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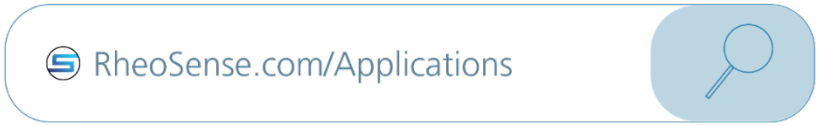
Differentiating cannabis products with viscosity measurements

Key Words: viscosity, cannabis oil, temperature sweep, Arrhenius model

Goal: The viscosity of three commercially available cannabis products was measured as a function of temperature. The results illustrate the ability to distinguish formulations based on composition and intended application. A modified Arrhenius model can also be fit to the data and used to predict the viscosity at other relevant temperatures.



Introduction

Viscosity is a critical parameter when formulating cannabis oil products since it will impact both the processing and performance. A common processing concern is the ability to consistently achieve accurate fill volumes so that manual correction is not required. Performance challenges can include device compatibility and failure at extreme environmental temperatures. Leaking can occur at elevated temperatures and dispensing can be difficult or limited in cold climates. Quantifying the viscosity response to temperature can guide any necessary modifications to the formulation composition, processing conditions, or application method to ensure success.

Experiment

Three commercially available cannabis products were tested between 30 and 70°C with the **VROC® Initium**. Product details are provided in **Table 1**. The samples were manually injected, and the viscosity data was collected in automatic mode with a C05 flow channel (depth = 50 μm, P_{max} = 200 kPa). The samples and syringes were pre-heated to facilitate loading of the high viscosity fluids. Measurements began at 70°C and temperature was ramped down. Three data points were averaged at each temperature.

Product Name	Ingredients	Intended Use
Pure INDICA	Cannabis oil, natural terpenes (THC 91.8%, CBD 1.1%)	Dabbing, eating, smoking
Raw Garden Mendo Snaps	Whole flower terpenes, cannabis oil (THC 79.50%, CBD 0.32%)	Vape cartridge
KINGPEN JILLY BEAN	Cannabis oil (THC 82.88%, CBD 0.20%)	Vape cartridge

Table 1: Cannabis products, ingredients, and intended use.

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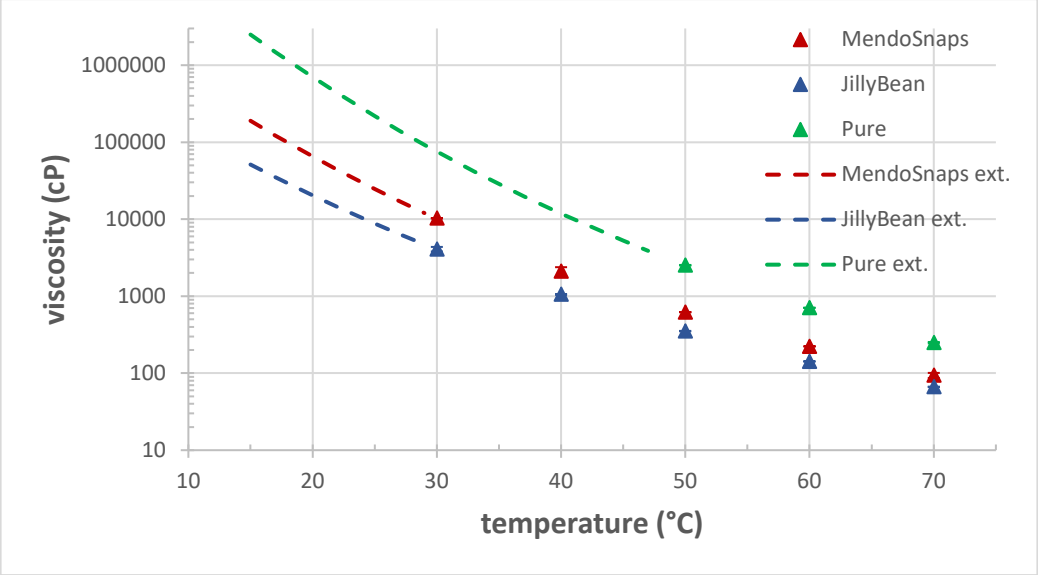

Figure 1: Viscosity versus temperature for the three cannabis products. Error bars represent three standard deviations. Dashed lines correspond to extrapolation from model fitting parameters.

Viscosity Data and Analysis

The viscosity versus temperature data for the three products is presented in **Figure 1**. Viscosity values decrease with increasing temperature for all samples. The drop in viscosity between 30 and 70°C is two orders of magnitude. The multi-purpose Pure product is higher in viscosity than the two others intended for vaping cartridges. The maximum difference between formulations is nearly a factor of ten at 50°C.

Fitting the data to interpolate or extrapolate to other relevant temperatures can be convenient. The original Arrhenius or exponential model has the following form.

$$\eta = Ae^{\frac{E_a}{RT}}$$

η is the viscosity, A an exponential pre-factor, E_a the activation energy, R the universal gas constant, and T the temperature. Taking the natural logarithm and adding a higher order term ($\frac{1}{T^2}$) to improve the fit quality produces the following expression.

$$\ln \eta = \ln A + \left(\frac{E_a}{RT} + \frac{B}{T^2}\right)$$

The data is presented in an appropriate form in **Figure 2** to facilitate fitting to the modified model. The parameters are used to extrapolate to lower temperatures and included with the measured data in **Figure 1**. Although it is best to be cautious when interpreting an extrapolation of data, it can still be used to gauge the rate of increase in viscosity with cooling and predicting difficulties in handling or performance.

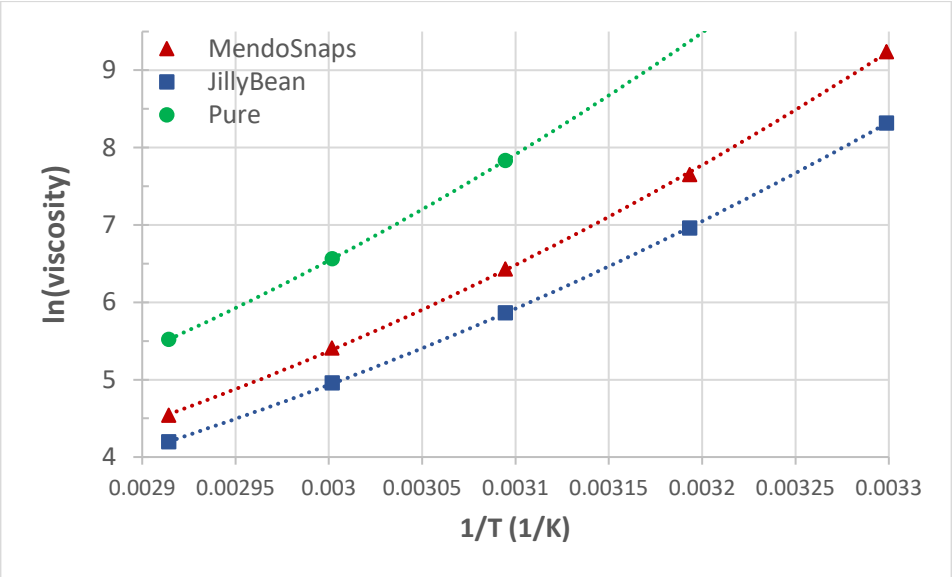

Figure 2: Natural logarithm of viscosity versus inverse temperature in Kelvin. Dashed lines correspond to modified Arrhenius fits.

Concluding Remarks

Viscosity is very sensitive to both temperature and formulation composition. Viscosity measurements can distinguish samples based on ingredients and predict performance and handling under a variety of practical environmental conditions.

If this note is helpful, please let us know! If you have questions or need more information about this product or other applications, please contact us:

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