



VISCOSITY OF BIOLOGICAL FLUIDS AND THEIR RHEOLOGICAL PROPERTIES: THEORETICAL FOUNDATIONS, PATHOLOGICAL CONDITIONS, AND MEASUREMENT METHODS

Komilova Dilovar Turug'unboyevna

Teacher, Andijan State Medical Institute

E-mail: komilovadil72@gmail.com

Tel: (+998 90) 202-28-00

Abdulfattoyeva Oyshabonu

Student, Andijan State Medical Institute

Abstract: *This article discusses blood viscosity, its physical and rheological properties, and the differences between Newtonian and non-Newtonian fluids. The behavior of blood as a non-Newtonian fluid and its relationship with its components - erythrocytes, leukocytes, thrombocytes, and plasma—are explained. Additionally, pathological conditions resulting from increased or decreased blood viscosity, including thrombosis, stroke, myocardial infarction, and hemorrhagic syndromes, are analyzed. The main methods for determining viscosity, such as the capillary viscometer, Hess viscometer, rotational viscometer, and Stokes method, are also reviewed.*

Keywords: *viscosity, blood, non-Newtonian fluid, erythrocyte, thrombosis, hemorrhagic syndrome, viscometer, rheology, flow velocity, internal friction.*

Introduction. Viscosity is an important physical parameter that characterizes a fluid's resistance to flow. It is associated with internal friction occurring between layers of fluid and determines the degree of fluid flow. The higher the viscosity, the more difficult it is for the fluid to flow.

Fluids are classified into Newtonian and non-Newtonian types based on their physical properties. In Newtonian fluids, viscosity does not depend on the velocity gradient, whereas in non-Newtonian fluids, such dependence exists. Blood, as a non-Newtonian fluid, performs essential biological functions in the body, and its viscosity directly affects human health.

Literature Review. Scientific literature extensively studies the viscosity and rheological properties of fluids. It is noted that in Newtonian fluids, viscosity

remains constant and does not depend on external influences. Examples include water, alcohol, and glycerin.

Non-Newtonian fluids, particularly blood, have a complex composition, and their viscosity changes depending on flow velocity. Studies emphasize that blood viscosity is closely related to the deformability of erythrocytes and their aggregation. It is also highlighted that changes in blood viscosity can lead to various diseases such as thrombosis, stroke, myocardial infarction, and hemorrhagic syndromes.

Research Methodology. Several methods are used to determine blood viscosity:

Capillary Viscometer Method. In this method, the time required for a certain volume of liquid to pass through a thin capillary tube is measured. Based on Poiseuille's law, the relative viscosity of the fluid is determined. Measurements are typically carried out at 37°C, corresponding to normal human body temperature. While this method provides accurate results for Newtonian fluids, its application to non-Newtonian fluids like blood is more complex due to viscosity dependence on flow rate.

Hess Viscometer. The Hess viscometer is used to determine the relative viscosity of biological fluids, especially blood. In this method, a constant volume of blood is used, while the volume of water is determined based on its level in the tube. The method is based on comparing the volume occupied by the test liquid in a capillary tube with that of distilled water. Since water viscosity is known and stable, blood viscosity is calculated relative to it. This method is simple and widely used in medical practice.

Rotational Viscometer. Rotational viscometers are universal laboratory instruments used to measure viscosity. The fluid is placed between a rotating rotor and a stationary cylinder. As the rotor spins, shear occurs in the fluid layers, generating torque on the stationary cylinder. Viscosity is determined based on angular velocity and torque. This method allows analysis of non-Newtonian behavior by varying shear rates.

Stokes Method. In this method, spherical particles of known radius are introduced into the fluid, and their terminal settling velocity is measured. The motion depends on viscosity, density, and particle size. For accurate results, the fluid must be transparent, homogeneous, and well-characterized. This method is mainly suitable for Newtonian fluids.

Analysis and Results. The analysis shows that blood viscosity directly depends on flow velocity. At high flow rates, erythrocytes deform and align along the flow direction, reducing viscosity. Conversely, at low flow rates, erythrocyte aggregation increases, leading to higher viscosity.

Increased blood viscosity can cause hypercoagulation, leading to thrombosis, stroke, myocardial infarction, and pulmonary embolism. Decreased viscosity results in hypocoagulation, which may cause hemorrhagic syndrome, internal bleeding, and hemorrhagic stroke. Results obtained using different viscometric methods confirm the complex non-Newtonian nature of blood.

Conclusion. Blood viscosity is one of the key rheological properties ensuring normal circulation in the body. Its non-Newtonian characteristics are closely related to its structural components.

Deviations from normal viscosity levels can lead to severe pathological conditions, making its monitoring and measurement essential. Modern viscometric methods provide reliable results and are widely used in medical practice.

References

1. Ahmedov A.A. *Biofizika asoslari*. – Toshkent: O‘zbekiston tibbiyot nashriyoti, 2020. – 256 b.
2. Kholiqov S.S. *Tibbiy biofizika*. – Toshkent: TDMI, 2019. – 198 b.
3. Fayzullayev M., Yo‘ldoshev S. *Tibbiyotda eksperimental biofizika asoslari*. – Toshkent: TDMI, 2018.
4. Hasanov B. *Biofizika fanining zamonaviy yo‘nalishlari*. – Toshkent, 2023.
5. Bazarbayev M.I., Mullajonov I. *Biofizika, Darslik*. Toshkent. 2018 y

6. Remizov A.N. Tibbiy va biologik fizika, Darslik. Toshkent. 2005 y.
7. Paul Davidovits Physics in Biology and Medicine, Darslik. 2013 y.
8. Harten Physik fur Mediziner, Darslik. 2011y.
9. Komilova, D. T. (2023). Integrating steam educational technology in biophysics. *Экономика и социум*, (12 (115)-2), 234-236.
10. Komilova, D. T. (2022). Specific aspects of modular educational technology. *Экономика и социум*, (11-2 (102)), 126-129.
11. Komilova, D. (2025). The importance of using interactive methods in teaching biophysics in higher medical education institutions. *Science*, 4(1-2), 146-149.
12. DT, K. (2023). Organization and conduct of laboratory work in physics integrated in virtual forms. *Экономика и социум*, (10 (113)-1), 120-122.
13. Komilova, D. T. (2022). Tibbiy ta'lim muassasalarida fanlarni o'qitish jarayonida yangi texnologiyasidan foydalanish. *Экономика и социум*, (12-1 (103)), 158-160.
14. Komilova, D. T. (2021). Biophysics as an interdisciplinary science. *Экономика и социум*, (11-1 (90)), 279-282.