ABSTRACT

The present work constitutes a biophysical study of the dielectric properties of biological mammalian tissues and the effects of ionizing and non-ionizing radiation. In addition human tumor (prostate and lung) tissues were studied following the specific methodologies. The aim was the use of the Dielectric Relaxation Spectroscopy (DRS) in the field of structural studies of tissues with different types of stresses and the examination as to whether the method employed is sufficient enough for use in non-invasive diagnostics.

This study includes rat and human tissues, healthy and stressed, exciled either from the same organism (parts remote from the maleficence) or from a healthy animal used as control, in order to allow comparison between them as counterparts. Specifically, rats were exposed to γ-irradiation (a dose of 5Gy) or to DECT radiofrequencies (Digital Enhanced Cordless Telecommunications) and their skin or cerebellum (respectively) was studied. Furthermore, another type of stress was included, ie lung and prostate cancer in humans. In the same experimental philosophy, tumor and remote from tumor tissues were exciled. All samples were subjected into DRS measurements, which means isothermal recording of the complex dielectric permittivity responding to 10^{-1}-10^{-6} Hz alternate electric field for temperatures between -150 ^{o}C and 20^{o}C. Additionally, Equilibrium water Desorption Isotherm (EDI) method was employed when necessary to evaluate the water content of tissues during the different experimental stages.

Measurements and some critical calculated quantities like conductivity are presented in comparative diagrams and tables. Useful conclusions were extracted from data analysis, in combination with respective literature, regarding the measurement accuracy and tissue handling.

More specifically, DRS method was successfully employed in biopolymeric materials with such a complex geometry and high sensitivity and the recorded dielectric magnitudes spectra form meets the bibliographic standards. A fact of outmost importance is the detection of multiple relaxation mechanisms after unbiased data analysis, the identification of them as literature's α-, β- and γ- dispersions and the confirmation of δ- dispersions' existence, which are faint overlapping sub-dispersions attributed to the dipolar moments of large bio-molecules (proteins) and their bound water. The later dispersion is a particular feature of the biological matter in relation to the other physical or artificial polymeric materials.

The mild nature of DECT does not appear to cause an actual difference in the dielectric permittivity, ε′, and the dielectric loss , ε′′, spectra of rat cerebellum, possibly due to equally mild interaction of electromagnetic radiation with this particular part of the brain tissue. On the other hand, some first signs of reduction in conductivity, σ_{AC}, were recorded in the measurements of rat skin which was exposed to the more effective γ- irradiation. Focusing on the magnitude of

conductivity in 20^{o}C, for practical reasons, and in the frequency of 10^{5}Hz, as suggested in literature, there was observed satisfactory agreement with the literature values for the majority of samples. This also includes the human lung tissues, which, furthermore, showed greater values of conductivity in case of malignancy than in the healthy ones. This fact indicates the possible satisfactory resolution of DRS technique towards its potential contribution in medical diagnosis. Unlike lung tissues, the conductivity of high Gleason score prostate adenocarcinoma appears to be of lower value in this particular frequency, as suggested in literature.

Finally it should be marked that the extraction of these interesting, but rather complex and insufficient, results and their comparison with the previous relative work, underline the need for further investigation of biological structures with the DRS method. Better statistics are of vital importance in the direction of establishing a standard protocol, exploiting the sensitivity of the method, determining specific quantified thresholds for each pathogenic situation and drawing univocal conclusions.