Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-1 Issue-3 || August 2022 || PP. 216-221

https://doi.org/10.55544/jrasb.1.3.28

To Investigate the Refractive Index of Blood Plasma Suspended in Various Tonicity Solutions

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www.jrasb.com || Vol. 1 No. 3 (2022): August Issue

Received: 18-07-2022	**Revised:** 08-08-2022	**Accepted:** 18-08-2022

ABSTRACT

This paper reports the data of the RI of plasma of normal blood, which is measured using Abbes' refractometer. The experimental values are compared to normal blood serum erythrocytes with Blood of Plasma suspended in various tonicity solutions between and 1.336 to 1.343, whereas the normal blood plasma refractive index is 1.351. As a result, the refractive index the worth of erythrocytes washed with different tonicity solutions are slightly lower than those of normal blood. If this optical parameter is standardized, it has the potential to be used as a tool in the medical field.

Keywords- plasma from human blood, Profile of the refractive index, tonicity solutions, The Abbes' refractometer.

I. INTRODUCTION

Plasma is also referred to as blood plasma, is the liquid component of blood. Plasma transports nutrients and waste products to the cells of the body's organs derived from cellular metabolism to excretion through the kidneys, liver, and lungs. It also functions as a mode of transportation. In relation to blood cells and is essential in maintaining blood pressure is normal. Plasma of blood aids in heat distribution and the maintenance of homeostasis, or biological stability, which includes blood and body acid-base balance. When all of the cells of the blood - RBCs, WBCs, and platelets are distinct from whole blood, Plasma is created. 90 to 92% of the straw that remained -colored the fluid is water. However, it contains essential solutes. Required in order to maintain one's health and life. Sodium, potassium, chloride, bicarbonate, magnesium, and calcium are examples of electrolytes are important constituents. Other substances are also present in trace amounts. Such as amino acids, pigments, organic acids, enzymes and vitamins. The endocrine system secretes hormones such as insulin, corticosteroids, and thyroxin into the bloodstream. Plasma hormone concentrations must be taken into consideration regulated for better health. The amount of nitrogenous waste produced by kidney failure increases (e.g., urea and creatinine) transported to the kidney for excretion significantly increases. (Via Google) Any disease first within the human body manifests itself in both blood and urine. Refractive index profile of human blood is an important parameter in which pathologists are interested.

Mohamed A. Elblbesy investigated the refractive index of blood in the visible spectral range was measured. A significant difference between the refractive index of hemoglobin solution of healthy individuals and anemic ones was indicated [1]

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One of the fundamental optical properties is the refractive index. The refractive index based on the wave length is known as the refractive index dispersion (IRD)[2]. IRD reflects the physiological condition of biological tissues and cells in therapeutic and diagnostic medical devices [3]. IRD for biological materials such as blood is only available for a few wavelengths [4]. There are many methods used to measure RID, such as examining at discrete wavelengths, or over a continuous spectrum [5–7]. The optical properties of blood can be studied at the macroscopic and microscopic levels. Blood consists of two main parts, plasma, and cells. Red blood cells make up to 99% of blood cells, so the optical properties of blood depend on the physiological properties of red blood cells [8,9].

As one of the optical properties of blood, the refractive index depends on many physiological factors, including hemoglobin concentration, hematocrit, temperature, and oxygen saturation. Measurements of the optical properties of blood at the visible light and near-infrared spectrum are the basis for the diagnosis of blood disease [10-12].

Studying the optical properties of blood helps in determining the optimal wavelength that provides the maximum penetration depth for the radiation used in treatment or diagnosis [13,14]. The study of the optical properties of blood focuses on measurements of absorption, dispersion, and refractive index at specific wavelengths. One of the most common blood disorders is anemia, which arises from a deficiency of Iron, Vitamin B12, or Folic acid. Hemoglobin concentration of blood drops as a result of anemia [15]. As most of the optical properties of blood depend on hemoglobin concentration, this makes anemia is an ideal model when examining a new theatrical or experimental optical technique for blood [16–18].

In the present study, the method used in the previous study to measure the refractive index of turbid media has been used to determine the refractive index of blood [19]. Compression between the measured for anemic and normal blood was done to evaluate the use of as a diagnostic tool for blood disorder.

Tonicity is a possible solution's ability to changing the water content of cells. When water enters a cell, when it exits the cell, it can cause hypotonicity or hypertonicity. The ability of an intracellular solution to cause water to move into or out of a cell via osmosis is referred to as tonicity. Tonicity is divided into three types: isotonicity, hypotonicity and hypertonicity, there is no net flow of water into or out of a cell when immersed in an isotonic solution and the cell volume remains constant. When a cell is immersed in a hypotonic solution, there is a net flow of water into the cell, causing it to expand and swell. When a cell is immersed in a hypertonic solution, there is a net flow of water out of the cell, and the cell loses volume, causing it to shrink. When compared to the corresponding biological function, the complex refractive index (RI) of biological cells describes their interaction with light and is affected by the concentrations and spatial distribution of extracellular molecules. The refractive index measures how much a light ray bends when passing from one medium to another. Here, there are two types of refractive index. In this paper, we present the results of our investigation into the RI of blood plasma from healthy human blood samples. Various experimental methods are being used to assist in medical diagnosis and interpretation of basic cellular processes. The review article by Liu et al. provides an overview of applications and experimental techniques. As summarized the resulting information on cellular RI in this reference is dependent on the measurement tool and includes the average cell RI suspended in different tonicity solutions (isotonicity, hypotonicity, and hypertonicity), the effective RI of isotonicity, the RI of hypotonicity, and the RI of hypertonicity. Different blood samples suspended in different tonicity solutions can cause local or integral changes in cell RI, so distinguish between healthy blood samples privileged in different tonicity solutions. As well as pathological cells such changes have a direct impact on the light scattering properties of the cell, allowing optical detection of pathologies.

II. MATERIALS AND METHODS

In this study, 40 fresh samples of healthy human blood were chosen to investigate blood plasma's refractive index. Samples of 3 ml were drawn from healthy people aged 20-24 years with various blood groups. To prevent coagulation, the blood samples were stored in a heparin anticoagulant. and the experiments were completed four hours after they were collected. After collecting fresh samples of human blood in the volume of 3ml and mixing them with various tonicity solutions (isotonicity, hypo tonicity and hypertonicity). Plasma was extracted from prepared blood samples by centrifuging them at 1500 rpm for 20 minutes, and the blood samples were prepared by mixing with blood an equal amount of plasma and erythrocytes. The volume percentage of RBCs in the blood sample is kept constant by this process.

Refractive Index:

In a vacuum, the speed of light is constant; however, light travels more slowly via any other medium because light is constantly absorbed by the medium and emit light by its atoms. When light travels from one medium to another, Light rays bend at an angle, just like air to water. This physical property is observed as a result of a light's velocity changes as it travels from one medium to another. A substance's refractive index n is defined as the ratio of the speed of light in vacuum to the speed of light in another substance. It is not necessary to determine a sample's index of refraction by measuring its speed of light. By determining the index of refraction of the layer in contact with the sample and measuring the angle of refraction, the refractive index of the sample

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ISSN: 2583-4053

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can be determined precisely. With a few exceptions in their optical design, all refracto-meters operate on this principle.

Light is refracted when its speed changes as it strike a boundary from one medium to another. The relationship between the light speeds in the two mediums, as well as the incidence and refraction angles. The speed of light, and thus the index of refraction, varies dramatically with wavelength in most solids and liquids. For accurate measurements, monochromatic light is required. The sodium wavelength at 5890 A^0 is the most commonly used wavelength of light for refractometers. The refractive index values cited, such as 1.33 for water, are based on sodium wavelength is 5890 A^0. The refractive index is also affected by temperature, and the values given are based on a standard temperature. Because the density of a liquid reduces with temperature, the speed of light in a liquid should gain as the temperature rises. A liquid's index of refraction normally reduces as its temperature rises. The majority of refractive index values are taken at 22 to 26 °C.

Experimental Procedure:

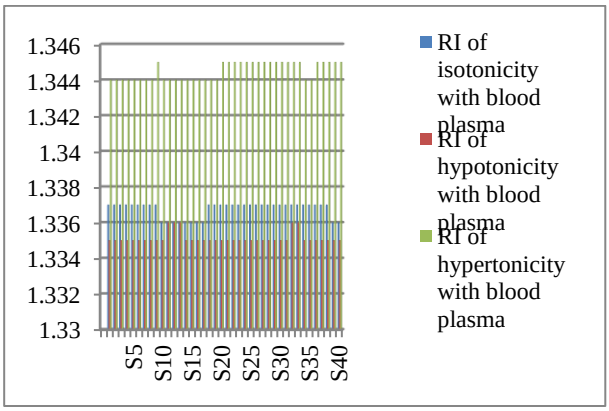
Description of R.I: The tool used to study the refractive index of samples is known as a refractometer. Which can directly provide the refractive index, In the Abbes' refractometer, the sample is sandwiched between an illuminating prism and a refracting prism. (Figure.1) The refracting prism is made of glass that has a high refractive index of 1.75, making it suitable for determining the refractive index of samples that have a lower refractive index than the refracting prism. The illuminating prism projects a light source, which has a rough bottom surface that allows light rays to travel in all directions.

Different refractive index samples will result in varying refraction angles, as a result of which The line separating the light and dark regions has shifted. With proper calibration of the scale on the refractometer, the position of the borderline on the refractometer can be used to determine the refractive index of any sample. A few drops of plasma should be placed distinct the ruminating and refracting prisms. Place this refractometer opposite the sodium lamp and expose the sample to light at 5890 A^0 wavelength. We can see some dark and white regions through one of the refract meter's eyepieces. To obtain the sample's Refractive index, adapt the refractometer knob so that the borderline of the light and dark zones aligns with the cross wires' centres, and take a reading on the instrument through another viewfinder, in which the horizontal line aligns.

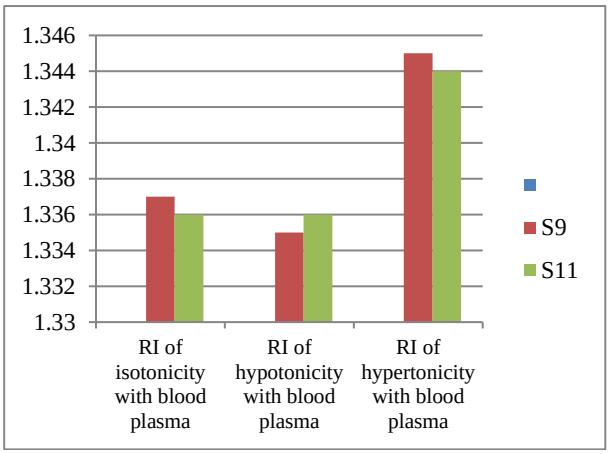
III. RESULTS AND DISCUSSION

Below table (Table:1) The refractive index values of plasma of blood suspended in different tonicity solutions range from 1.337 to 1.344, whereas the refractive index of plasma of normal blood is 1.351. As a result, the refractive index values of isotonicity and hypotonicity solutions When compared to normal blood, blood plasma levels are lower, and the worth of refractive index of hypertonicity solutions with plasma ofblood are marginally lower when compared to normal blood, hence here calculating standard deviation and error also. The graph below depicts the variation of plasma refractive index with isotonicity, hypotonicity, and hypertonicity.

Figure 1: Refractometer



Graph 1: Depicts the variation in the RI of plasma of Tonicity for various samples



Graph 2: The variation of plasma's refractive index in different tonicity solutions for two samples is shown.

Journal for Research in Applied Sciences and Biotechnology

www.jrasb.com

ISSN: 2583-4053

Volume-1 Issue-3 || August 2022 || PP. 216-221

https://doi.org/10.55544/jrasb.1.3.28

In optical diagnosis and laser treatments, biological tissue's refractive index is an important parametric quantity. The refractive index of blood plasma from healthy people suspended in different tonicity solutions was measured using the Abbes' refractometer technique in this study. If this optical parameter is standardized, it has the potential to be used as a tool in the medical field.

Table 1: The refractive index values of plasma of blood suspended in different tonicity solutions.

Sample code	RI of isotonicity with blood plasma	RI of hypotonicity with blood plasma	RI of hypertonicity with blood plasma
S1	1.337	1.335	1.344
S2	1.337	1.335	1.344
S3	1.337	1.335	1.344
S4	1.337	1.335	1.344
S5	1.337	1.335	1.344
S6	1.337	1.335	1.344
S7	1.337	1.335	1.344
S8	1.337	1.335	1.344
S9	1.337	1.335	1.345
S10	1.336	1.335	1.344
S11	1.336	1.336	1.344
S12	1.336	1.336	1.344
S13	1.336	1.336	1.344
S14	1.336	1.335	1.344
S15	1.336	1.335	1.344
S16	1.336	1.335	1.344
S17	1.336	1.335	1.344
S18	1.337	1.335	1.344
S19	1.337	1.335	1.344
S20	1.337	1.335	1.345
S21	1.337	1.335	1.345
S22	1.337	1.335	1.345
S23	1.337	1.335	1.345
S24	1.337	1.335	1.345
S25	1.337	1.335	1.345
S26	1.337	1.335	1.345
S27	1.337	1.335	1.345
S28	1.337	1.335	1.345
S29	1.337	1.335	1.345
S30	1.337	1.335	1.345
S31	1.337	1.335	1.345
S32	1.337	1.336	1.345
S33	1.337	1.336	1.345
S34	1.337	1.335	1.344
S35	1.337	1.335	1.344
S36	1.337	1.335	1.345
S37	1.337	1.335	1.345
S38	1.337	1.335	1.345
S39	1.336	1.335	1.345
S40	1.336	1.335	1.345
Mean:	1.33675	1.335125	1.3445
standard deviation:	0.000438529	0.000334932	0.00050637
standard error:	6.93375E-05	5.29574E-05	8.00641E-05

ISSN: 2583-4053

Volume-1 Issue-3 || August 2022 || PP. 216-221

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IV. CONCLUSIONS

Here, experimental values are compared to normal blood serum erythrocytes with healthy blood suspended in different tonicity solutions. The refractive index values of isotonicity solutions added with blood plasma are 1.336 to 1.337, hypotonicity solutions added with blood plasma are 1.334 to 1.335, and the refractive index values of hypertonicity solutions added with blood plasma are 1.343 to 1.344, whereas the normal blood plasma refractive index is 1.351. This was compared to normal blood serum erythrocytes with blood plasma suspended in various tonicity solutions. As a result, the refractive index and the worth of erythrocytes washed with different tonicity solutions are lower than those of normal blood. In the above graphs, the values of the Refractive Index of isotonicity with plasma are high , compared with the hypo tonicity of plasma in the blood, and the Refractive Index of hypertonicity with blood plasma is greater than the Refractive Index of isotonicity and hypo tonicity of plasma in the blood. This optical parameter is standardized, and it has the potential to be used as a tool in the medical field.

FUNDING

No funder

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest that could have influenced their work in this paper.

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