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A Study of Cholesterol Percentage in Blood Tissue in the Presence of Salt

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Abstract: This article reports the study of Cholesterol percentage in blood tissue in the presence of Salt and other major blood components like Urea, Glucose and Alanine. The response is measured in the 10 - 500 MHz range with varying Salt from normal to 3 times the normal value. The aim of the study is to determine the influence of Salt on Cholesterol measurement. In order to record the responses, a Radio Frequency spectroscopic technique is used in this study. The study is performed with a low cost Tracking Generator and Spectrum Analyzer and has been found to give constant results.

Keywords: Cholesterol, Salt, CVD, Tracking Generator, Spectrum Analyzer.

I. INTRODUCTION

It is essential for a human being to be familiar with one's blood level parameters in order to stay healthy. Cholesterol is one of the important parameters of over 100 constituents present in human blood, which is required to be estimated in order to keep fit.

Cholesterol is a waxy like substance which is somewhat soluble in water. It dissolves in the blood stream in minute concentrations. Therefore lipoproteins are used to transport Cholesterol, where the inner surface is lipid soluble and the outer surface is water soluble. There are many types of lipoproteins in the blood. In order of decreasing density they are as follows:

- High-Density Lipoprotein (HDL),
- Intermediate-Density Lipoprotein (IDL),
- Low-Density Lipoprotein (LDL),
- Very-Low-Density Lipoprotein (VLDL) and
- Chylomicrons

Cholesterol consists of 4 major functions, which is very important to a human being.[1][2] They are as follows:

- Enables the body to produce vitamin D.
- Allows the body to make certain hormones.
- Creates bile acids in the intestines for digestion.
- Gives a structure to the cell walls.[3]

Cholesterol is recycled in the body. The liver expels it into the digestive tract via bile in a non-esterified form. The small bowel reabsorbs around half of the excreted Cholesterol into the blood stream. High blood Cholesterol level is a major risk for atherosclerotic disease which can lead to peripheral vascular diseases, strokes and heart attacks.

LDL particles are known as "Bad Cholesterol" because they have been associated with atheroma formation, since higher blood LDL, especially smaller LDL particle size and higher LDL particle concentrations contribute to the process much more than the content of Cholesterol of the HDL particles. [4] Whereas high concentrations of functional HDL, which can remove Cholesterol from cells and atheroma, offer protection, are known as "Good Cholesterol". These balances are mostly determined by genetics, but can be changed by food choices,[5] medications and many other factors.[6]

Edible Salts comprises of Sodium and Chloride whereas unrefined Salts like Magnesium and Calcium are bitter and so seldom consumed.[7] Table Salt contains around 40% sodium in weight, wherein 1 teaspoon consists of 2.3g of sodium.[8] The consumption of Salt has been widely studied for the impact on the human physiology and health. Excess Salt is bad for health and the general recommendation for people is to reduce Salt intake as it is correlated with the risk of CVD, Stroke,[9][10][11][12] hypertension and other health problems.

[13][14] Hence the reduction of sodium intake of around 1g per day may reduce CVD by around 30%.[15] The WHO strongly recommends that adults should consume less than 2g of sodium per day.[11] Around 0.5g of sodium per day is the minimum requirement for functioning of the normal human body. The kidneys control the serum levels of sodium and chloride. Surplus intake of either would lead to adverse health problems especially the serum sodium.[16]

The human body requires a variety of Salts of which Sodium Chloride (NaCl) is essential to perform various functions and is extremely involved in maintaining the body fluid in the blood cells which helps in transmitting information to the muscles and nerves and absorbing particular nutrients from the small intestines.[17] The body cannot produce Salt by itself, so it has to rely on the food intake to get the requirements needed. Blood Pressure and regulating body temperature are maintained by the circulation of water and solutes in the blood. Blood Pressure decreases when excess Na^+ is expelled by the kidneys.[18] Foods which contain less Salt can also decrease the blood pressure.[19]

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II. METHODOLOGY

Salt in the normal human blood is 9g/L. The concentration of Cholesterol is below 250mg/dL, Alanine is 10-20mg/dL, Urea is 10-20mg/dL and Glucose is 70-110mg/dL. The experiment is performed with average concentrations of Urea i.e. 15mg/dL Glucose i.e. 90mg/dL and Alanine i.e. 15mg/dL. 1mL alcohol along with 14mL double distilled water is used to prepare solution samples with Cholesterol concentrations ranging between 0.75 and 2.5 times the normal concentration of Cholesterol (25.5mg/15mL to 85mg/15mL). Salt varying from 1 to 3 (135mg/15mL to 405mg/15mL) along with constant average concentrations of other constituents is used to prepare the solution samples. The experiments are conducted in 2 sweeps: fast & slow and are also repeated after one hour and two hours, to ensure constant results.

Cell design is previously seen in [20]. The main part in the cell is a radiating central electrode which takes the signal from Tracking Generator and passes it to the Signal Analyzer connected at the receiver end. Since the entire experiment works in the RF range, the connectors required should have good contacts and therefore gold plated SMA connectors are used with care to minimize the radiation loss by using short feed cables prepared using RG-58 coaxial wire. The central electrode is placed equidistant from the cell walls and the cell walls are also fixed with gold foils. The gold foils basically act as ground electrode and gold being an inert element has less corrosion, as compared to other conducting materials like copper and aluminium.

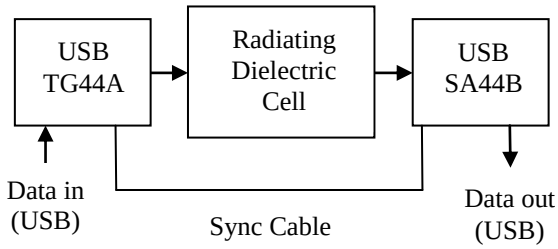

Fig. 1: Schematic of the Experimental Setup

Fig. 1 shows the schematic of the experimental setup. Normally in instrumentation one uses a network analyzer for this type of studies. Here an attempt is done to fabricate the instrument using low cost components such as USB-TG44A and USB-SA44B. They have been configured on a scalar network analyzer mode to probe the signals to estimate the Cholesterol percentage.

III.RESULTS

It is seen from the graphs shown in Fig. 2 to Fig. 4 that the absorption of Cholesterol increases at different concentrations of Salt as the concentration of Cholesterol increases from 0.75 to 2.5 in the range of 10MHz to 25MHz.

As shown in Fig. 2, the variation in the signal attenuation for varying Cholesterol concentration is seen in between -33 dB and -36 dB wherein Salt is maintained at the normal level i.e. 1 and the other components are also maintained at the normal level. As the concentration of Cholesterol increases from 0.75 to 2.5, the absorption also increases.

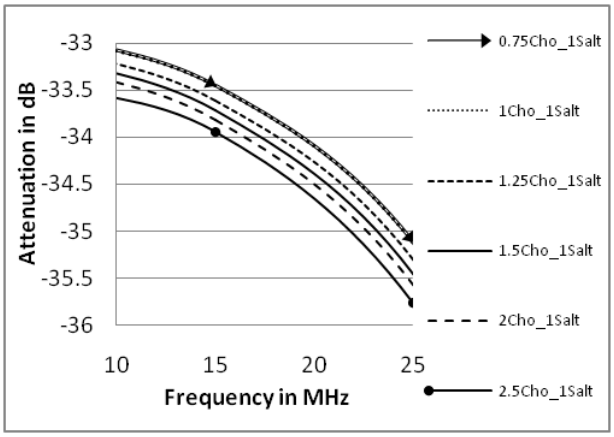

Fig.2: Graph of 10-25MHz with normal Salt concentration

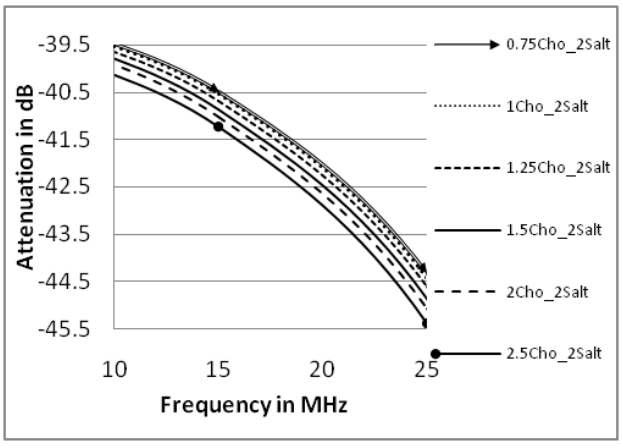

Fig. 3: Graph of 10-25MHz with twice the normal Salt concentration

Fig. 3 depicts the graph of 10MHz to 25MHz wherein Salt is maintained at twice the normal level i.e. 2 and the other constituents are maintained at the normal level. The signal attenuation for varying Cholesterol concentration exists between -39.5 dB and -45.5 dB. The absorption increases as the Cholesterol concentration increases from 0.75 to 2.5.

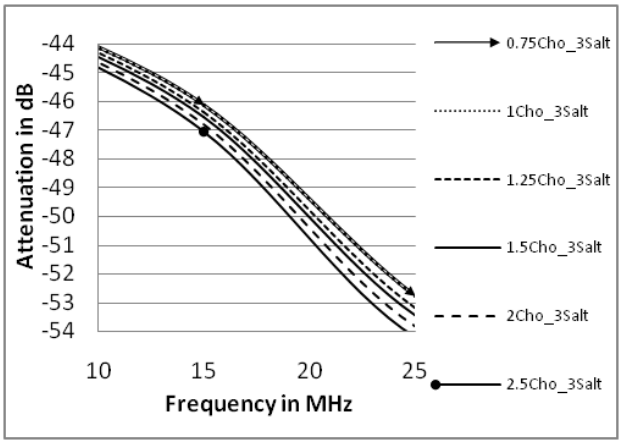

Fig. 4: Graph of 10-25MHz with 3 times the normal Salt concentration

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In the above figure (Fig. 4), it is seen that as the concentration of Cholesterol increases from 0.75 to 2.5, the absorption also increases in the range -44 dB and -54 dB wherein Salt is kept at 3 times the normal level i.e. 3 and the other constituents are at the normal level.

IV. CONCLUSION

In this article, the results of the study is done on sample solution prepared using various components like Cholesterol, Salt, Urea, Alanine and Glucose. The emphasis of the study is given on the effect of Salt on Cholesterol response. It may be seen from the graph that Cholesterol has got significant variation in the frequency range of 10MHz - 25MHz. This indicates that if Salt level of a patient varies, there could be a difficulty in the prediction of Cholesterol. However a better estimate can be done if one uses tools like PLSR algorithm.

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BIOGRAPHY

Ingrid Anne P. Nazareth born in Sharjah, U.A.E. is currently a Ph.D. Scholar in the Department of Electronics, Goa University, Goa (India). She completed her Masters in Electronics having secured the 1st place and is an awardee of the 'IV SERC School in Physics Gold Medal'. She is also a visiting faculty at the Goa University. She has attended a number of National Symposiums and Conferences where she has presented her research work. Her research interest is in the field of Biomedical Electronics.

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Dr. Rajendra S. Gad Ph.D. in Electronics, is an Associate Professor in the Department of Electronics, Goa University, Goa, India. He has worked on the ICMR and UGC, New Delhi, funded research project in the area of noninvasive glucometer. Also closely associated with the Million Book Project of Carnegie Mellon University, USA and related digital repository projects of Indian Navy associated with ALTERA Inc. USA under the MOU with ALTERA University program. Dr. Gad is Sponsored and Administered "Leading Engineer of the World 2008" & 2000 Outstanding Intellectuals of the 21st century 2009/2010, by International Biographical Center, Cambridge, England. Dr. Gad, was a winner in Mentor Graphics Design contest "Design and verification of LC3 processor" for the year 2010 in India. He is also a recipient

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Prof. Gourish M. Naik obtained his Ph.D from Indian Institute of Science, Bangalore (1987) and served the institute as research associate in the areas of Optoelectronics and Communication till 1993. For the last 20 years, he is associated with Goa University Electronics Program. He is the founding head of USIC and established Fiber optic LAN & Wireless Communication Network at Goa University. He is also a coordinator of DEITI (an educational broadcast studio supported by Indian Space Research). He has to his credit around 50 odd research papers published in National and International Journals and has presented research works at various National and International Forums. He has authored a book on Embedded Systems published by Springer (Holland). Presently he is Head of Dept. of Electronics at Goa University, Goa, India.