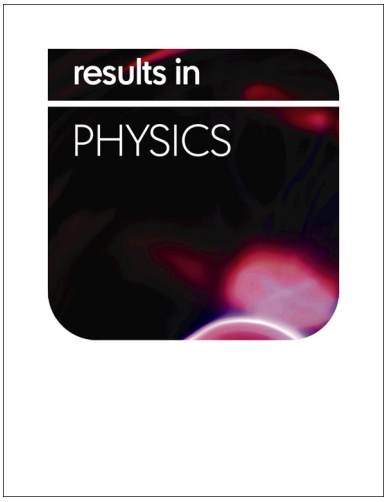

Microarticle

Insulin overlapping in whole blood FTIR spectroscopy in blood glucose measurements

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A B S T R A C T

For the last decade, several studies on mid-IR spectroscopy for blood glucose quantification have not considered the compounds involved in the glucose regulation mechanism, in which insulin plays an important role. This work shows how insulin overlaps in the same mid-IR region in which glucose is quantified. This optical absorption interference is an important factor to be considered for this type of studies, in the scope of whole blood modeling for spectroscopy applications and the possible use of computer based metrics.

Introduction

In the search to develop non-invasive alternatives to the common digital glucometer, several studies have explored techniques for blood glucose quantification based in mid-IR spectroscopy [1, 2]. In [3], authors reported that wavelengths between 9 to 11μm are useful for the proper measurement.

Several studies, in their *in vitro* stages, have reported the use of aqueous glucose samples, in order to analyze the viability of the technique, using a simplified blood phantom and from there, developing a protocol to acquire and analyze spectra aiming to quantify glucose [3-5]. But, when these techniques have been transferred into an *in vivo* scenario, they had required the application of different mathematical methods to transform the results and get a possible reading for the glucose concentration [6, 7]. Therefore, in order to obtain a better understanding of the interaction between actual blood samples and infrared light in the IR region mentioned above, it is important to consider whole blood composition and the compounds involved in the glucose regulation mechanism. In both, insulin plays a predominant role for the optical absorption in the region in which glucose had been measured, and in the glucose concentration regulation [8]. A study in this scope would bring a better understanding of the role of insulin during glucose quantification by spectroscopic means in the mid-IR region.

Methods

An initial spectroscopy characterization for insulin was made with an intermediate-acting, human recombinant DNA origin insulin pharmaceutical sample (Lilly, Humulin N®), which was compared with the spectrum obtained from a glucose standard solution at 550 mg/dL (Carolina Biological Supply). The acquisition of blood samples with glucose concentration gradient, was done using an oral glucose tolerance test (OGTT). For health and safety reasons, it was applied to a healthy subject [9]; from whom drop size blood samples were acquired and quantified with a digital glucometer (Jhonson & Jhonson, One touch Ultra 2®). The absorption spectra for the blood, glucose and insulin samples were obtained with a FTIR spectrometer (PerkinElmer, Spectrum Two), with a resolution of 4 cm^{-1}. In order to obtain specific readings from the changes in glucose concentration from the OGTT trials, a sample from the fasting state of the subject was considered to be the background reading. Therefore, all changes in the absorption spectra from the blood samples are related to concentration variations in glucose and its correspondent regulation mechanism compounds, neglecting the effects from the rest of blood components.

Results

Insulin is a peptic hormone which has an absorption spectrum in the mid-IR region that also corresponds to glucose [8]. Figure 1 shows that the absorption spectrum is found in the same region for both glucose and insulin (1100-900 cm^{-1}). Even though they correspond to different vibrational modes [10], their absorption magnitude is on the same range.

Figure 2 shows the spectra obtained from blood samples during the OGTT, in which an increase in the absorption spectra at the glucose specific region (1100-1000 cm^{-1}) is observed. Nonetheless, in the same figure, the absorption peaks for the samples