Comparison of Trace Element Levels in Fasting and Postprandial Blood Serum Samples

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Abstract

Trace elements play important role in Insulin metabolism and alterations in trace elemental concentrations in the human body have been studied for their association with the occurrence of Diabetes Mellitus. However there have been no specific investigations on comparison of trace element levels between Fasting and Postprandial blood. Comparative studies on trace element concentrations in Fasting and Postprandial blood serum samples have been carried out using PIXE. We find that there are no statistically significant differences in the major and trace element concentrations in the two sets of samples.

Introduction

Diabetes Mellitus (DM) results from defects in insulin production, insulin action or both [1]. The hormone insulin produced by the pancreas helps the glucose to enter the cells where it is used as fuel by the body. The metabolic process is completely disturbed in the body either due to lack of insulin or due to ineffectiveness of the insulin that the body produces. Consequently, glucose or sugar builds up in the blood stream. This is typically the case in people with Diabetes. Several studies in the past [2-8] have demonstrated the involvement of some trace elements in regulating or potentiating insulin action. These studies have found alterations in micronutrient status of patients with diabetes and in some studies deficiency of certain minerals or vitamins have been correlated with presence of diabetic complications.

Various methods have been employed to determine the trace element concentrations in blood, urine and other biological samples from patients suffering diabetic disorder. All these studies have drawn conclusions by determining the differences in the concentration of essential elements between samples collected from diabetic patients and healthy control group [9]. However, specific studies on comparison of trace element levels in the blood serum samples collected before (Fasting) and after food (Postprandial) have not been reported earlier. In this work trace element studies were conducted on fasting and postprandial samples of diabetic patients using the Particle Induced X-Ray Emission technique (PIXE).

Methods

The elemental characterization of any material is best done by looking at the X-ray spectrum of the sample. Among the several well established techniques available for the determination of trace elements and their concentrations in different samples, PIXE clearly offers significant advantage over other X-Ray emission techniques. PIXE is a versatile non-destructive technique for multi-elemental analysis [10-12] and finds use for trace element analysis in varieties of fields. Many early applications of PIXE took advantage of one of its unique aspects, namely the ability to cope with very tiny specimens (e.g. 0.1-1 mg). The applications of PIXE in the fields of Biology, medicine, environmental analysis, oceanography, geology, etc., are well known [13, 14].

Blood samples were collected from diabetic patients with the help of the doctors in Sri Sathya Sai General Hospital (SSSGH) situated in the vicinity of our Institute. These patients hailed mainly from places in the region of Anantapur district of Andhra Pradesh and the samples were collected as the patients came for treatment. The study consisted of comparison of the trace element concentrations in the Fasting (F) and Postprandial (PP) specimens from the same patient. All data pertaining to the details of the patient, namely, name, age, gender, locality, staple food, sugar count, type of diabetes (type I or II), etc., were noted for each of the samples. After centrifuging, the serum was separated from the plasma, labeled and stored under -20°C conditions in high quality laboratory grade polypropene vials. The advantage with serum is that they can be preserved for 3-4 months without any degradation. The samples were collected over a period of two-three weeks.

Addition of internal standard provides a means for calibration and standardization in any PIXE experiment. Palladium (Pd), used as standard in many PIXE experiments, was chosen as the internal standard for our work. Palladium is a rare metal and its presence in any biological sample can be ruled out. This mixture of serum and internal standard was used for the PIXE study.

The accelerator facility available at the Indira Gandhi...
Center for Atomic Research (IGCAR), Kalpakkam, India, was used for conducting the PIXE experiment on the serum samples. About 50ml of the mixture was put on a strip of mylar foil and allowed to dry. The proton beam of 2 MeV from the Tandetron Accelerator was made to fall on the sample and the X-rays were detected by a LN2 cooled Si(Li) detector (ORTEC). A total of 50 samples of diabetic blood were used for the study. PIXE experiment was performed on all these samples under similar conditions and the data were collected by a PC based multi channel analyzer attached to the detector. Elemental analysis was carried out by using the software GUPIXWIN?. GUPIX? and GUPIXWIN? are versatile software packages [15] for fitting PIXE spectra from thin, thick, intermediate and layered specimens. They extract peak intensities and convert these to concentrations via the H-value standardization method [16].

Results and Discussion

A few typical PIXE spectra obtained from the blood serum samples are shown in Figures 1. Generally, the blood glucose level is different in fasting and postprandial samples. People are advised on medication based on the sugar levels in these two samples. Clinically this carries so much important for diagnosis and treatment. But our study, focused on determining the trace element concentrations, reveals that the concentrations of the major and trace elements in the F and PP samples of diabetic people are same to within the experimental errors. The average values of the concentrations of major and trace elements in F and PP samples are listed in the table 1, which highlights this particular aspect. This is also illustrated in the graphs [Fig. 2]. The concentrations vary across the patients, and only very few abnormalities have been observed. A statistical analysis [t-test] was performed on these data and the results of the t-tests were much greater than 0.1 and hence we conclude without any reservation that, statistically, there is no significant difference in the mean values of the concentrations of trace elements in fasting and postprandial samples.

In essence, we draw the following conclusions from the present study. Comparison of F and PP samples clearly indicate that the concentrations of major and trace elements are not significantly different in them. As said before, trace elements have a strong influence on the metabolism in the body and alterations in the trace element levels have been found as either the cause for or the result of any disorders like diabetes. However it is clear that in people with diabetes, the trace element concentrations in the blood serum does not vary between fasting and postprandial samples even though there will be marked differences in these levels when compared with healthy blood. Hence it will not matter whether one uses the fasting or the postprandial sample for trace element studies with respect to diabetic disorder. Separate investigation has been carried out for determining the cause for major onset of diabetes in people of the region of Anantapur district of Andhra Pradesh in terms of comparison of trace element concentrations in diabetic and healthy people and also correlating them with studies on water, soil and staple food.

Conclusions

In essence, we draw the following conclusions from the present study. Comparison of F and PP samples clearly indicate that the concentrations of major and trace elements are not significantly different in them. As said before, trace elements have a strong influence on the metabolism in the body and alterations in the trace element levels have been found as either the cause for or the result of any disorders like diabetes. However it is clear that in people with diabetes, the trace element concentrations in the blood serum does not vary between fasting and postprandial samples even though there will be marked differences in these levels when compared with healthy blood. Hence it will not matter whether one uses the fasting or the postprandial sample for trace element studies with respect to diabetic disorder. Separate investigation has been carried out for determining the cause for major onset of diabetes in people of the region of Anantapur district of Andhra Pradesh in terms of comparison of trace element concentrations in diabetic and healthy people and also correlating them with studies on water, soil and staple food.

References

15. http://pixe.physics.uoguelph.ca/gupix/
Illustrations

Illustration 1

Fig 1: Typical PIXE spectra of blood serum – left Fasting and right postprandial samples
Illustration 2

Table 1: Average values of Concentrations (in ng/cm²) in fasting and postprandial blood serum samples

<table>
<thead>
<tr>
<th>Element</th>
<th>S</th>
<th>Cl</th>
<th>K</th>
<th>Ca</th>
<th>V</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>3205 ± 157</td>
<td>14113 ± 198</td>
<td>718 ± 16</td>
<td>345 ± 5</td>
<td>7.0 ± 1.2</td>
<td>4.6 ± 0.6</td>
</tr>
<tr>
<td>PP</td>
<td>3197 ± 138</td>
<td>14930 ± 224</td>
<td>721 ± 14</td>
<td>339 ± 5</td>
<td>8.5 ± 2.0</td>
<td>4.0 ± 0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element</th>
<th>Mn</th>
<th>Fe</th>
<th>Ni</th>
<th>Cu</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>29.6 ± 1.3</td>
<td>590 ± 6</td>
<td>3.8 ± 0.8</td>
<td>28.5 ± 1.1</td>
<td>27.8 ± 1.5</td>
</tr>
<tr>
<td>PP</td>
<td>34.0 ± 1.7</td>
<td>598 ± 6.6</td>
<td>3.9 ± 0.9</td>
<td>29.8 ± 1.2</td>
<td>24.2 ± 1.3</td>
</tr>
</tbody>
</table>
Illustration 3

Fig 2.: Comparison graphs for trace element concentrations. t-test values are 0.77, 0.80, 0.91, 0.41, 0.86, 0.93, 0.56 for Ca, S, Fe, Mn, Cu, Zn and V respectively.
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