Infrared Spectroscopic Study on Human Blood of Patients Suffering from Renal Failure

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Abstract: *The paper reports IR spectroscopic data on blood of patients suffering from chronic renal failure. IR analysis has been made on whole blood, plasma and serum. The characteristic spectral bands pertaining to Albumin, Creatinine and Urea present in the blood are identified. The paper explores the possibility of disease analysis by IR spectroscopy.*

Keywords: *FTIR spectroscopy; Human blood; Plasma; Blood Serum; Chronic Renal failure.*

1. INTRODUCTION:

FTIR spectroscopy is being used by chemists as a powerful tool to characterize organic and inorganic compounds. IR spectroscopy was used to determine glucose concentration in dried serum [1]. IR spectroscopy is emerging as a potential diagnostic tool in the medical and pharmacological fields to provide information about the different chemical structures of healthy and pathological tissues [2]. In recent past, mid infrared and UV - Visible spectroscopy was efficiently employed in the fields of biological sciences [3]. The role of FTIR spectroscopy in diagnostic aspects involving body fluids, besides tissue diagnostic is gaining importance.

2. MATERIALS AND METHODS:

The blood samples were collected from patients suffering from Renal failure. The FTIR spectrum of blood was recorded. First, spectral grade pure KBr powder was dried in an oven up to 60 ^{0}C for 24 hours. Then 1 gm powder was taken in an agate motor and was ground until it becomes fine powder. The powder was mixed with blood sample and transferred into the bore of a cylinder so that it was distributed across the polished face of the lower plate. The polished face of the second plate towards the powder was inserted into the bore by a plunger. The die assembly was connected to a vacuum pump and was kept under vacuum for approximately 2 min so as to remove air from the sample disc. The die was dismantled and the KBr disc was removed without touching its faces.

Here, FTIR spectrometer of make Shimadzu FTIR-8400s was used. The resolution was kept at 4 cm^{-1} and scanning time was fixed at 38 sec. A total number of 32 scans were carried out on each sample. The scanning range fixed from 4000 cm^{-1} – 400 cm^{-1} for each sample.

3. RESULTS AND DISCUSSION:

Fig 1 shows IR spectrum of the blood drawn from the patients suffering from renal failure. The spectral data is presented in Table 1.

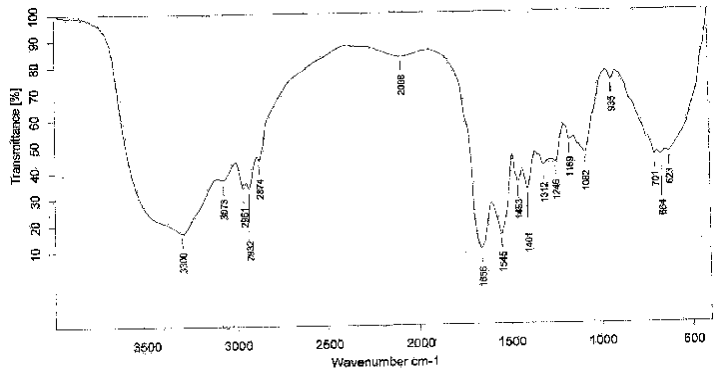

Fig. 1. A typical FTIR Spectrum of blood of Renal Failure patient

Table 1 present FTIR data on blood of patients suffering from renal failure. The data comprises wave numbers and corresponding transmittance (%) of bands concerned with characteristic vibration of functional groups of diseased blood sample.

Table 1- FTIR data on Blood of patients suffering from Renal failure

Wave Number (cm^{-1})	Transmittance (%)	Characteristic vibrations of functional groups
3362	63	N-H in $\upsilon_{(N-H)}$

2112	99	C ≡ C (symmetry reduces intensity) variable
1740	62	Ketone
1642	75	Amide – I of β pleated sheet structure
1543	60	Creatinine
1441	65	Albumin
1401	99	CH_2 and CH_3 bending modes of lipids, proteins and ring vibrations of nucleic acids
1369	69	CH_2, CH_3 bending modes of lipids, proteins, ring vibrations of nucleic acids
1233	99	P = O asymmetric stretching of PO_2^-Phospodiestres
1113	74	Carbohydrates
1093	74	P = O of stretching (symmetry) of PO_2^-
1082	77	Urea
977	83	Nucleic acids
932	85	C-O-H of glycogen
738	97	$\upsilon_{(S2)}$ in free state, S-OR esters
708	97	S-OR esters
680	80	$\upsilon_{(S2)}$ in free state

The IR spectrum serves as a finger print of biological macromolecules present in the sample. It is to be noted that the intensities (% transmittance or % absorbance) of IR spectral bands proved quantitative information, while their absorption positions reveal qualitative information on the nature of chemical bonds, their structure and their molecular environment. In blood major absorption band arise from the functional group C=O, C-O, NH, and P=O concerned with proteins, lipids and nucleic acids. The spectra of human blood indicate the presence of bands characteristics of water molecule and also of some functional groups concerned with protein and lipids. A band around 2960 cm^{-1} is due to the C-H asymmetric stretching of $–CH_3$ in fatty acids, phospholipids, Cholesterol esters. The bands in the region between 1470 cm^{-1} and 1350 cm^{-1} are concerned with various deformation modes of the functional groups, hence are concerned to present complimentary information. The dominating band at 1396 cm^{-1} may be originated due to the important protein of blood fibrinogen. This band is related to the stretching C=O symmetric stretching vibrations of COO^-. The region between 1800 cm $^{-1}$ and 1500 cm^{-1} is dominated by conformation sensitive Amide I and Amide II bands, which are very sensitive bands as far as biological complex system are considered. As is known, IR spectroscopy is averaging technique and as such Amide I and Amide II bands cannot provide structure information of a particular protein. IR spectrum of molecules shows its characteristic absorptions, In the case of Albumin, Creatinine and Urea the following absorption bands may be found ν(O-H) between 3570 $cm^{-1}$and 3120 cm^{-1}, ν (C-H) between 3085 $cm^{-1}$and 3020cm^{-1}, ν (C-O) between 1230 cm $^{-1}$ and 1000 cm^{-1} and ν (C-O-C) between 1275 cm^{-1} and 800cm^{-1}. The mid IR spectral bands of Albumin, Creatinine and Urea and other carbohydrates have been assigned to C-C, C-H, O-H stretching and bending vibrations. The characteristic bands for Albumin, Ceatinine and Urea in blood and serum are at 1441cm^{-1}, 1543 cm^{-1}, 1082 cm^{-1} respectively..

4. CONCLUSIONS:

The FTIR spectroscopy is a complementary technique to biochemical estimations. The bands at 1441cm^{-1}, 1543 cm^{-1}, 1082 cm^{-1} are characteristic bands for Albumin, Ceatinine and Urea in blood as well as serum respectively and can be used comfortably to measure their concentration.

The IR study can be extended for administration and monitoring of a drug and recovery of kidney patients to normal health.

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