Original Research Article **Microbiology**

International Journal of Pharma and Bio Sciences

ISSN 0975-6299

DIELECTRIC PROPERTIES OF BLOOD OF PULMONARY TUBERCULOSIS PATIENTS

N. MANOHAR REDDY*

Department of Physics, S. V. Degree College (SVColleges), Kadapa - 516003, A.P, India.

ABSTRACT

The objective of the research is to study the dielectric properties of blood of pulmonary tuberculosis patients. The parameters such as dielectric constant, dielectric loss and electrical conductivity are measured at the frequency of 1 KHz. In this paper a conductivity meter (Elico, CM 183) was used in the present investigation. The accuracy of conductivity measurement is ±1%.The dielectric properties such as dielectric constant, dielectric loss were determined at the frequency of 1 kHz, using the digital LCZ meter of tuberculosis patient's blood. It is observed that the values of dielectric constant, dielectric loss are very high and electrical conductivity is slightly low in tuberculosis blood, compared with normal blood. It is believed that the findings of this study may be useful as indicators of disease progression, cardiovascular risk factors and response to therapy in pulmonary tuberculosis patients.

KEY WORDS: Dielectric properties, pulmonary tuberculosis blood, Conductivity meter, LCZ meter

N. MANOHAR REDDY
Department of Physics, S. V. Degree College (SVColleges), Kadapa - 516003, A.P, India.

INTRODUCTION

According to world health organization (WHO), 9.6 million people were infected with tuberculosis (TB) and 1.5 million were dead in 2014 because of this disease. Poor health services, the spread of HIV/AIDS and the TB pathogen (Mycobacterium) acquiring resistance to the available drugs are issues' making the TB more dangerous disease.[1] Tuberculosis is an infectious disease caused by *Mycobacterium bacillus*, which spreads through the air by a person suffering from TB. It is possible that a single TB patient can infect *mycobacterium bacillus* to 10-15 people in a year.[2] More deaths are recorded due to the infection of *mycobacterium tuberculosis*, compared to any other microbial pathogen, with the rate of one infection per second. Therefore, TB is a common disease in developing countries from ancient times. It is necessary to detect TB in the beginning due to its pathogen culture, thus; TB is detectable only after 25 to 30 days.[3] Currently, the available techniques for the diagnosis TB are acid bacilli, smear microscopy, nucleic acid amplification test.[4] In this context, much attention has not been paid to examine the blood of TB patient either pathologically or biochemically for the diagnosis of Tuberculosis. Schwan[5] reported the electrical properties of biological cells and tissues at very low frequencies and discussed the mechanisms responsible for such properties. Asami et al[6] analyzed the electrical properties like membrane capacitance C_m and dielectric increment $\Delta\varepsilon$ of yeast cells suspended in KCl solution by the bridge method in the frequency range of 1 kHz to 100MHz. The C_m was obtained to be 1.6μF/cm^2. Schwan[7] examined the dielectric data of biological material obtained from advanced dielectric techniques. He proposed three better and distinct relaxation effects which characterize the total dielectric response from to d.c. to GHz, and various minor ones are superimposed. Schwan[8] reported the electrical properties of biological cells and tissues over the entire investigated frequency range. He also discussed mechanisms amenable for ascertained frequency dependencies and indicated the most possible sites for electromagnetic field interactions.Pethig[9] studied proton transport in proteins along with pH results on protein structure. He re-examined the work on electric and dielectric properties of protein at low hydration content to show proton transport.Schwan[10] reported dielectric properties such as dielectric growth, membrane capacitance of biological cells by the electro rotation method. He summed-up biological effects of non-ionizing radiation, which is nearly related to electro physiology. Takashima et al[11] quantified dielectrophoretic properties of *micrococcus lysodeiktcus* in the frequency range 20 Hz to 4 MHz as a function of ionic strength of suspending electrolyte. They concluded that low frequency DEP response is prevailed by the electrical properties of the cell wall. Hakes and Pethig[12] remarked dielectric properties of lysozyme-compressed powder as a role of hydration and pH at which the samples were lyophilized. They resolved the dielectric dispersion in β -region. They concluded that the dielectric dispersion in β -region appear in the range 10^4 Hz to 10^5 Hz for lysozymes of hydration ranging from 5 - 20 % weight water is associated to the state of ionization of acidic and fundamental groups in the protein structure. Foster and Schwan[13] demonstrated a very useful review of the work done on dielectric properties of tissues and biological particles. Various dielectric relaxation mechanisms and dielectric dispersions in tissues are delineated. Dielectric properties of some tissues like muscle, bone, blood are resumed. Basharath Ali and Adeel Ahmad[14] examined anisotropy in permittivity and resistivity of fresh and oven dried ox muscle and heart tissues. They reported that anisotropy in permittivity and resistivity was considerable in fresh tissues, while it was lacking in dry tissues. Further, dielectric constant, dielectric loss and conductivity were high and resistivity was degraded in fresh samples, when compared to oven dry tissues. Basharath Ali and Adeel Ahmad[15] looked into dielectric parameters (dielectric constant, dielectric loss, conductivity or resistivity) of various types of tissues of the liver, kidney and brain of the animal Ox at 1 kHz frequency. They reported a considerable variation in these parameters to the extent of hydration, molecular composition, presence of reliable elements in traces, structural and morphological differences in cells and tissues, and concluded that structural constituents and molecular composition of tissues have unified activity in influencing the dielectric properties of tissues. A search of literature reveals no information on blood of tuberculosis patients. In view of this, an attempt is made to study the dielectric behavior of tuberculosis patients, blood.

MATERIALS AND METHODS

About 10 patients suffering from Pulmonary T. B. (all males) were selected to study dielectric properties of blood and plasma. Samples of volume 5 ml were drawn in the anticoagulant - EDTA at RIMS Hospital, Kadapa and brought to the laboratory in siliconised bottles and stored at 4˚C until use. The experimental investigations were completed within three hours after the collection. Plasma was separated from blood samples by centrifuging the blood at the rate of 1500 rpm about 15 min. and the blood samples were prepared by mixing equal amount of plasma and erythrocytes. By this process hematocrit of sample is maintained to be constant. A conductivity meter (Elico, CM 183) was used in the present investigation. The accuracy of conductivity measurement is ±1%.To study the dielectric behavior of tuberculosis patient's blood, the dielectric parameters such as dielectric constant, dielectric loss were determined at the frequency of 1 kHz, using the digital LCZ meter. A standard conductivity cell was selected for dielectric studies of the blood. This cell contains two parallel plates, the leads of which plug directly into the live terminals of capacitance measuring bridge. The dielectric constant, dielectric loss and conductivity can be calculated by the given formulae,

Dielectric constant, $\varepsilon' = Cs / Ca$
$= (Cs' - C_L) / (Ca' - C_L)$
Where, C_ε = Actual sample capacitance
C_L = Lead capacitance
C_a = Actual air capacitance
Cs' = Measured capacitance of cell with sample
Ca' = Measured capacitance of cell without sample
Dielectric loss, $\varepsilon'' = (1.8 \times 10^{12} k) / v$
Where, v = Frequency; k = electrical conductivity,
Electrical Conductivity k = GL / A
Where G = Conductance; L = Distance between the plates of the cell
A = Area of the plates

RESULTS AND DISCUSSION

Table 1 presents data on dielectric parameters such as dielectric constant, dielectric loss and electrical conductivity for 10 samples of blood drawn from the patients suffering from pulmonary tuberculosis. For the comparison of data with that of normal , 10 blood samples were collected from RIMS hospital and average values of dielectric parameters are reported in Table 1. Mean values with SD of normal and TB blood are presented for comparison. It is observed that dielectric constant and dielectric loss are significantly high and electrical conductivity is low in TB blood, compared to normal blood (Fig. 1–3). Dielectric constant and dielectric loss bears significant relations with electrical conductivity. Dielectric constant increases non - linearly and dielectric loss also increases, but linearly with the increase of electrical conductivity of TB blood. The considerable change in dielectric parameters of TB blood could be due to the absorption of CO_2 from the atmosphere and ion exchange from the cell as the respiratory exchange is disturbed. This disturbance could have a significant change in the electrical makeup of the red blood cell, which may be analyzed by computing the dielectric parameters of the whole blood.

Table 1
Dielectric data on blood of pulmonary TB patients

Sample Code	Dielectric Constant, ε' (x 10^3)	Dielectric Loss, ε'' (x 10^3)	Electrical Conductivity (mho.cm)
HHB (Normal)	**138 ± 8**	**318 ±17**	**1.77 ± 0.08**
TB01	354	993	1.79
TB02	342	858	1.66
TB03	338	824	1.63
TB04	327	744	1.56
TB05	240	261	1.12
TB06	311	650	1.47
TB07	320	1291	2.13
TB08	317	686	1.50
TB09	355	1058	1.86
TB10	315	1303	2.15
Mean:	322	867	1.69
SD:	±33	±314	±0.31

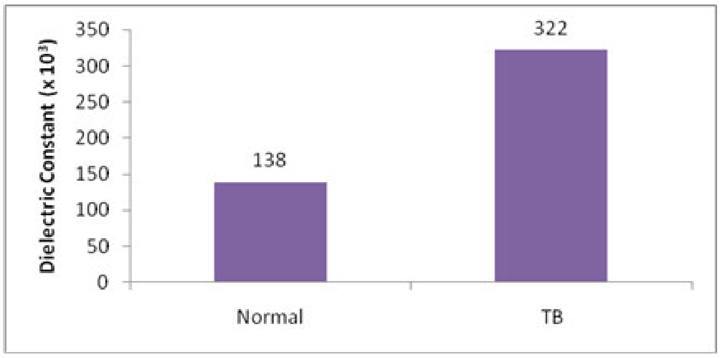

Figure 1
A comparison between dielectric constant of blood of healthy persons and pulmonary TB patients

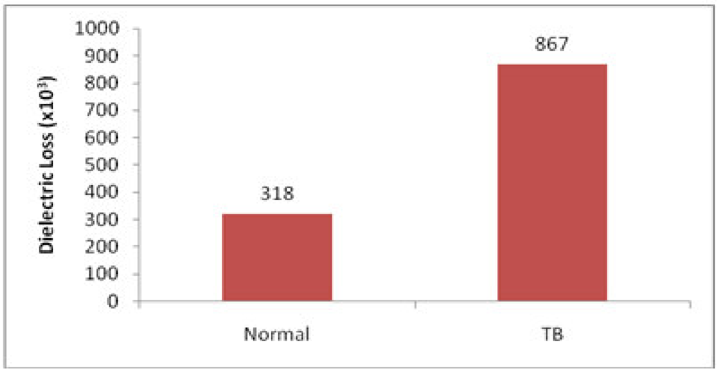

Figure 2
A comparison between dielectric Loss of blood of healthy persons and pulmonary TB patients

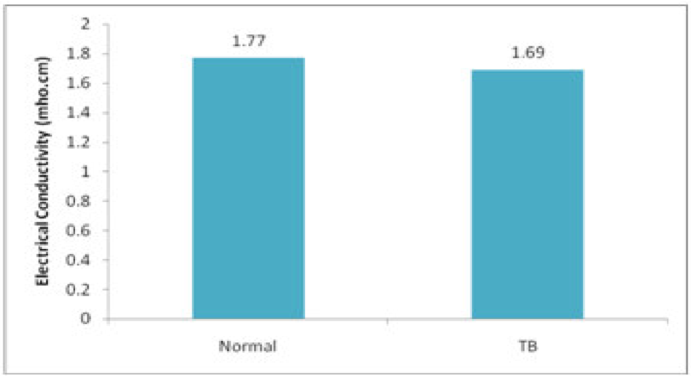

Figure 3
A comparison between electrical conductivity of blood of healthy persons and pulmonary TB patients

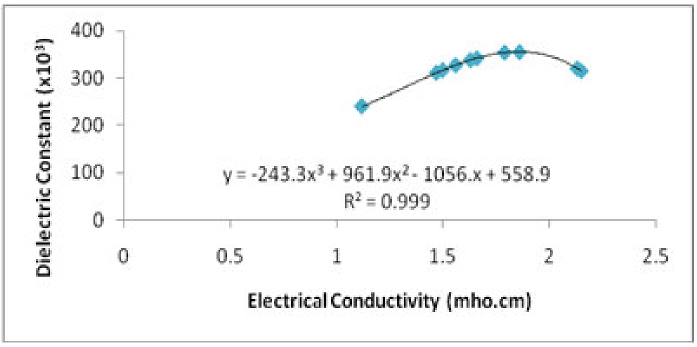

Figure 4
A plot between electrical conductivity and Dielectric Constant

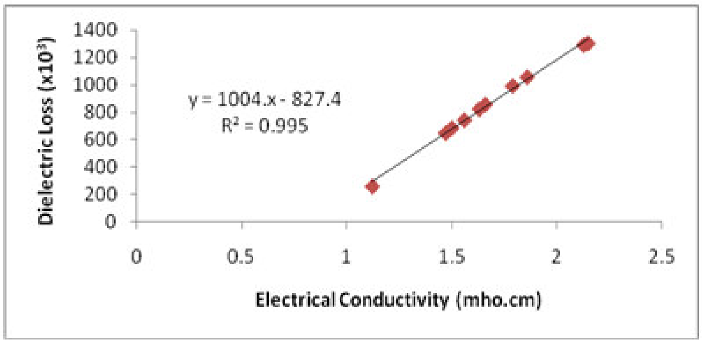

Figure 5
A plot between electrical conductivity and Dielectric Loss

CONCLUSION

Finally, it may be concluded that the alterations in the electrical conductivity of human blood due to Tuberculosis are expected to alter the electrical double layer structure of the membrane. Such subtle changes in cell (erythrocyte) physiology could be sensed by the dielectric parameters. It is believed that the findings of this study may be useful as Indicators of disease progression, cardiovascular risk factors and response to therapy in pulmonary tuberculosis patients.

ACKNOWLEDGEMENT

This work was financially supported by the University Grants Commission under Minor Research Project Scheme No.F. MRP-4858/14(SERO/UGC) for distinguished teachers working in Colleges. In this regard the author Dr.N.Manohar Reddy would like to sincerely thank the Joint Secretary (UGC- SERO, Hyderabad, A.P., India.) for his kind co-operation and support for this present work.

CONFLICT OF INTEREST

None.

REFERENCES

1. Global Tuberclosis Report; 2015 [updated 2015 cited 2015] Available from: http://www.apps.who.int/iris/bistream/10665/191102/1/9789241565059_eng.
2. WHO. Media centre Fact sheet N0104. Reviewed 2013, Feb.
3. R. Sanjuan-Jimenez, P. Morata, P. Bermudez, M. J. Bravo and J. D. Colmenero PLoSNeglected Trop. Dis., 2013; 7: 2593-96.
4. M. Caws, S. M. Wilson, C. Clough and F. Drobniewski, J. Clin. Microbiol., 2000; 38: 3150-3155.
5. H. P. Schwan, Trans. Elec. Insulation, 1985; 120(6): 913-915.
6. K. Asami, T. Harai and N. Moizumu , J. Membrane Biol. 1976; 28:169.
7. H. P. Schwan, Stud. Bio. Phys, 1985; 110: 13.
8. H. P. Schwan, Magnetic fields, (Eds.) M. Grandolfo M.S. Michealson andA. Rindi pelunum press, New York, 1985: 243.
9. R. Pethig, 'Biological polymers'In Non crystalline semi conductors,M. Pollack.ed, CRC Press.
10. H. P. Schwan, Ferroelectrics, 1988; 86: 205.
11. Takashima Inove, R. Pethig, A. K. Talal, Al Ameen and Julian PH Burt, J.Electrostatics, 1988; 21: 215.
12. Hawkes and R. Pething, Biochimica et Biophysica Act, 1988; 952: 27.
13. K. R. Foster and H. P. Schwan, Rev. Biomed. Engg, 1989; 17: 25.
14. Basharath Ali and Adeel Ahmad J. Pure & Appl. Phys., 2007; 19(4): 243.
15. Basharath Ali and Adeel Ahmad J. Pure & Appl. Phys., 2008; 20(1): 37.