Phantom Skin Absorption Coefficients from Spectrophotometric and Integrating Sphere Methods: Preliminary Comparative Results

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INTRODUCTION: Minimalistic or non-invasive diagnosis and treatment of skin disorders requires accurate information regarding skin optical properties [1]. Spectrophotometric and Integrating Sphere (IS) methods are commonly used to extract information regarding absorption and scattering properties of samples, although in the field of skin optics the latter is used more widely [1,2]. The aim of this study is to extract and compare absorption coefficients of liquid skin phantoms with these two methods.

METHODS: Absorbance spectra of liquid phantom skin samples were measured with a UV-VIS spectrophotometer (Shimazdu UV-1650 PC) using standard 1 cm pathlength. The liquid phantoms consisted of green food dye (GFD) of specific absorption and added in varying concentrations to either 0.01% Intralipid (20%) or 0.1% Pheroid™ artificial vesicle aqueous stock solutions. Absorption coefficients ($\mu_a(\lambda)$) were calculated from the Beer-Lambert law

$$\mu_a(\lambda) = A(\lambda)ln(10)/L \quad [cm^{-1}] \qquad (1)$$

where $A(\lambda)$ is the wavelength dependent absorbance of the sample and L the pathlength (cm). Reflectance and transmission measurements were also taken for each sample using an 8 inch diameter Integrating Sphere (Labsphere) connected to a 7.4 mW He-Ne laser (λ=632.8 nm) coupled into a multimode fibre (core diameter 62.5 µm). Sample holders with a diameter of 25 mm were connected onto the entrance and exit ports of the IS. The signal was used as input to the detector (Ocean Optics USB4000 spectrometer) using a fibre (600 µm core diam, Ocean Optics). A calibration model with known μ_a was created using Intralipid (20%) (scatter, non-absorbing) and black dye (absorber, non-scattering) solutions. The optical parameters were extracted from the calibration model using the Newton-Raphson method.

RESULTS: Absorbances measured with both methods displayed the Beer-Lambert law's linearity, although the IS method's absolute result values are about a factor 6 smaller (Fig. 1). Calculated μ_a residual values of GFD in either Intralipid (20%) or Pheroid™ suggested a difference in sensitivity between methods as the absorbance of the GFD was increased (Fig. 2).

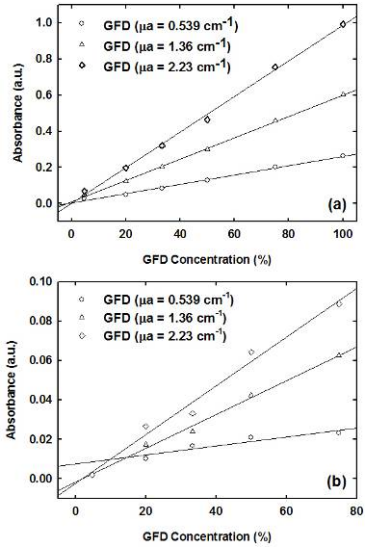

Fig. 1: Absorbance as a function of GFD concentration (in 0.1% Pheroid™ solution) for (a) spectrophotometric and (b) IS methods.

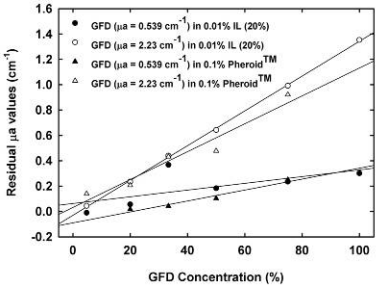

Fig. 2: Residual data between spectrophotometric and IS methods.

DISCUSSION & CONCLUSIONS: Preliminary results indicated similar trends with increased μ_a values as GFD concentration and absorbance was increased. Differences in the methods' sensitivity may be due to shortcomings in the IS calibration model, or differences in measuring methodology with the two experimental set-ups.

REFERENCES: [1] B.J. Wilson, S.L. Jacques (1990) *IEEE J Quantum Electron* **33**:1471-77 [2] J.W. Pickering, S.A. Prahl, N. van Wieringen, et al (1993) *Appl Opt* **32**:399-410.