8000
120	-	1264.8000	1182.0000	1099.2000	1023.6000	948.0000	788.4000

Figures 2-4 show the dependence of the dynamic viscosity on the shear speed, respectively the log of the dynamic speed against on the log of the shear speed.

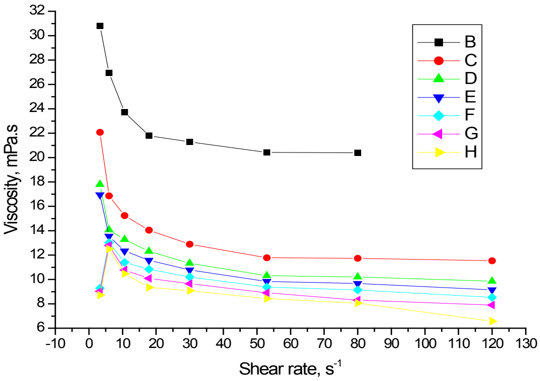

Fig. 2. The dependence dynamic viscosities–shear rates at different temperatures B-40°C, C-50°C, D-60°C, E-70°C, F-80°C, G-90°C and H-100 °C

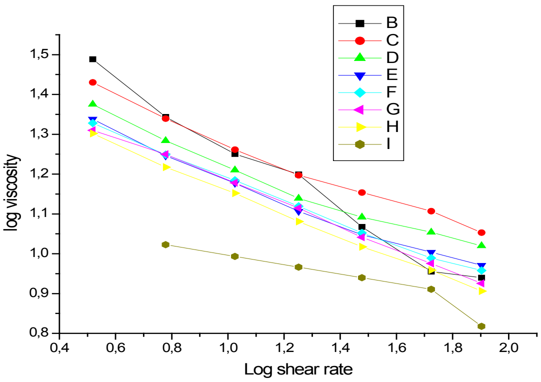

Fig. 3. A log-log plot of viscosity versus shear rate of Figure 2.

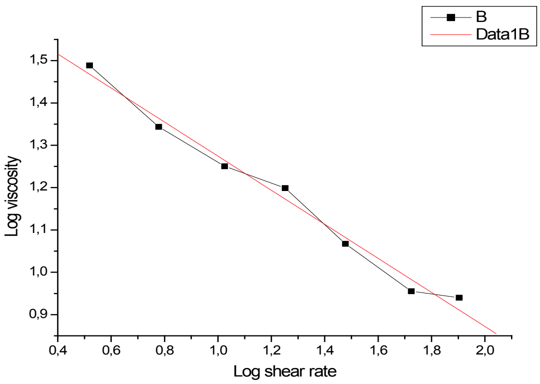

Fig. 4. A log-log plot of viscosity versus shear rate of Fig. 2 at temperatures 40°C

The figure shows a very good linearity of the data and the equation obtained by linear regression is expressed as:

log η= 1.67673–0.40245 log

With a very good value of correlation coefficient (r = 0.99286) and a standard deviation SD = 0.02657.

Figure 5 shows the dependence of dynamic viscosity on temperature for low shear rates as $3.3s^{-1}$, $6s^{-1}$ and $10.6s^{-1}$. The viscosity of corn oil decreases with increasing temperature due to the orientation of the oil molecules.

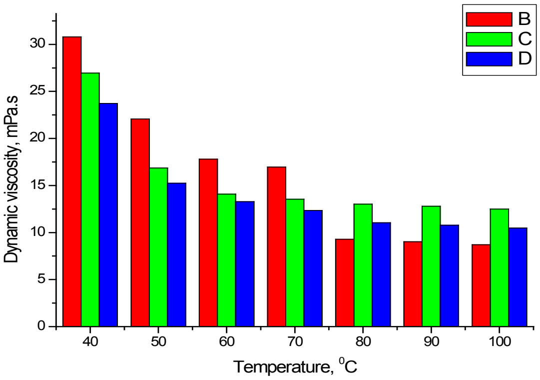

Fig. 5. Variation of viscosity with temperature at different shear rate as $3.3s^{-1}$, $6s^{-1}$ and $10.6s^{-1}$ for corn oil

To support our results regarding the variation in viscosity depending on temperature, the Andrade equation (1) and the Azian equation (2)[12-16] were used:

$$\ln \eta = \ln A + \frac{B}{T} \quad (1)$$

$$\ln \eta = A + \frac{B}{T} + \frac{C}{T^2} \quad (2)$$

Where T is the absolute temperature and A, B and C are material constants. The rheological parameters of the Andrade and Azian equations as well as the correlation coefficients are presented in Tables 2 and 3. It should be noted that the resulting correlation coefficients are higher for the Azian equation (values between 0.94128 and 0.99984). This equation approximates very well the experimental results, and can be used to determine the variation of the dynamic viscosity of the corn oil depending on their temperature.

Table 2: Parameters of the Andrade equation

Shear rate, s^{-1}	Value of parameters of the described by equation Andrade		R^2
	A	B	
3.3	-4.9816	2625.6311	0.96784
6	-2.0283	1656.1019	0.99576
10.6	-1.9884	1600.9316	0.99196
17.87	-2.2789	1668.5066	0.99533
30	-2.3967	1707.6516	0.99878
52.95	-2.6264	1776.6710	0.99873
80	-2.6887	1779.9461	0.99984
120	-0.7790	1024.6746	0.9492

From Table 1 it can be seen that the parameter A decreases at low shear rates and remains almost constant at high shear rates. Parameter B with increasing shear rate approaching unity. The correlation coefficients have values close to unity.

Table 3: Parameters of the Azian equation

Shear rate, s^{-1}	Value of parameters of the described by equation Azian			R^2
	A	B	C	
3.3	10.7517	-0.0221	-4.49107E-6	0.94128
6	24.7091	-0.1147	1.47912E-4	0.99934
10.6	25.2414	-0.1186	1.53445E-4	0.9997
17.87	21.0494	-0.0937	1.15816E-4	0.9995
30	11.1425	-0.0348	2.85875E-5	0.99956
52.95	6.2486	-0.0058	-1.43982E-5	0.99963
80	14.2905	-0.0537	5.61732E-5	0.99958
120	4.7011	-0.0080	2.37143E-6	0.99972

Table 2 shows the parameters of the Azian equation applied to the studied corn oil. Parameter A of the equation decreases with increasing shear speed, parameter B approaches the zero value, and parameter C increases with increasing shear speed. The correlation coefficients have values close to unity.

CONCLUSION

This study focuses on the variation of dynamic viscosity with temperature and shear rate for corn oil. It was noted that the viscosity decreases with increasing shear rate and temperature. A significant decrease in viscosity is recorded at low shear rates. Corn oil has a pseudoplastic behavior throughout the temperature range at which it was studied.

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Conflict of interest

The author declare that we have no conflict of interest.

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