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Water and *Ceratophyllum demersum* analyses in Al-Jubail, East Saudi Arabia

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ABSTRACT

Water and shoot system samples were analyzed for heavy metals detections, from four areas in Al-Qatif district, east of Saudi Arabia. The four areas are 1- Snabis beach 2- Al-Nasra beach 3- Marine Cornish, north Al-Qatif and 4- Al-Shatek district. The water analyzed using Inductively Coupled Plasma Emission Spectroscopy (ICP-OES) to estimate their heavy metal contents; Cd, Cu, Fe, Mn, Ni, Pb and Zn. The plants were dried and analyzed by using X-ray analyses for the same elements. Generally the water in these studied areas has high contents of heavy metals, especially lead and copper and the most contaminant area is Al-Shatik beach, then Marine Cornish. *Ceratophyllum demersum* plants in these areas has considerably high contents of heavy metals especially cadmium, ferrous and lead. In spite of that, heavy metal concentrations are still safe and the water in the tested areas is nontoxic. The results discussed according to oil pollution which happened in these areas after the Gulf War.

INTRODUCTION

Ceratophyllum demersum is a submerged rootless, perennial macrophyte which grows with the base of its stem buried in sandy or silt substrates. It is prone to dislodgement, and its buoyant stems may become free-floating. It can form a dense subsurface canopy and reach of height of 5-6m and frequently grows as a mono-specific community as it has an allelopathic effect (Gross *et al*., 2003). The *C. demersum* plant can form modified leaves when growing near the lake bottom, which it uses to anchor to the sediment (Keskinkan *et al.* 2004).

Ceratophyllum demersum plants tolerates a wide range of water levels as indicated by Armstrong *et al.* (2003). Armstrong *et al.* (2003) stated that it may have thread-like rhizoid shoots which penetrate the substrate to aid absorption and anchorage. It is used as biomarkers for water pollution with

metals. Thus, aquatic plants such as algae, bryophytes, mosses and higher aquatic plants received extensive interest as biomarkers for water pollution. Gupta and Chandra (1994) found that 24% Pb was adsorbed in aquatic liverworts when it was exposed to 20ppb metal solution. Mouvet, ***et al.*** (1993) used aquatic bryophytes (mosses and liverworts) as biomonitors of heavy metals pollution. Noaman (2000) investigated the response of two algal species to pollutants. Meanwhile, Stankovic ***et al.*** (2000) pointed to the use of *C. demersum* plants as a measure of lake pollution, as it can contain trace metals such as cadmium and lead in plant tissue. Keskinkan ***et al.*** (2007) noted to the use of *C. demerum* plants in heavy metal removal under dilute metal concentration.The *C. demersum* plants consider as Aquatic Beds that requires surface water for optimum growth and reproduction. They are best developed in relatively permanent water or under conditions of repeated flooding. The plants are either attached to the substrate or float freely in the water above the bottom or on the surface.

Ceratophyllum demersum plant is a native to North America. It now has a worldwide distribution, even in the cold regions (Otahelova and Valachovic, 2002) at least in part due to the aquarium and pond trade. It is a submerged aquatic plant which is capable of forming dense monospecific beds, excluding other plant species, causing problems to recreational activities on waterways and in some cases causing blockages at hydroelectric power stations. *C. demersum* plant can spread rapidly, and grows in a large range of aquatic habitats.

Barth and Niestlė (1994) gave a description of the environmental effects of the 1991 Gulf War on the ecosystems in the area between Abu Ali and Ras Azaur on Saudi Arabia. They mentioned that the thick layer of oil covered the tide zone damaged the vegetation in that area. Because of the importance of aquatic environment and water quality to both plants and animals, researchers and even health committees do their best to know how much this war affected our environment. Böer (1994) found that the salt marshes and mangroves of the Saudi Arabian Gulf areas are the most severely affected habitats after the Gulf War. Warnken (1994) found that the oil-impacted area was restricted to the upper one third of the intertidal area and the salt march vegetation was affected to such a degree that less than 1% of the plants survived and there was no evidence of generation after two years of the War.

For that this study has been carried after about 18 years of the 1991

Gulf War on *Ceratophyllum demersum* plant grown at Al-Quatif beaches in Jubail region to estimate the heavy metal contents in its tissues to evaluate how much this species was affected by the water pollutants.

MATERIALS AND METHODS

The study was carried out along two years, from June 2007 till May 2009.The study area was at Al-Qatif district, 65 North Jubail region, eastern Saudi Arabia (map 1). This area has a lot of beaches on the Arab Gulf shore. Four locations have been chosen for this study. Monthly visits were made to four locations at Al-Qatif beaches (Snabis beach , Al-Nasra beach , Marine Cornish; north Al-Qatif and Al-Shatek district).

Water and plant samples (leaves and stem) have been taken in each visit. The water samples were taken from about 25 cm below the surface and analyzed using Inductively Coupled Plasma Emission Spectroscopy (ICP-OES) to estimate their heavy metal contents; Cd, Cu, Fe, Mn, Ni, Pb and Zn. The plant samples were dried and analyzed by using X-ray analyses for the same metals. The low and higher values are given in Table 1 as well as the means of the 24 readings have been calculated.

A **B**

A *Map1 Jubail region at the Arab Gulf shore, east Saudi Arabiaa,*
B *Photo of Ceratophyllum demersum*

RESULTS

Ceratophyllum demersum plant was found in Al-Qatif beaches dense communities in the water with no other plant species beside it. From Table 1 and Fig.1, we find that the water and the plants in Al-Shatek districh (Loc.4) were the highest content in cadmium and zinc. The water in this area contains highest contents in copper Magnesium and lead, while the plants have highest contents in ferrous and lowest content of copper. Water in Marine Cornish (Loc.3) has the highest contents of ferrous and Nickel, but has the lowest contents of Cadmium, copper and lead. The plants in that area have the highest contents in ferrous,

Table (1): ***Means of heavy metals contents in the water and the tissues of*** **Ceratophyllum demersum** ***in the four locations***

Locations→		Al-Qatif district			
Elements↓		Loc.1	Loc.2	Loc.3	Loc. 4
Cd	W. (mg/1)	0.024-0.036 (0.031)	0.033-0.038 (0.036)	0.017-0.023 (0.021)	0.040.048 (0.042)
	C.d.(mg/kg)	0.63-0.74 (0.69)	0.77-0.95 (0.82)	0.54-0.61 (0.59)	0.86-0.92 0.88
Cu	W. (mg/1)	0.88-1.07 (0.94)	0.75-0.89 (0.81)	0.53-0.66 (0.55)	1.02-1.06 (1.04)
	C.d.(mg/kg)	118-128 (121)	105-118 (110)	79-86 (81)	70-83 72)(
Fe	W.(mg/1)	0.22-0.27 (0.24)	0.19-0.27 0.22)(	0.31-0.37 (0.33)	0.29-0.34 (0.32)
	C.d.(mg/kg)	4298-4373 (4335)	4319-4450 (4387)	5216-5229 (5221)	5519-5539 (5529)
Mn	W.(mg/1)	0.022-0.036 (0.031)	0.042-0.056 (0.044)	0.033-0.038 (0.036)	0.045-0.069 (0.054)
	C.d.(mg/kg)	3755-4308 (3811)	2966-3010 (2988)	4210-4328 (4268)	2938-3010 (3009)
Ni	W.(mg/1)	0.08-1.2 (0.09)	0.04-0.08 (0.05)	0.11-0.15 0.12)(	0.08-1.02 (0.94)
	C.d.(mg/kg)	22.8-29.8 (25.3)	15.9-29.3 (23.3)	33.2-42.5 (39.5)	13.9-16.9 (14.02)
Pb	W.(mg/1)	0.72-0.88 (0.81)	1.02-1.15 (1.06)	0.62-0.77 (0.71)	1.13-1.19 (1.15)
	C.d.(mg/kg))	7.1-8.9 (8.0)	4.7-7.2 (5.1)	7.2-10.8 (8.6)	3.9-6.8 (5.2)
Zn	W.(mg/1)	0.095-0.13 (0.11)	0.14-0.18 (0.15)	0.13-0.17 (0.14)	0.33-0.45 (0.39)
	C.d.(mg/kg)	77.4-120 (108)	118-129 (121)	92-112 (105)	125-160 (134)

manganese, nickel and lead. The Snabis beach (Loc.1) and Al-Nasra beach (Loc.2) are the least contaminated areas; they have low to moderate contents in most of the studied metals (Table 1 and Figs.1& 2).

From Fig.2 we can notice the differences in mineral contents in the tissues of the aerial shoots of *Ceratophyllum demersum* plants grown in the four locations. From Fig.2 we find that Location 4 (Al-Shatik district) has the highest contents of the investigated heavy metals, then comes location 3 (Marine Cornish) and finally location 1 and 2 (Snabis and Al-Nasra beaches). Plants grown in Location 3 have the highest contents in manganes, nickel and lead, while location 4 is the highest in cadminm ferrous and zinc (figs. 2 & 3). Plants grown in Location 1 (Snabis beach) have the highest contents in copper, while those grown in Al-Nasra beach have the lowest contents in manganes, nickel and lead (Table 1 and Figs. 2& 3).

DISCUSSION

The aquatic environment with its water quality is considered the main factor controlling the state of health in both plants and animals. A water contamination is considered one of the dangerous problems as it controls both the aquatic flora and fauna. Aquatic plants play an important role in organic production of most inland water systems, they also provide shelter and nourishment to fish, water fowl, and other aquatic organisms; some of them are hosts for many epiphytes and others, as many species of *Ceratophyllum*, *Lemna* and *Potamogeton* are eaten by birds (Haslam, 1976).

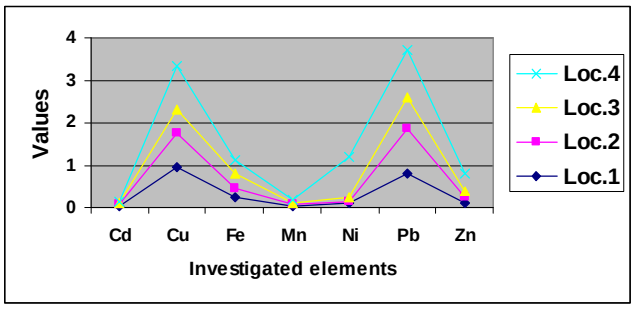

Fig. 1 Elemental contents in the water of the 4 locations (mg/1)

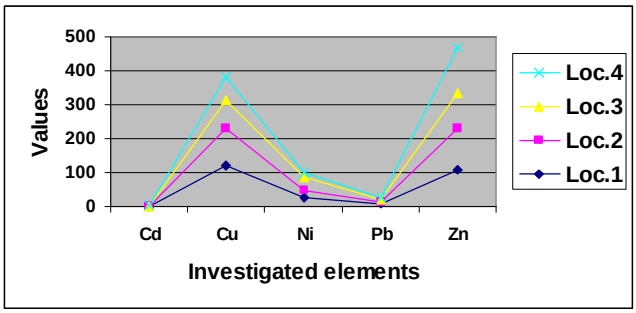

Fig.2

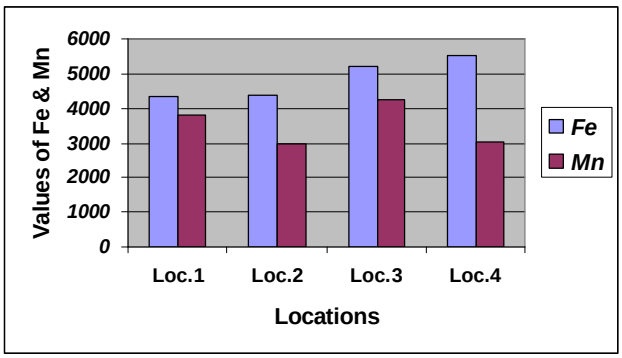

Fig.3

Fig. 2 & 3 Elemental contents in *Ceratophyllum demersum* **in the 4 locations (mg/K)**

Banat *et al.*(1998) measured the concentrations of the major nutrients, heavy metal ions, selected hydrocarbons and selected bacterial communities in the Gulf water after the war. They found high nutrient levels with some fluctuations in the different seasons during their study. Their results coordinate with our result as the gulf water in the area of this study has high heavy metal concentration, especially in locations 3 and 4 (Marine Cornish and Al-Shatek district). Locations 1 and 2 (Snabis and Al - Nasra beaches) are, considerably, moderate in heavy metal concentrations. This variation in heavy metal concentrations can be referred to the caring services in the beaches, while the other two locations are more susceptible to be polluted by wasting materials. In spite of these variations, the water in these areas is considered to be safe as the concentration of heavy metals is similar, or even lower, than those of other areas worldwide. This coincides with Juma and Al-Madany (2008) results in their study on the heavy metals in the gulf water in Bahrain, and they found that the water is safe and nontoxic.

The high contents of heavy metals in the tissues of *Ceratophyllum demersum* can be due to the ability of this species to adsorb heavy metals as indicated by Keskinkan *et al.* (2004 & 2007). Monferran *et al.* (2007) found that the exposure of *Ceratophyllum demersum* to dichlorobenzene is able to cause an activation of the antioxidant system and the defense system in that plant plays an important role in protecting him against adverse oxidative effects. This conclusion can be the reason of the wide spread of this plant even after the oil spots which covered the Gulf after the war.

Thus we can say that the water of the studied cites is nontoxic, and the heavy metal concentrations are within the safe limits. Meanwhile the tissues of *Ceratophyllum demersum* Plants have the ability to adsorb heavy metal concentrations and can be used to purify the polluted water. In the same time we have to improved knowledge about water pollution; empowering local people to become more involved in protecting beaches and Cornish; and encourage more effective operational mechanisms for implementing protection of our shores.

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دراسة تحليلية علي كل من مياه و نبات نخشوش الحوت النامي بمياه القطيف في الجبيل بالمنطقة الشرقية بالمملكة العربية السعودية

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تناولت الدراسة تحليل مياه مأخوذة من عمق ٢٥سم من سطح البحر في أربع مواقع بالقطيف , ٦٥ كم من الجبيل, بالمملكة العربية السعودية وهي :- سنابس - الناصرة - الكورنيش البحري شمال القطيف و الشاطئ. كما تناولت تحليل نبات نخشوش الحوت النامي بهذه المواقع.

هذه التحاليل تناولت العناصر الثقيلة وهي الكادميوم, النحاس, الحديد, المانجنيز, النيكل, الرصاص والزنك.

ومن النتائج التي توصلنا إليها أن تركيز هذه العناصر تعتبر عالية, ولكنها أقل من مناطق كثيرة بالعالم.ولقد كانت تركيزات العناصر الثقيلة بمياه الشواطئ أقل من التركيزات بمياه الخليج في مناطق المتنزهات. وقد أعزينا هذه الزيادة إلي الاهتمام بنلافة الشواطئ والي إلقاء بعض المخلفات بمياه المتنزهات. وبالرغم من هذا, فأن مياه الخليج العربي في مواقع الدراسة تعتبر مأمونة ولم تصل إلي حد السمية. كما أن نبات نخشوش الحوت له قدرة علي أدمصاص أيونات العناصر الثقيلة مما يؤدى إلي تنقية المياه منها. وبناءا علي هذه النتائج نوصي بنشر الوعي العام بين المواطنين بضرورة الحفاظ علي مياه الشواطئ وزيادة معرفتهم بطبيعة تلوث المياه. كما نوصي بتشجيع الجهود المبذولة للحفاظ علي الشواطئ والمتنزهات من الملوثات المختلفة.