Refractive properties of human adipose tissue at hyperthermic temperatures

I. Yu. Yanina,[1,2] E. N. Lazareva,[1,2] A. N. Bashkatov,[1,2] E.A. Genina, [1,2] V. V. Tuchin[1,2,3]
[1]Research-Educational Institute of Optics and Biophotonics, Saratov National Research State University, SSU, Saratov, Russia
[2]Interdisciplinary Laboratory of Biophotonics, Tomsk National Research State University, TSU, Tomsk, Russia
[3]Laboratory of Laser Diagnostics of Technical and Living Systems, Precise Mechanics and Control Institute, Russian Academy of Sciences, Saratov, Russia
e-mail irina-yanina@yandex.ru

***Abstract* — The refractive index (RI) of human adipose tissue (AT) in the visible and near-infrared ranges were measured at heating (from 40°C up to 50°C). For the first time, RI temperature increment was quantified for a wide wavelength range. The critical temperatures corresponding to lipid phase transitions of AT were determined.**

Keywords — human adipose tissue; refractive index; hyperthermia; phase transition

I. Introduction

Nowadays, there is an extensive interest to the development of laser-based diagnostic modalities to monitor efficiency of treatment of obesity and cellulite by destruction of adipose tissues (AT) associated with its heating [1,2]. The mechanism behind these treatment and monitoring techniques are related to the gel/liquid crystalline phase transitions of different lipids [3], modification of collagen fiber structure [4], degradation of cellular components [5], and corresponding variations of refractive index (RI) of the intercellular fluid [6]. The knowledge of thermal response of RI of AT is important for getting more precision information about processes occurring during fat cell destruction and light transport through fat tissue. Therefore in this study, we performed measurements of RI dispersion and temperature increments of AT in the hyperthermic temperature range and on selected wavelengths in the Vis and NIR ranges.

II. MATERIALS AND METHODS

The materials for the proposed work were samples of abdominal AT from humans (5 men, 40–50 year old, 70–80 kg). Samples were provided by the Centre of Collective Use of Saratov State Medical University (Russia). Frozen tissue was sliced (0.21±0.04 mm) manually with a scalpel. A multi-wavelength Abbe refractometer Atago DR-M2 1550 (Atago, Japan) has been used for the quantitative assessment of the RI in a range from the 40 °C to 50 °C. A sample under study was displaced on the prism of the Abbe refractometer connected to a circulating thermostat LOIP LT 100 (LOIP Ltd., St. Petersburg, Russia).

III. RESULTS AND DISCUSSION

The phase transitions between the lipid components are clearly visible in Fig. 1a. The RI increment dn/dT for experimental data presented in Fig. 1b equals to $-(2.48\pm0.24)\times10^{-4}$ °C^{-1} with n_0= 1.491 that corresponding well to the slope measured for the oleic acid, -3.8×10^{-4} °C^{-1} with n_0= 1.467 [7].

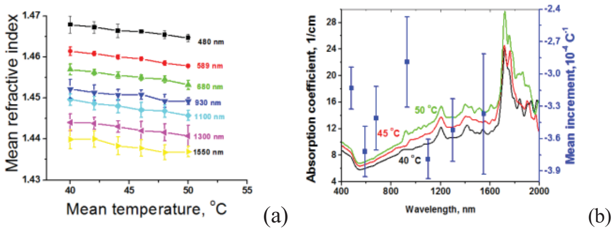

Fig. 1. The mean RI temperature dependences (a) and absorption coefficient and temperature increment ($\times10^{-4}$°C^{-1}) (b) of human abdominal AT for different wavelengths. Temperature phase transitions are seen as alterations from the monotonical dependence on temperature.

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