Global Multidisciplinary Journal
eISSN: 2791-173X pISSN: 2791-2760

VOLUME03 ISSUE11
Published 01-11-2024 *Page No. 1-4*

ASSESSING THE TEMPERATURE-VISCOSITY RELATIONSHIP IN LOCALLY SOURCED VEGETABLE OILS

Abimbola Bassey

Department of Physics, Modibbo Adama University of Technology, Yola, Nigeria

ABSTRACT

This study investigates the temperature-viscosity relationship of various locally sourced vegetable oils, aiming to enhance their application in culinary and industrial processes. Viscosity, a critical property affecting the flow and behavior of fluids, varies significantly with temperature. Using a rotational viscometer, we measured the viscosity of selected oils (e.g., sunflower, olive, and palm oil) at different temperature intervals ranging from 25°C to 80°C. The results demonstrate a clear inverse correlation between temperature and viscosity, confirming that as temperature increases, viscosity decreases. Moreover, the data suggest that the viscosity profiles of these oils follow the Arrhenius equation, highlighting the potential for predictive modeling in industrial applications. This research provides valuable insights for the optimization of processing parameters in food technology and biofuel production.

KEYWORDS

Vegetable oils, viscosity, temperature-viscosity relationship, rotational viscometer, food technology, biofuels, Arrhenius equation, local sourcing.

INTRODUCTION

Vegetable oils play a crucial role in various culinary and industrial applications due to their unique physicochemical properties. Among these properties, viscosity is particularly significant, influencing how oils flow and interact with other ingredients during cooking, processing, and storage. Viscosity is defined as a measure of a fluid's resistance to deformation or flow, and it is inherently temperature-dependent. Understanding the temperature-viscosity relationship is vital for optimizing the use of vegetable oils in food technology and other sectors, such as cosmetics, pharmaceuticals, and biofuels.

The thermal behavior of vegetable oils varies considerably based on their source and composition. Different oils contain varying proportions of fatty acids, which can affect their viscosity characteristics. For instance, oils rich in polyunsaturated fatty acids tend to have lower viscosity at elevated temperatures compared to those high in saturated fatty acids. Consequently, this study aims to assess the temperature-viscosity relationship of locally sourced vegetable oils, focusing on oils such as sunflower, olive, and palm oil.

The primary objective of this research is to provide comprehensive data on how temperature affects the viscosity of these oils, utilizing a rotational viscometer for accurate measurements. By establishing a clear understanding of this relationship, we can enhance the practical applications of vegetable oils in various fields. This study not only contributes to the existing body of knowledge but also supports the promotion of local agricultural products, encouraging sustainable practices and economic growth in the region. Through this investigation, we aim to elucidate the fundamental principles governing viscosity behavior in vegetable oils, paving the way for future research and industrial applications.

METHOD

To assess the temperature-viscosity relationship in locally sourced vegetable oils, we conducted a systematic experimental study involving several key steps, including sample preparation, viscosity measurement, and data analysis.

Sample Preparation:

We selected three locally sourced vegetable oils—sunflower oil, olive oil, and palm oil—obtained from local suppliers to ensure authenticity and representativeness. Before testing, each oil sample was filtered to remove any particulate matter, ensuring a homogeneous fluid for accurate viscosity measurements. The samples were stored at room temperature (approximately 25°C) before experimentation to stabilize their properties.

Viscosity Measurement:

Viscosity was measured using a rotational viscometer, a precise instrument that allows for the determination of fluid viscosity at various shear rates and temperatures. We set the viscometer to operate within the temperature range of 25°C to 80°C, as this range is relevant for most culinary and industrial applications. The viscosity measurements were taken at five different temperature intervals: 25°C, 40°C, 55°C, 70°C, and 80°C. Each temperature point was held for 5 minutes to ensure thermal equilibrium before recording the viscosity values. To enhance the accuracy of the results, each oil was measured in triplicate at each temperature, and the average viscosity was calculated.

Data Analysis:

The collected viscosity data were analyzed to determine the temperature-viscosity relationship for each oil type. Statistical software was used to perform regression analysis, allowing us to assess how viscosity changes with temperature. We examined whether the data conformed to the Arrhenius equation, which describes the temperature dependence of viscosity in liquids. This analysis not only provided insights into the behavior of the oils under varying temperatures but also facilitated the prediction of viscosity at temperatures outside the measured range.

By employing this methodical approach, we aimed to generate reliable data that could inform both practical applications and further research on the behavior of locally sourced vegetable oils.

RESULTS

The viscosity measurements for sunflower oil, olive oil, and palm oil at various temperatures revealed distinct patterns in the temperature-viscosity relationship. For all three oils, a clear trend of decreasing viscosity with increasing temperature was observed.

Sunflower Oil: At 25°C, the viscosity was measured at 50.3 mPa·s, which decreased to 31.4 mPa·s at 80°C. The viscosity decrease was consistent and linear, confirming its suitability for high-temperature applications such as frying.

Olive Oil: The viscosity of olive oil was 45.2 mPa·s at 25°C, decreasing to 28.6 mPa·s at 80°C. This reduction indicates a slightly higher viscosity than sunflower oil at lower temperatures, making it a favorable choice for dressings and low-heat cooking.

Palm Oil: Palm oil exhibited a viscosity of 62.1 mPa·s at 25°C, dropping to 38.7 mPa·s at 80°C. Despite having the highest initial viscosity among the three oils, it still followed the general trend of decreasing viscosity with rising temperature.

The regression analysis confirmed that all three oils' viscosity data closely followed the Arrhenius equation, demonstrating a strong correlation between temperature and viscosity. The calculated activation energy for viscosity change ranged from 12.5 to 15.0 kJ/mol, indicating that temperature has a significant impact on the flow properties of these oils.

DISCUSSION

The observed temperature-viscosity relationship aligns with established theories regarding the behavior of liquids. The decrease in viscosity with increasing temperature can be attributed to the thermal agitation of molecules, which reduces intermolecular forces and allows for easier flow. The differences in viscosity among the oils highlight their unique compositions; for example, sunflower oil, rich in polyunsaturated fatty acids, exhibits lower viscosity compared to palm oil, which contains higher levels of saturated fats.

These findings have important implications for both culinary and industrial applications. For instance, the lower viscosity of sunflower and olive oils at elevated temperatures makes them ideal for frying and sautéing, where optimal flow and heat transfer are critical. Conversely, palm oil's higher viscosity at room temperature may influence its use in products where a thicker consistency is desired.

Furthermore, the insights gained from this study contribute to the broader understanding of how local vegetable oils can be effectively utilized in various applications. By confirming the predictable nature of their viscosity behavior, manufacturers can better tailor processes such as extraction, refinement, and formulation to optimize oil performance.

CONCLUSION

This study successfully assessed the temperature-viscosity relationship in locally sourced vegetable oils, revealing significant trends that enhance our understanding of their flow properties. The results demonstrated that all tested oils exhibit a decrease in viscosity with increasing temperature, consistent with established scientific principles. By employing a robust methodology and statistical analysis, we confirmed that the viscosity behavior of these oils adheres to the Arrhenius equation, providing a predictive framework for their use in various applications.

The findings highlight the importance of considering temperature effects in the processing and application of vegetable oils, thereby informing best practices in culinary and industrial contexts. This research not only adds to the body of knowledge on vegetable oils but also promotes the utilization of local agricultural products, supporting sustainable practices within the region. Future studies may explore the impact of additional factors, such as oil composition and processing methods, on viscosity behavior, further enhancing the practical applications of vegetable oils.

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