Dielectric Properties of Human Blood of Patients Suffering from Jaundice

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Abstract: *The paper reports dielectric properties of plasma, whole blood and 90% packed cells of blood drawn from patients suffering from jaundice. Dielectric constant, dielectric loss and electrical conductivity are calculated, measuring capacitance and dissipation factor of dielectric cell with blood sample and electrical conductance of blood at 1 kHz using digital LCZ meter. It is found that the values of dielectric constant, dielectric loss and electrical conductivity are high in plasma and low in 90% packed cells and in between whole blood. The dielectric parameters are high in blood of jaundice patients, when compared with those of normal blood. The study suggests that Bilirubin plays vital role in influencing dielectric properties of jaundice affected blood as bilirubin is less covalently bonded and it diffuses in tissues easily. Hence, it affects plasma more than whole blood and 90% erythrocytes.*

Key Words: *Plasma, Human blood and 90% Packed cell, Bilirubin, Dielectric constant, Dielectric loss, electrical conductivity, LCZ meter.*

1. INTRODUCTION:

Blood consists of fluid plasma in which erythrocytes, leukocytes and platelets are suspended. The former, in the great majority, are concerned with the transport of oxygen from the lungs to all parts of the body and they conveyance back carbon dioxide. The latter are broadly concerned with protective functions. Hence blood is described as fluid of life.

2. LITERATURE REVIEW:

Kaleem Ahmed Jaleeli and Adeel Ahmad [1] studied dielectrophoretic behavior of erythrocytes of patients suffering from jaundice and normal blood and concluded that high concentration of bilirubin in the blood when compared with the normal level decreases the dielectrophoretic properties of the erythrocyte. Ateeba et al [2] reported dielectrophoretic data on erythrocytes of blood of patients suffering from jaundice subjecting to non-uniform electric field at the frequency range of 1 MHz to 10 MHz and concluded that as the bilirubin concentration increases, the DCR decreases, which perhaps lead to perturb the erythrocyte membrane. Biju Kumar et al [3] studied dielectric properties of biomaterial employed cavity perturbation technique and concluded that dielectric constant of infected bile and gastric juice varies from patient to patient. Detection and extraction of bile stone with possible method of treatment was also discussed. Ong et al [4] developed modified lambert Beer model to predict skin bilirubin absorptivity in the wavelength range of 440 - 490nm. They concluded that the developed system and strategy can be used as an alternative means to assess skin bilirubin level. Beving H. et al. [5] investigated the dielectric properties of human blood and erythrocytes at radio frequencies based on cell volume fraction and its composition. They used rectangular sample cavity with four pure gold electrode pins and was circulated by a roller pump. It was concluded that electrical conductivity behaves in accordance with the desired value. Cook H. F., [6,7] studied the dielectric behavior of human blood at microwave frequencies. It was found that the specimens with red cell concentration were heparinized to prevent coagulation by employing coaxial-line and wave-guide methods. He further compared the dielectric behavior of pure water and human blood at micro wave frequencies. Fricke [8] concluded that the dielectric properties depend on the volume fraction and the shape of the RBCs. In the present investigation, an attempt has been made to differentiate jaundice blood with normal one dielectrically.

3. MATERIALS AND METHOD:

The collection and handling of a sample are an integral part of obtaining valid results. Blood samples were collected from patients suffering from jaundice from diagnostic centre. Here a disposable plastic syringe was used to draw venous blood. Blood was collected in blood collection tubes with anticoagulant Ethylene Di amine tetra Acetate (EDTA) and were inverted gently as soon after collection as possible to prevent clotting. The blood samples were brought to the laboratory keeping them in ice cooled thermos. The samples were kept in refrigerator at 4 ℃ until used.

Investigations were made within two to three hours after collection. The blood sample was centrifuged at the rate of 3000 rpm for five minutes. The plasma was separated, while residue contains 90% packed cells.

To study dielectric behaviour of patients suffering from jaundice and its constituents of different bilirubin concentrations, the dielectric parameters such as dielectric constant, dielectric loss were determined at the frequency of 1 kHz, using digital LCZ meter. A standard conductivity cell was used.

The dielectric constant, dielectric loss and conductivity were calculated by using the relations,

Dielectric constant, $\in' = \frac{C_s}{C_a} = \frac{(C_s' - C_L)}{(C_a' - C_L)}$

where C_s: Actual capacitance of the cell with sample; C_L: Lead capacitance C_a: Actual capacitance of the cell with air; C_s' : Measured capacitance of the cell with sample; C_a' : Measured capacitance of the cell with air i,e without sample.

Dielectric loss, $\in'' = \in' \tan\delta$,

where $\in'$ is the dielectric constant and δ is the dissipation factor.

Electrical Conductivity, $k = \frac{GL}{A}$

where G = Conductance; L = Distance between the plates of the cell; A = Area of the plates.

4. RESULT AND DISCUSSION:

Table.1 presents the data on dielectric constant, dielectric loss and electrical conductivity of blood and its constituents of jaundice patients which were measured at the frequency of 1 kHz. It is observed that patients suffering from jaundice, dielectric constant, dielectric loss and electrical conductivity are high in plasma, low in 90% packed cells and in between in whole blood, when compared with that of normal blood as shown in (Fig.1, Fig.2, Fig.3). The increase in dielectric constant, dielectric loss and electrical conductivity in plasma for the jaundice patients is due to free radicals. Bilirubin plays vital role in influencing dielectric properties of jaundice affected blood as bilirubin is less covalently bonded and it diffuses in tissues easily. Hence, it affects plasma more than whole blood and 90% erythrocytes. The concentration of the blood cells suspended in plasma influences the dielectric behavior of blood therefore; the dielectric parameters are low in 90% packed cells. This is possibly due to the presence of erythrocyte membrane, which acts as an electrical insulator. In whole blood the dielectric parameters are in between plasma and 90% packed cells as it possess both plasma and 90% packed cell.

Table.1 Data on dielectric parameters of jaundice blood and its constituents.

	PLASMA			WHOLE BLOOD			90% PACKED R.B.C		
	ε′(×10^6)	ε″(×10^8)	k(μs)	ε′(×10^6)	ε″(×10^8)	k(μs)	ε′(×10^6)	ε″(×10^8)	k(μs)
	231	16	8146	240	20	7100	284	45	4418
	301	25	8745	277	27	7028	237	24	5888
	291	20	10023	241	19	7434	185	18	4531
	292	23	9144	234	21	6425	147	16	3407
	281	21	9067	276	30	8829	199	20	4750
	279	20	9416	263	19	8545	189	19	4587
Avg	279	21	9090	255	23	7560	207	24	4596
SD	24	3	630	19	4	935	47	10	792

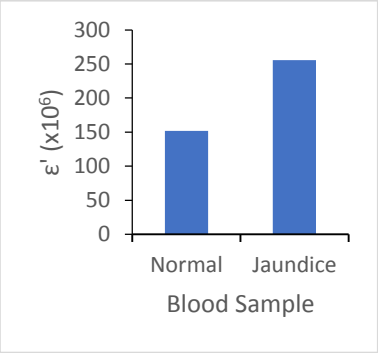

Fig.1

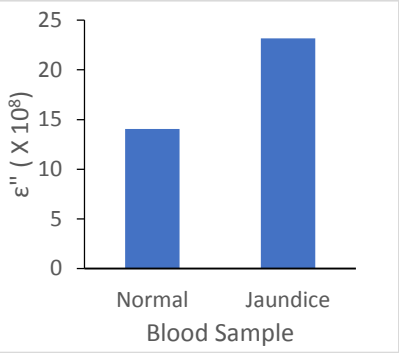

Fig.2

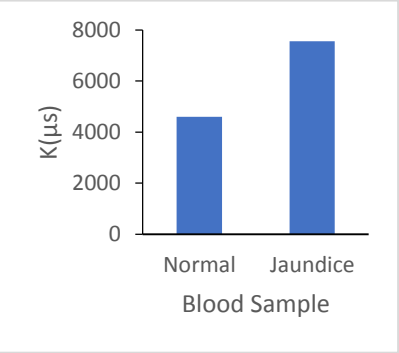

Fig.3

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