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PHYSICO-CHEMICAL CHARACTERIZATION OF 1-ETHYL-3-((4-METHOXY-3,5-DIMETHYLPYRIDIN-2-YL)METHYL)THIOUREA IN 50% ETHANOL-WATER SOLUTIONS

Usha Wasnik[1], V. P. Patil[2], M. R. Soyam[3], P.V. Raut[4]*
1-Department of Chemistry, Arts, Science and Commerce College, Chikhaldara Dist- Amravati Maharashtra, India .
2;3,4-Department of Chemistry, Smt. Radhabai Sarda Arts, Commerce and Science College Anjangaon Surji Dist Amravati Maharashtra India.
***Email:** -*pavanraut523@gmail.com*

ABSTRACT

Heterocyclic molecules play a vital role in medicinal chemistry, serving as the fundamental framework for numerous pharmaceutical drugs. Pyridine, a six-membered heteroaromatic ring, is a key component of various natural compounds, including vitamins and alkaloids, and its derivatives are widely recognized for their versatility in drug development. In a recent study conducted in our laboratory, we examined the viscosity and density of 1-ethyl-3-((4-methoxy-3,5-dimethylpyridin-2-yl)methyl)thiourea under controlled concentrations and different temperature conditions. The experimental data provided valuable insights into solute-solvent interactions and the effects of solvent dilution. The findings demonstrated that relative viscosity decreases as temperature increases, suggesting enhanced solvation effects. This research contributes to a deeper understanding of the physicochemical behavior of pyridine derivatives, aiding in the development of more effective pharmaceutical compounds.

KEYWORDS

Heterocyclic molecules, pyridine derivatives, Viscosity, Density, Solute-solvent interactions, 1-Ethyl-3-((4-Methoxy-3,5-Dimethylpyridin-2-yl)Methyl)Thiourea,etc.

INTRODUCTION

Heterocyclic compounds containing sulfur and nitrogen are essential for life. These molecules play a crucial role in various biological systems and processes, appearing in diverse ring structures. The presence of nitrogen and sulfur atoms is fundamental to their biological activity, giving them distinct chemical properties and reactivity patterns[1,2]. Pyridine derivatives exhibit a wide range of biological applications. Due to its pharmacological properties, the pyridine heterocycle is extensively utilized in the development of new drugs. Pyridine-based compounds are employed in the formulation of anti-inflammatory, antibacterial, antiviral, anticancer, antioxidant, antihypertensive, antidiabetic, and antimalarial medications. Additionally, their strong affinity for various ions and neutral species makes pyridine derivatives highly effective as chemosensors for detecting different substances[3]. Pyridine nucleus substitutions target a wide spectrum of biological concerns, including microbial infections, viral diseases, and various cancer cells. Pyridine derivatives interact with enzymes, proteins, and DNA, playing a crucial role in addressing diverse biological challenges[4]. The compounds that contain the nucleus of 2-(Chloromethyl)-4-Methoxy-3,5- Dimethylpyridine have gained their own relevance and importance in organic chemistry because of their numerous applications in pharmaceutical,

industrial, biological, agricultural, and industrial science[5-7].Measurements of viscosity are important. Viscosity is a fundamental property of liquids that defines their resistance to flow. It measures how resistant a liquid is to its layers shifting relative to one another. This resistance is brought on by internal friction that develops as the liquid's molecules move and interact with one another[8].Solute-solvent interactions occur in both aqueous and non-aqueous solutions, and valuable insights into these interactions can be gained through viscometric measurements. The viscosity and solvent interactions of a drug play a crucial role in determining its absorption, distribution, and effects within the human body[9].

Considering these aspects, evaluating the viscometric concentration of 1-Ethyl-3-((4-Methoxy-3,5-Dimethylpyridin-2-yl)Methyl)Thiourea across different temperatures is highly significant[10]. Numerous pharmacological and biochemical properties of pyridine derivatives, including antiviral, antibacterial, anti-inflammatory, anesthetic, and mydriatic effects, have been documented in the literature. Additionally, the heterocyclic compound featuring a 1,3,5-dithiazino core is widely utilized in medicine, biochemistry, biotechnology, and pharmaceutical sciences[1,2,8]. One of the most important applications of thiourea derivatives is their anti-cancer properties[11-16]. All things considered, this kindof research advances the field of drug science and helps create pharmaceutical goods that are more dependable and effective, which eventually improves patient outcomes[1,2,17].

Water-alcohol mixtures are intriguing systems due to their complex dynamics, influenced by hydrogen bonding and hydrophobic interactions. These mixtures are extensively studied both theoretically and experimentally because of their broad applications as solvents. Various factors, including temperature, molecular size, weight, intermolecular forces, and impurities, can impact a liquid's viscosity. Analyzing viscosity helps in understanding the molecular interactions and characteristics of binary and ternary liquid systems, where favorable interactions can lead to increased viscosity. Density plays a crucial role in determining whether a substance will float or sink in a liquid, with materials floating if their density is lower than that of the liquid. Moreover, density is a fundamental physical property used to evaluate various acoustic and physical characteristics, such as surface tension, molar refraction, dipole moment, and boiling point[18].

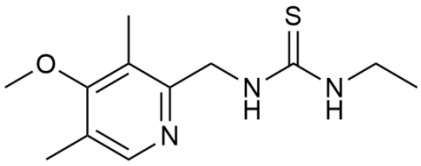

Fig.1. Structure of 1-Ethyl-3-((4-Methoxy-3,5-Dimethylpyridin-2-yl)Methyl)Thiourea

EXPERIMENTAL

In this study, double-distilled water and analytical grade (A.R.) chemicals were used for all experiments. The compound weights were precisely measured using a Mechaniki Zektady Precyzyjnej Gdansk balance with an accuracy of ±0.001 grams. Liquid viscosity was determined

using an Ostwald viscometer, while temperature was maintained at 29°C (±0.1°C) with an Elite thermostatic water bath. Density measurements were conducted using a bicapillary tube with an internal diameter of 1 mm. Sufficient time was allowed for the viscometer and water bath to reach thermal equilibrium before taking measurements.

The viscosity of1-Ethyl-3-((4-Methoxy-3,5-Dimethylpyridin-2-yl)Methyl)Thiourea was analyzed at a 0.1 M concentration in a 50% ethanol-water system at different temperatures. Freshly prepared solutions were used for the assessment, and viscometric readings were recorded following established literature guidelines.

OBSERVATIONS AND CALCULATIONS

Molecular interactions were analyzed through the solute's β-coefficient, which was determined from the data obtained in this study, as presented in Table 1. The Jones-Dole equation, $C(\eta r - 1) = A + BC$, was used to compute values at varying temperatures for a 0.1 M concentration. The resulting A and β-coefficients are summarized in Table 2.

TABLE No.1
THE MEASUREMENT OF RELATIVE AND SPECIFIC VISCOSITIES AT VARYING TEMPERATURES AT 0.1 MS CONCENTRATION, ALONG WITH VISCOSITY ASSESSMENTS AT FIXED CONCENTRATIONS.

MEDIUM - 50% ETHANOL-WATER							
Conc.	**Temp. (°C)**	**√C**	**Time (sec.)**	**Density ρx10^3 (kg.cm^{-3})**	**$\acute{\eta}_r$**	**$\acute{\eta}_{sp}=\acute{\eta}_r-1$**	**$(\acute{\eta}_r-1)/\sqrt{C}$ (pa$^-$s)**
0.1 M	21	0.314	70	0.8551	0.066456	-0.933544	-2.9730
	23	0.314	65	0.8325	0.062641	-0.937359	-2.9852
	25	0.314	55	0.8243	0.058946	-0.941054	-2.9969
	27	0.314	41	0.8014	0.055617	-0.944383	-3.0075

It shows that as temperature rises, the movement time of the solution decreases, and the density also decreases. The lowest relative viscosity was observed at 27°C, while the highest was at 21°C. As the temperature increased from 21°C to 27°C, both relative viscosity and specific viscosity decreased.

TABLE No.– 2
THE A AND B VALUES FOR THE 60% COEFFICIENT ARE PRESENTED WITH REFERENCES TO 1-Ethyl-3-((4-Methoxy-3,5-Dimethylpyridin-2-yl)Methyl)Thiourea.

W-E Mixture(%)	Temp° C	Mean "A"	β (Slope "m")
50	24	-2.9906	0.0071

RESULT AND DISCUSSION

The following formula was used to determine the relative viscosity.

η_r = Ds x ts / Dw x tw.

The Jones-Dole equation was employed to analyze the relative viscosities,

$(\eta r-1)/\sqrt{C} = A+B\sqrt{C}$

Were,

A = Falkenhagen coefficient

B = Jones-Dole coefficient

C = concentration of solutions

The Jones-Dole coefficient (B) was used to assess the solute-solvent interaction, while the Falkenhagen coefficient (A) was used to evaluate the solute-solute interaction. A graph was plotted between $\sqrt{C}$ and $(\eta r-1)/\sqrt{C}$. For each system, the graph displayed a straight linear relationship, yielding a value for the β-coefficient.

CONCLUSIONS

As temperature increases, both density and relative viscosity decrease in the current study. This is due to the fact that the solvation effect strengthens with rising temperature, enhancing the solute-solvent interaction. Pharmacodynamic and pharmacokinetic studies play an important role in scientific research and public understanding.

A positive β-coefficient of viscosity indicates a strong solute-solvent interaction, which is referred to as a "structure former." When hydrogen bonding forms in a solution, structure formation or breakdown occurs depending on whether solute-solvent interactions increase or decrease. This is influenced by changes in density or viscosity, leading to hydrophilic (structure-breaking) or hydrophobic (structure-forming) properties of the solute.

As temperature increases, intermolecular interactions decrease, causing molecules to move more quickly, which in turn reduces viscosity. The lower viscosity facilitates the movement of molecules or drug particles. This is crucial for the transport and diffusion of drug molecules, contributing to favorable pharmacodynamics and pharmacokinetics. After drug metabolism, ions move toward the target more efficiently, and solutions with lower viscosity exhibit better diffusion activity.

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