THE USE OF NITROGEN CONTENT OF *Lemna gibba* GROWTH MEDIUM AS AN INDICATOR OF CADMIUM TOXICITY

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ABSTRACT

Nitrogen content of *Lemna gibba* medium was measured in order to examine changes in concentrations of three nitrogen forms, ammonia, nitrate and nitrite, induced by the presence of cadmium over 10 days. Cadmium concentration of 100 µg L^{-1} caused a complete inhibition (100 %) of growth and a 74.4 % decrease of ammonia production. However, control experiments using *Lemna gibba* plants sterilized by sodium hypochlorite and diluted alcohol solutions before culturing suggested that NH_4^+ present in experimental medium originated from microorganisms` activity. Slight increase of nitrite was observed in response to cadmium. Significant increase of NO_3^- concentrations (159 ± 32 to 385 ± 23 mg L^{-1}) was observed in the medium of plants exposed 10 days to 100 µg L^{-1} Cd^{2+}. Decrease in cadmium content of the culture medium after 10 days of incubation indicated a strong relationship between cadmium uptake, toxicity, and inhibition of nitrate absorption. Changes in nitrate concentration are proposed as a marker of cadmium contamination in water.

KEYWORDS: cadmium, heavy metals, bio-monitoring, aquatic plants, nitrate uptake, ammonia uptake.

INTRODUCTION

Duckweed and other aquatic plants have often been used as a tool for monitoring water pollution, particularly with metals [1, 2]. Significant correlation between metals in aquatic plants and aqueous concentrations were observed in field studies [3-6] and laboratory experiments [7, 8]. The final metal concentration in aquatic plants is usually significantly higher than that of the water, and this fact led investigators to be interested in their use not only as indicators of environmental quality [9-12], but also as tools for studying the transport of metals into plants [13, 14] and the biochemistry of metals in plants [15]. Physiological parameters are being evaluated for their ability to provide information on responses of aquatic plant to toxic compounds and also to investigate the mechanisms of inhibition [16]. All the nutrients and pollutants taken up by plants come from the surrounding water [17]. Metal uptake by aquatic plants depends on adsorption phenomena, and it is also directly related to metal concentration in the water, contact time, and pH which affects both cell surface metal binding sites and metal chemistry in water [18]. Thus, the chemical characteristics of the water may be directly related to the metabolic responses of aquatic plants to metal stress which may, in turn, influence water characteristics; these changes could, in turn, be envisioned to quantify pollutant effects.

Among several species utilized in the assessment of pollutant toxicity, *Lemna gibba* was used to study the effect of metals and pesticides [2]. Among them, the herbicide glufosinate induced a strong ammonia accumulation leading to death of the plant [19]. This ammonia accumulation induced inhibition of nitrate uptake and its assimilation in a variety of aquatic plants [20].

In another context, investigations were described under *in vitro* and field conditions, in which aquatic plants, such as duckweed, could be used in phytoremediation to recover nutrients or pollutants from wastewater [21, 22]. These experiments are an alternative technology to convert nutrients into potentially useful products and prevent excessive nutrient load of the aquatic environment [21].

In aquatic organisms, sensitivity to heavy metals is related to the biochemical activity of the metal including its effects on nitrogen metabolism. Therefore, the objective of this laboratory study was to determine whether the levels of different forms of nitrogen in the medium could be used as an endpoint to assess ecosystem stress caused by a metal, for example, cadmium. In this context, the effect of cadmium on nitrate, nitrite, and ammonia contained in the medium of *Lemna gibba* was examined.

MATERIALS AND METHODS

The aquatic plant, *Lema gibba*, was chosen because of its common use in laboratory studies, its great rapidity of