Cd, Cr, Cu, Pb, and Zn concentrations in *Ulva lactuca*, *Codium fragile*, *Jania rubens*, and *Dictyota dichotoma* from Rabta Bay, Jijel (Algeria)

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Abstract Concentrations of Cd, Cr, Cu, Pb, and Zn were determined in algae samples collected from the Rabta Bay in the Mediterranean Sea, Algeria. The levels of heavy metals in the macroalgae, *Ulva lactuca*, *Codium fragile* (green algae), *Jania rubens* (red algae), and *Dictyota dichotoma* (brown algae) recorded high concentrations except for Cd. Moreover, Zn was the most predominant metal in the seaweeds. The obtained HM contents indicate that different species demonstrate various degree of metal accumulation and the obtained higher values in site 1 of the studied zone can be attributed to the discharge influence of two rivers (Mouttas and Larayeche Rivers), entering the Mediterranean Sea and local pollutant emissions. The abundance of heavy metal concentrations in the macroalgae samples was found in the order below: Zn > Cu > Pb > Cr > Cd from the studied zone. The highest amounts of heavy metals in algae samples were Cd, Cu, and Pb in brown algae, and Cr and Zn in green and brown algae from the studied zone (Rabta Bay).

Keywords Algae · Algeria · Heavy metals · Mediterranean Sea · Rabta Bay

Introduction

Deterioration of the aquatic environment and groundwater contamination are usually attributed to domestic sewage, industrial effluents, and agricultural products leaching from cultivated areas (Nguyen-Ngoc et al. 2009). Heavy metals such as cadmium, lead, zinc, copper, and chromium or their compounds have been used extensively by various metal-finishing, mining and chemical industries (Hamidi et al. 2008). The presence of these heavy metals affects numerous metabolic or developmental processes in all living organisms (Přibyl et al. 2008) because of its toxicity, non-biodegradability, bioaccumulation and persistence in nature (Bayhan et al. 2001; Villaescusa et al. 2004; Ahluwalia and Goyal 2007; Bahadir et al. 2007; Garg et al. 2007; Pérez-Marín et al. 2007; Bulut and Baysal 2006; Kamala-Kannan et al. 2008; Vilar et al. 2008; Wang and Fowler 2008; Pathak et al. 2009; Bhatnagar and Minocha 2010; Farooq et al. 2010; Pahlavanzadeh et al. 2010).

Many metal ions are essential as trace elements (Cu, Zn) but at higher concentrations, they become toxic (Yoshida et al. 2006) to aquatic flora and fauna even in relatively low concentrations. Some of these are capable of being assimilated, stored, and concentrated by organisms (Mohan and Singh 2002). As many heavy metals are mutagenic and clastogenic, they cause teratogenic and/or carcinogenic effects (Babich et al. 1985).
Mechanisms of carcinogenicity are discussed for metals and their compounds, classified as carcinogenic to humans or considered to be carcinogenic to humans: cadmium, chromium, and lead (Beyersmann and Hartwig 2008).

Determination of heavy metal levels in marine organisms are usually preferred than the measuring of the metal concentrations in seawater and sediment samples due to their capacity to give information on concentrations of heavy metal or changes in metal availabilities in the surrounding environment (Topcuoğlu et al. 2003). Algae are amongst the more suitable organisms for studies of heavy metal contamination in aquatic ecosystems (Wallenstein et al. 2009) due to their abundance in various environmental systems, ability of adaptation to environmental conditions (Rajfur et al. 2010) and great ability to accumulate high quantities of heavy metals such as lead, zinc, copper, cadmium, chromium, manganese, etc., acting as a sink for these pollutants (Anastasakis et al. 2011).

The high degree of industrialization and urbanization has substantially enhanced the degradation of our aquatic environment through the discharge of industrial effluents and domestic wastes. Rabta Bay is a very important area devoted to the fishing for food, but with considerable pollution problems for its location in proximity of the mouth of the Mouttas River, the carrier towards the sea of a large amount of various industrial and urban wastes (Leghouichi et al. 2009).

The objectives of the present study are: (1) to determine the levels of Cd, Cr, Cu, Pb, and Zn in algae, samples collected from different stations of the Rabta Bay; (2) to know the class of studied algae which have the ability to accumulate more Cd, Cr, Cu, Pb, and Zn than the other classes.

**Material and methods**

Samples of algae *Ulva lactuca*, *Codium fragile* (green algae), *Jania rubens* (red algae), and *Dictyota dichotoma* (brown algae) were handpicked at 3–6 m depth during the sampling period July 2009 from three sampling sites (S1, S2, and S3) located in the Rabta Bay (Western Mediterranean Sea, Jijel, Algeria). Sampling sites in this study were selected to cover all regions of study area (Fig. 1).

![Fig. 1 Map of the sampling sites in Rabta Bay, Jijel (Algeria)](image)