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Photobiomodulation and Oxidative Stress: 980 nm Diode Laser Light Regulates Mitochondrial Activity and Reactive Oxygen Species Production

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Abstract

Photobiomodulation with 808 nm laser light electively stimulates Complexes III and IV of the mitochondrial respiratory chain, while Complexes I and II are not affected. At the wavelength of 1064 nm, Complexes I, III, and IV are excited, while Complex II and some mitochondrial matrix enzymes seem to be not receptive to photons at that wavelength. Complex IV was also activated by 633 nm. The mechanism of action of wavelengths in the range 900-1000 nm on mitochondria is less

understood or not described. Oxidative stress from reactive oxygen species (ROS) generated by mitochondrial activity is an inescapable consequence of aerobic metabolism. The antioxidant enzyme system for ROS scavenging can keep them under control. However, alterations in mitochondrial activity can cause an increment of ROS production. ROS and ATP can play a role in cell death, cell proliferation, and cell cycle arrest. In our work, bovine liver isolated mitochondria were irradiated for 60 sec, in continuous wave mode with 980 nm and powers from 0.1 to 1.4 W (0.1 W increment at every step) to generate energies from 6 to 84 J, fluences from 7.7 to 107.7 J/cm^2, power densities from 0.13 to 1.79 W/cm^2, and spot size 0.78 cm^2. The control was equal to 0 W. The activity of the mitochondria's complexes, Krebs cycle enzymes, ATP production, oxygen consumption, generation of ROS, and oxidative stress were detected. Lower powers (0.1-0.2 W) showed an inhibitory effect; those that were intermediate (0.3-0.7 W) did not display an effect, and the higher powers (0.8-1.1 W) induced an increment of ATP synthesis. Increasing the power (1.2-1.4 W) recovered the ATP production to the control level. The interaction occurred on Complexes III and IV, as well as ATP production and oxygen consumption. Results showed that 0.1 W uncoupled the respiratory chain and induced higher oxidative stress and drastic inhibition of ATP production. Conversely, 0.8 W kept mitochondria coupled and induced an increase of ATP production by increments of Complex III and IV activities. An augmentation of oxidative stress was also observed, probably as a consequence of the increased oxygen consumption and mitochondrial isolation experimental conditions. No effect was observed using 0.5 W, and no effect was observed on the enzymes of the Krebs cycle.

Figures

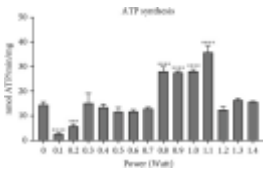

Figure 1 Effects of the 980 nm...

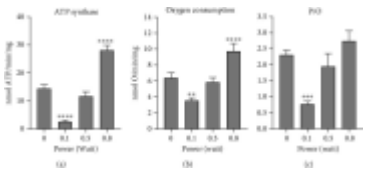

Figure 2 Effects of the 980 nm...

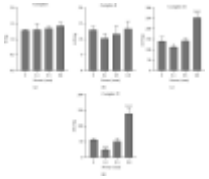

Figure 3 Effects of the 980 nm...

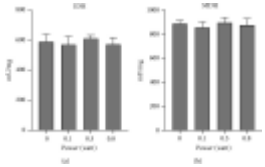

Figure 4 Effects of the 980 nm...

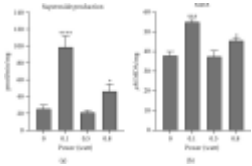

Figure 5 Effects of the 980 nm...

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