Effects of Modulated Concentration of ZnO Nanoparticles on Enhancing Biosynthesis of Metabolites and Protecting Plant Membrane

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ABSTRACT

Nowadays, nanoparticles are raising their applications around the world. ZnO nanoparticles are extensively used in the industrial and agricultural processes because of low price and less toxicity. Nevertheless, the pros and cons, effects of ZnO nanoparticles are still under discussing. This research aimed to study the protective effects of ZnO nanoparticles on plant physiology at the cellular level by analyzing biomaterial levels in relation to the stability of cellular membranes. Shoots of wild type and tt8 transgenic tobaccos were grown under tissue culture condition in the medium, adding 0, 10, 20 mg/L ZnO nanoparticles. Under media conditions adding 10, 20 mg/L ZnO nanoparticles, tobacco increased accumulation of plant metabolites (total soluble sugar and flavonoids). In these ZnO conditions, wild type and transgenic tobaccos enhanced total soluble sugar about 30-50% and 20-30%, respectively. The highest content of total soluble sugar was found in 20 mg/L ZnO nanoparticle condition. In similarity to the content of total soluble sugar, tobacco plants showed the highest average contents of flavone, flavonol and anthocyanin after growing in 20 mg/L ZnO nanoparticle conditions, 92.8%, 61.39% and 48.81% in wild type and 73.49%, 52.39% and 81.68% in transgenics, respectively. Tobaccos under 10 mg/L ZnO media condition increased the accumulation of total soluble sugar and flavonoid contents less than those under 20 mg/L ZnO media condition. However, these plants showed the lowest average percentage of cell membrane injury, 19.5% in wild type and 10-18% in transgenic tobaccos, following with plant under 20 mg/L ZnO nanoparticle and non ZnO nanoparticle conditions. Therefore, 10-20 mg/L ZnO nanoparticles in

the media showed the induction of plant metabolites, especially in transgenics, and the enhancements of plant protection when compared with the same line tobacco under condition of non ZnO nanoparticles. Ten mg/L ZnO nanoparticle media is the best condition in protecting cellular membrane of tobacco.

Keywords: Nanoparticle, ZnO, Plant, Cell membrane, Flavonoid, Sugar, Protection

INTRODUCTION

The rapid development of nanotechnology influences on the applications of nanoparticles in multilaterally fields (Ov, 2004; Srinivas et al., 2010). Nanoparticle usages are increasing in the processes of industry and agriculture for the decade. However, toxicology awareness is also rising. ZnO nanoparticles are the important nanoparticle that have been used around the world. These nanoparticles showed the impacts on inducing plant growth and biosynthesis much better than bulk ZnO did (Prasad et al., 2012; Bandyopadhyay et al., 2015). ZnO nanoparticles has been proven to have the effects on enhancing plant development, enzymatic activity and biomaterial synthesis (Mahajan et al., 2011; Mukherjee et al., 2014; Wang et al., 2016). Since, some researcher reported the toxicological impacts of ZnO nanoparticles on plant growth when a high concentration of ZnO nanoparticles was added into the planting material (Mukherjee et al., 2014; Bandyopadhyay, 2015; Wang et al., 2016). Pros and cons, effects of ZnO nanoparticles on plant growth and development are under discussing. The majority effects of ZnO nanoparticles on plant depended on the concentration of ZnO nanoparticles, stage and species of plants (Mahajan et al., 2011; Mukherjee, 2014). Plant synthesizes various types of plant metabolite in responding to environmental conditions. The level of these metabolites implies cellular status of plants. In this experimental work, the contents of total soluble sugar and flavonoids were quantified. Sugars are known as fundamental signaling in several signal transduction processes while flavonoids are groups of cellular protective metabolites which contain an antioxidant function.

This work had aimed to examine the ZnO nanoparticles effect on plant physiology at the cellular level. The plant was treated with an attenuating concentration of ZnO nanoparticles and analyzed the levels of biomaterials in responding to protect the cellular membrane. In this experiment, wild typeand transgenic tobaccos over expressing flavonoid regulatory gene were used to identify the obvious results of the plant responses.