Growth and antioxidant responses of *Saccharomyces cerevisiae* BY4741 exposed to titanium dioxide nanoparticles under heat-shock conditions

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Abstract

Nanomaterials are structures with size range between 1 and 100 nm, their strength, conductivity, reactivity and surface area/molecular size ratio, which differ substantially from macro- or micron- sized materials, shifting the rules of physics and chemistry to the side lines. Nanoparticles have geological origin and ubiquitous occurrence in the earth crust, this can lead to suppose a good phylogenetic adaptation of living beings. However, the industrial development have contributed to raise their environmental levels of nanoparticles in certain regions of the world. The reactivity of nanoparticles with biomolecules mainly depends on the physicochemical factors such as pH and temperature. Thus, the main objective of this study was to evaluate how heat-shock affects cell survival and antioxidant response of *Saccharomyces cerevisiae* BY474, that suffer a loss of proliferative capacity by an active process when the level exposure was 0.1 mg/ml. However, for 1 mg/ml TiO_2-NPs level, appears to occur a transition for necrosis.

Keywords: yeast; alkaline phosphatase; glutathione; lipoxygenase; catalase

1. Introduction

Nanomaterial are a new class of materials (<100 nm) have physicochemical and structural properties which depend of particle size. The industrial development has contributed to raise their environmental levels of nanoparticles in certain regions of the world. Titanium dioxide (TiO_2) has been used over the years as an inert substance, and regarded as safe for human health by the Food and Drug Administration (FDA) of the United States of America, allowing its use as an additive for pharmaceuticals and external application of cosmetics such as sunscreen products, as well as in the production of paper and plastics [1,2]. The reactivity of these materials with biomolecules mainly depends to physicochemical factors such as pH and temperature. Living organisms regulate their activities and shape their interactions with the environment to achieve homeostasis. Minimal fluctuations in growth conditions in the tolerance limits of cellular systems are buffered by the existing components. Therefore, when environmental changes occur cells are capable of activating factors appropriate response to stress to adapt and survive. *Saccharomyces cerevisiae* has been considered an experimental system to test hypotheses about the heat shock response, the nature of the sensory mechanism to heat stress, or simply how cells recognize gradual increases in temperature [3,4].

The enzymatic reactions have several speed ratios in which each is affected by temperature changes, so that the activation energy calculated from the Arrhenius representation will always be apparent or 'average'. The representation may be non-linear Arrhenius if the limiting steps are different at different temperatures. The transition temperature can be correlated with the composition of cell membranes acyl residues and presumably, the transition may be associated with alterations in membrane fluidity. The sharp decline in the representation of Arrhenius suggests protein denaturation. The high thermal capacity of the water mass ensures that growing cells are capable of withstanding rapid changes in temperature. The biological growth is considered by several authors as a chemical event which cannot be distinguished from any organic reaction in aqueous medium, except for its complexity, this process it is possible to assess in terms of the initial state of the substances in the composition forming cells and the final state that encompasses cells and growth products. Extracellular drastic changes may break the internal environment of the cell, affecting critical functions and impairs growth [5,6].