

Thermodynamic, kinetic investigation and shelf life of Oreganum herachoticum essential oil

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ABSTRACT

Essential oils and their main components are widely used in various industries. The essential oil of Oreganum herachoticum is used in the food industry to impart a specific flavour to certain foods, to stabilize them and to increase their shelf life. It has been studied long-term for 45 days at three temperatures. The oxidation process is presented and the rate constant is determined based on the Arrhenius equation. They have values from 0.015 at 6°C to 0.064 1.day⁻¹ at 25°C. Then the shelf life prediction is presented. It varies in the range from 71 days at 6°C to 15 days at 25°C. The thermodynamic parameters of the active state - enthalpy, entropy and Gibbs free energy - were calculated at the presented temperatures. The Gibbs energy varies from 16.172 at 6°C to 16.413 kJ mol⁻¹ at 25°C. The enthalpy and entropy are respectively 11.748 kJ mol⁻¹ and - 0.015 kJ mol⁻¹ K⁻¹.

MATERIALS AND METHODS

The effect of temperature on the rate of the oxidation process was expressed by the Arrhenius equation and shelf life:

$$k = Ae^{-\frac{E_a}{RT}} \quad t_s = \frac{\ln A_0 - \ln A}{e^{-\frac{E_a}{RT}}}$$

RESULTS AND DISCUSSION

Oreganum herachoticum essential oil was investigated by provided experiment at three temperatures 6, 20 and 25°C. First is determined the main kinetic parameter rate constant with application of Arrhenius equation. Based on it the shelf life and activation energy were calculated.

On Fig. 1 is seen dependence between time in days and natural logarithm of absorbance. The figure used to determine the order of the reaction. The essential oil is presented zero order.

On the Fig. 2 is presented dependence between shelf life, Gibbs energy and temperature. According the obtained results the shelf life is so high at small Gibbs energy. These are the expected results.

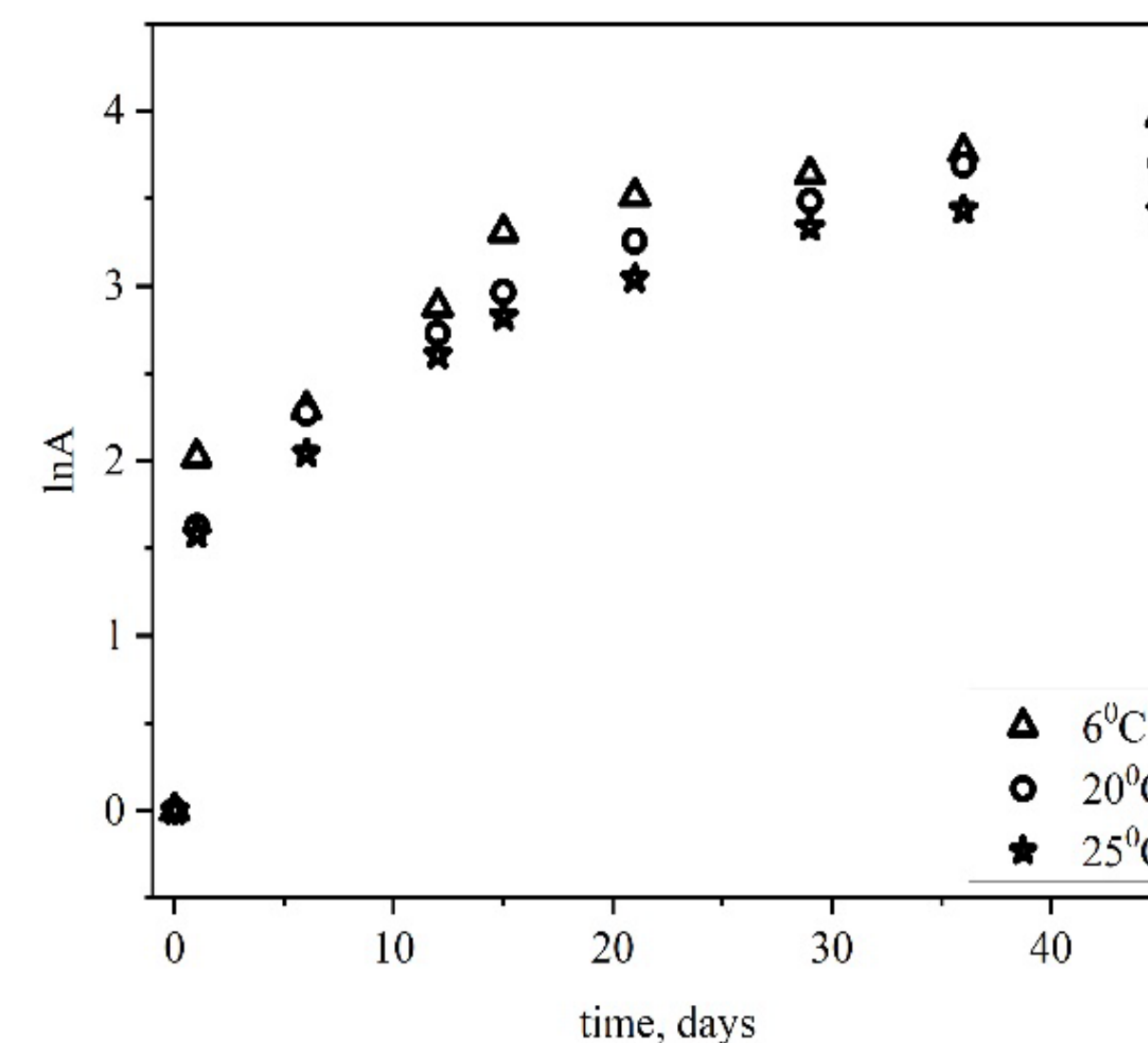


Fig. 1. Dependence between natural logarithm of absorption and storage time of Oreganum herachoticum essential oil.

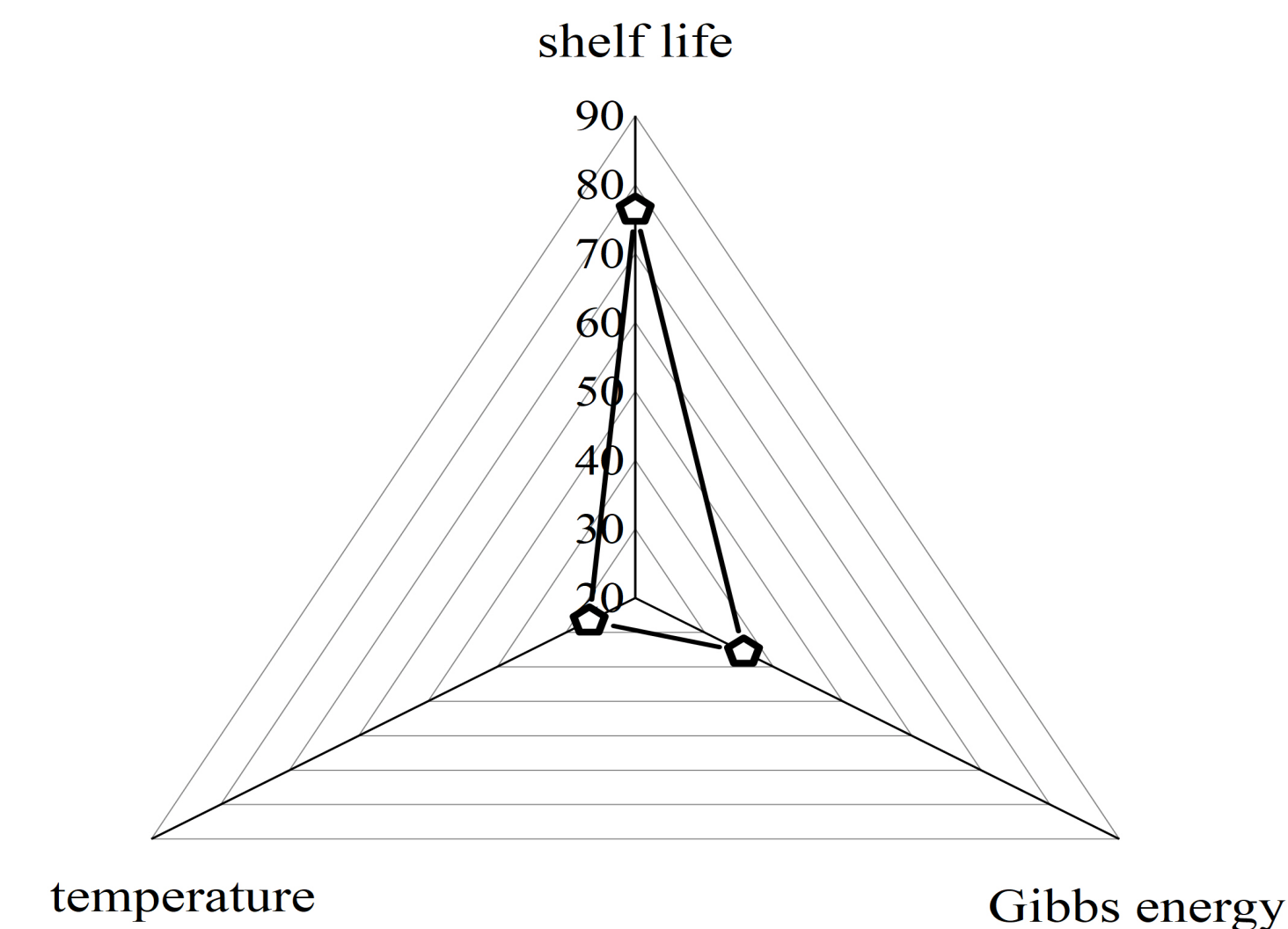


Fig. 2. Temperature dependence between shelf life and Gibbs energy of Oreganum herachoticum essential oil.

Table 1. Rate constant, shelf life and activation energy of Oreganum Herachoticum essential oil.

t, °C	k, 1.day ⁻¹	Shelf life, days
6	0.015±0.001	71.266±0.242
20	0.051±0.001	20.158±0.123
25	0.064±0.005	15.062±0.085

Table 2. Thermodynamic parameters of active complex of Oreganum Herachoticum essential oil.

t, °C	ΔG‡, kJ mol ⁻¹	ΔH‡, kJ mol ⁻¹
6	16.172±0.076	11.748±0.128
20	16.336±0.103	
25	16.413±0.094	

CONCLUSIONS

The essential oil of Oreganum herachoticum was studied at different temperatures (6, 20 and 25°C) to determine its oxidative stability. The three kinetic parameters rate constant, shelf life and activation energy were obtained. The rate constant has low values. The shelf life is represented by values: at 60°C - 72 days, at 20°C - 20 days and at 25°C - 15 days. The activation energy is 11.906 kJ.mol⁻¹. It has values comparable to essential oils. The active parameters were calculated: Gibbs free energy, enthalpy and entropy. The obtained values for physicochemical, kinetic and thermodynamic parameters show that the studied essential oil is suitable for inclusion in food products. It will increase their quality by preserving their shelf life.