

Composition determined by FTIR spectroscopy of blood plasma

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Abstract

This study investigates the chemical composition of blood plasma using Fourier transform infrared spectroscopy (FTIR). FTIR analysis allowed the identification of the main biochemical components, including proteins, lipids, carbohydrates and nucleic acids, by characterizing specific absorption bands. The results obtained highlight the structural and functional variations of biomolecules in plasma, providing valuable information for the assessment of physiological status and clinical diagnosis. The study demonstrates the efficiency of FTIR as a rapid, non-invasive and reproducible method for the detailed analysis of blood plasma, contributing to the development of spectroscopic tools in laboratory medicine.

Keywords: Blood plasma, composition, FTIR spectroscopy

Introduction

Blood plasma is the liquid component of blood, in which blood cells (erythrocytes, leukocytes and platelets) and other elements such as proteins, mineral salts and nutrients are suspended. Approximately 55% of the total blood volume is represented by blood plasma, the remaining 45% being represented by blood cells. Blood plasma is a viscous, yellow liquid, composed mainly of water (approximately 90%), but also contains proteins, mineral salts, nutrients, hormones and other substances essential for the functioning of the body^[1].

Blood plasma is not produced in a specific organ, but is represented by nutrient-rich fluids absorbed from the digestive system. It circulates through the circulatory system, playing an essential role in the transport of nutrients, oxygen, hormones and metabolic waste, as well as in the processes of coagulation and immune defense. In addition, blood plasma contains antibodies and other substances necessary for the body's defense against infections and other pathogens^[2].

The components of blood plasma are essential for the normal functioning of the body. Plasma proteins are the main component of blood plasma and include albumin, globulins, and fibrinogen. Albumin is responsible for maintaining osmotic pressure and transporting substances in the blood, while globulins play a role in immune function and hormone transport. Fibrinogen is essential for the blood clotting process^[3].

Electrolytes and minerals are other important compounds for maintaining the body's water and acid-base balance and include sodium, potassium, chlorine, bicarbonate, calcium, and magnesium ions. The balance of these electrolytes is crucial for the proper functioning of cells and tissues. Blood plasma also contains essential nutrients transported to the body's cells, such as glucose, amino acids, lipids, and vitamins. They provide the energy needed for the body to function and are involved in various metabolic processes and cellular functions^[4].

In addition, blood plasma also carries waste products and metabolites resulting from metabolic processes, such as urea, uric acid, and creatinine. These substances are eliminated from the body mainly through the kidneys, thus maintaining an optimal state of health.

Blood plasma is a yellow liquid in which blood cells swim and which represents approximately 55% of the total blood volume. This substance plays a vital role in the human body, having a number of important functions, including:

- 1. Transport of substances:** Blood plasma has the main role of transporting essential nutrients, such as glucose, lipids, amino acids, and mineral salts, as well as waste products, such as urea and carbon dioxide, to and from the body's cells. This process is vital for maintaining normal cellular function and for eliminating waste products resulting from cellular metabolism^[5].
- 2. Regulation of acid-base and osmotic balance:** Blood plasma contributes to maintaining the optimal pH in the body (around 7.4) by buffering acid-base variations. It also ensures an adequate osmotic balance, thus preventing imbalances between water and electrolytes in cells and in the extracellular environment^[3].
- 3. Heat distribution:** Blood plasma plays an important role in the thermoregulation of the human body. As blood circulates throughout the body, plasma helps to distribute the heat produced by cellular metabolism and to maintain a constant internal temperature. Thus, blood plasma contributes to maintaining the body's thermal homeostasis^[6].
- 4. Immunity and coagulation:** Blood plasma contains specific proteins that play a role in defending the body against infections and injuries. Immunoglobulins are antibodies that help neutralize and eliminate infectious agents, while coagulation proteins, such as fibrinogen, contribute to the formation of blood clots to prevent bleeding and allow tissue healing^[7, 9].

Blood plasma is an important component of blood that helps maintain the health of the body through many essential functions, including supporting the clotting process and immunity. Clotting proteins in blood plasma, such as fibrinogen, play a crucial role in the formation of blood clots that prevent excessive blood loss following vascular injury. When a vascular injury occurs, clotting proteins are activated and convert fibrinogen into fibrin, which forms a solid network that stops bleeding^[4].

In terms of immunity, blood plasma carries antibodies, which are proteins produced by the immune system in response to infections and other external aggressions. These antibodies bind to pathogens, such as bacteria or viruses, neutralizing them and helping to eliminate them from the body. In addition, blood plasma plays an important role in supporting the function of immune cells, including white blood cells (leukocytes), which help eliminate pathogens and abnormal cells from the body^[2].

Blood plasma also contains proteins called cytokines, which are involved in the process of inflammation. These cytokines help regulate inflammation, which is the body's response to infection or tissue damage and has the role of protecting and repairing damaged tissues^[1].

In conclusion, blood plasma is an essential component of blood, having many vital functions for the body, such as

transporting nutrients and oxygen, maintaining acid-base and water balance, as well as an important role in coagulation and immunity. Do not hesitate to get additional information from reliable sources on this subject: your family doctor can help you with additional details^[5, 12].

Materials and methods

The FTIR Spectral measurements of all the samples were carried out at Sophisticated Analytical Instrumentation Facility IIT, Madras, Chennai-36, using Spectrum-One Perkin- Elmer FTIR Spectrophotometer. The spectra are recorded in the mid infrared region of 4000 – 400 cm⁻¹ in the absorption mode. After the samples returned to room temperature 20 μ L of the aliquots were diluted with 80 μ L of water.



Fig 1: Perkin- Elmer FTIR Spectrophotometer

Result and discussion

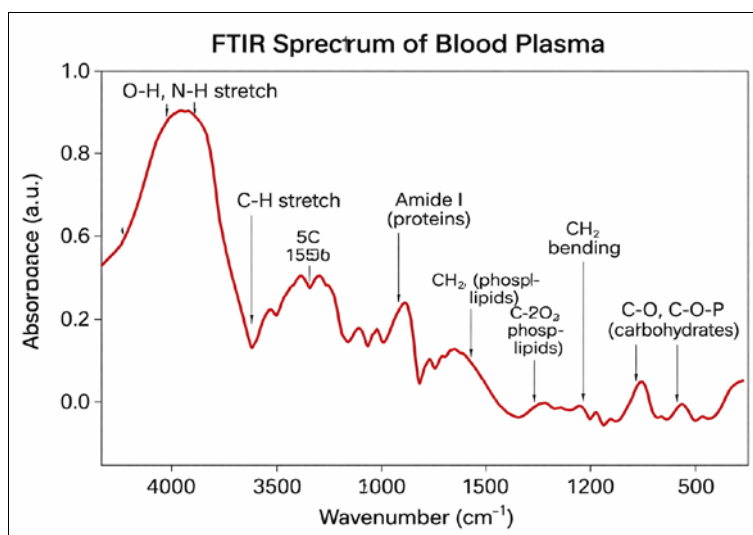


Fig 2: FTIR spectrum of blood sample.

A representative FTIR absorption spectrum of serum sample is shown in Fig. 2. The characteristic vibrational peaks are mainly dominated by the of the protein constituents of the sample.^[1, 2]. A vibration band assignment is done with the idea of the group frequencies of the various analytes present in the sample. The spectral region 3600 – 3000 cm⁻¹ comprises of C-H, O-H and N-H stretching vibrations of the

proteins. The prominent absorption peak 3300 cm⁻¹ is due to the N-H stretching mode (amide A) of proteins. The asymmetric and symmetric stretching C-H vibrations of methyl and methylene group are found to be present around 2930 – 2875 cm⁻¹. The strong absorption band at 1650 cm⁻¹ correspond to C=O stretching vibrations (amide I) whereas the vibration band at 1542 is attributed as amide II arising of

N-H bending vibrations strongly coupled with C-N stretching of proteins^[3].

The absorption peaks in the region 1400 – 1200 cm⁻¹ arise due to the C–H deformation of methyl and methylene group of the proteins. The asymmetric and symmetric P-O stretching vibrations are found to be around 1245 cm⁻¹ and 956 cm⁻¹ respectively ^[12, 19].

Conclusion

The FTIR spectrum allowed the detection of the main classes of biomolecules: proteins (amide I and II bands), lipids (C–H and C=O bands), carbohydrates and nucleic acids. Analysis of the characteristic bands provides information about the secondary structure of proteins and the degree of saturation of lipids in plasma. Changes in the intensity and position of FTIR bands reflect biochemical changes in plasma, which can be used to assess the physiological state or detect pathologies. FTIR proves to be an effective method for qualitative and semi-quantitative analysis of blood plasma, without the need for laborious processing. The results support the use of FTIR in health monitoring, disease diagnosis and plasma biomarker research.

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