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Toxic effects of Nickel on Artemia urmiana and Artemia franciscana

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Abstract. Although there is growing evidence that metals can be toxic to various aquatic species, there is still insufficient knowledge to integrate this information in environmental risk assessment procedures. In this study, we have investigated bioaccumulation and effects of nickel on mortality and growth of *Artemia urmiana* and *Artemia franciscana*. The LC_{50} in 24 h of *A. urmiana* and *A. franciscana* exposed to nickel were 0.0072, 0.0114 mg/l respectively. Results indicates that the mean length of animals in (0.001, 0.002 and 0.003 mg/l) Ni on first, fifth, eleventh and seventeenth days of life significantly decreases in comparison with control groups ($p<0.05$).Bioaccumulation of Ni in the same concentration, after 24 h in nauplius and also in adults of *A. urmiana* and *A. fransicana* were significantly higher than of the control groups ($P < 0.05$). Both species accumulate nickel in their bodies. However *A. urmiana* is more resistant to the heavy metals.

Key words: Nickel, Bioaccumulation*, Artemia urmiana, Artemia franciscana*

1. Introduction

Metals are considered very important and highly toxic pollutants in the various environmental departments[1]. Heavy metals naturally occur in seawater in very low concentrations, but their concentration levels have increased due to anthropogenic pollutants over time. Metals that are deposited in the aquatic environment may accumulate in the aquatic species and in the food chain and cause ecological damage also posing a threat to human health due to biomagnifications over time[2, 3]. The oxidative nature of metal-induced genotoxic damage has been provided by the detailed studies showing that metals (iron, copper, cadmium, chromium, mercury, nickel, vanadium, cobalt and others) possess the ability to produce the reactive radicals resulting in DNA damage, lipid peroxidation, carcinogenicity[4], depletion of protein sulfhdryls and others effects. Nickel is a common metal in most surface waters, with both natural sources (e.g., weathering of rocks) and anthropogenic ones (e.g., industrial discharges from electroplating and melting).

The brine shrimp *Artemia* (crustacean, Anostraca) is distributed worldwide with the exception of Antarctica[5]. *Artemia* lives in salt lakes and ponds. The Urmia Lake is the main habitat for the endemic Iranian brine shrimp, *Artemia urmiana* [6,7]. *Artemia franciscana* was not an endemic organism in Iran and the first introduction of it in Iran took palace in 1998[8]. *Artemia* is widely used in laboratory toxicity studies due to its small body size and short lifespan together with its availability from dry cysts [9]. In this research, we have studied the bioaccumulation and toxicity effects of nickel on growth of adults and nauplius of *Artemia urmiana* and have been compared with *Artemia franciscana*.

2. Materials and Methods

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At first, LC_{50} of each species with Nauplii of less than 24 hours were determined. In growth experiments, 0.5 gr of hatched cysts were put in 0.5 liter of solution with 0.001, 0.002 and 0.003 mg/l of Ni. Experiments were carried out in triplicate (9 treatments and 3 control groups) and each replicate underwent 95% volume every 4 days[10, 11].Length of Artemias carried out in first, fifth, eleventh and seventeenth days of life.

In bioaccumulation experiment, about 2000 Nauplius and 100 adult *Artemia* were exposed to 0.001, 0.002 and 0.003 mg/l of Ni for 24 hours. The experiment repeated 3 times [21]. Afterwards, the separated *Artemia* samples were kept in freezer with a temperature of – 20ºC up to digestion and analysis phases[12], [13]. Concentration of Nickel were estimated by atomic absorption spectrophotometer (Shimadzu flameless 670 G) and graphic oven. This part of experiment was performed in the Atomic Energy Organization of Iran. Data obtained were analyzed using SPSS software. All sets of data were tested for homogeneity of one way ANOVA and HSD test all figures drew with EXCEL program.

3. Results and Discussion

The LC_{50} in 24 h of nickel in *A. urmiana* and *A. franciscanna* were 0.0072, 0.0114 mg/l, respectively. The mean length of each species in different concentrations of Ni at first, fifth, eleventh and seventeenth days of life is shown in tables 1.

In both species, the growth in different treatments of metals indicated a significant increase compared to control group, but there were not significant difference in body length of treated groups ($P > 0.05$).

Table 1. Growth of A. *urmiana* and A. *freanciscana* in different concentrations of nickel

Concentration of Ni (mg/l)	**Test day**	**Average length (mm) ± Standard deviation of *A. urmiana***	**Standard error**	**Average length (mm) ± Standard deviation of *A. freanciscana***	**Standard error**
0	1	26.9±4.17532	1.32035	21.6±3.86437	1.22202
	5	34.2±2.34758	0.74237	34.8±2.04396	0.64636
	11	119.1±11.49348	3.63456	115.1±15.24941	4.8229
	17	162.6±12.94604	4.09390	160±21.80724	6.89605
0.001	1	21.1±3.28126	1.03763	21.2±3.96653	1.25433
	5	32.7±2.35938	0.74610	32.3±1.76698	0.55877
	11	57.8±4.02216	1.27192	49±1.82574	0.57735
	17	110.9±10.82641	3.42361	89.2±4.13118	1.30639
0.002	1	22.6±4.74225	1.49963	21.5±3.83695	1.21335
	5	33.8±3.08401	0.97525	31.8±32.97396	0.94045
	11	58.6±5.46097	1.72691	47±2.35702	0.74536
	17	117.9±9.03635	2.85754	82±6.53622	2.06694
0.003	1	23.8±3.11983	0.98658	21±3.65148	1.15470
	5	34.9±2.60128	0.82260	30.9±4.12176	1.30341
	11	59.9±5.15213	1.62925	43.1±2.18327	0.69041
	17	117.0±4.10634	4.46082	86.3±4.83161	1.52789

Bioaccumulation of Ni after 24 h in nauplius and also in adults of *A. urmiana* and *A. fransicana* are shown in fig 1, 2,. Bio-accumulation of treated groups with Ni was statistically significantly higher than of the control groups ($P < 0.05$).

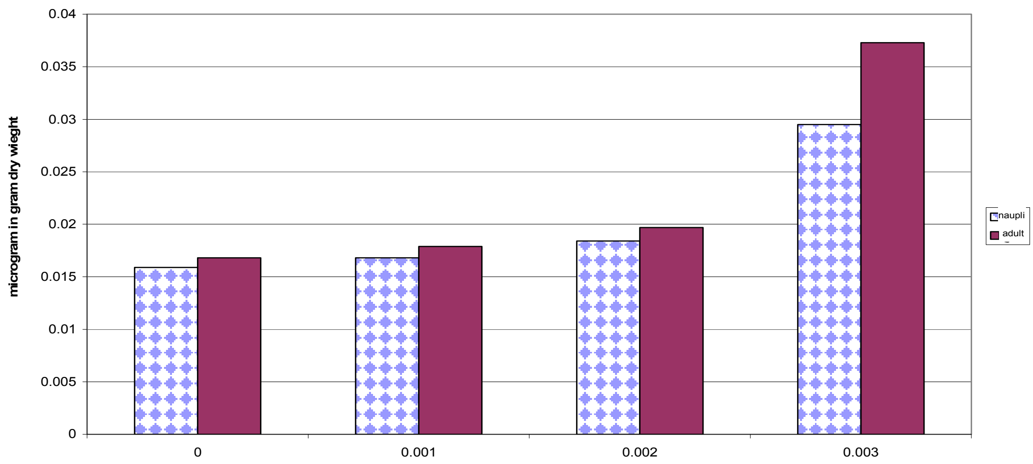
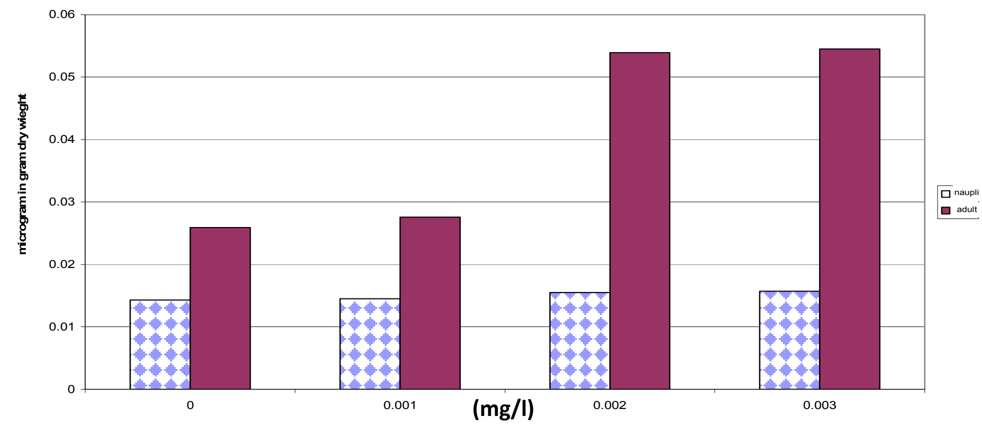


Figure 1. Bioaccumulation of nickel in nauplius and adult of *Artemia urmiana*



(mg/l)

Figure 2. Bioaccumulation of nickel in nauplius and gradult of *Artermia franciscana*

Nickel decreased Artemia`s growth rate in comparison with control group ($p<0.05$). However there was no significant difference between days of experiment and treatments ($p>0.05$). There was no difference in all treatments, too ($p>0.05$).

Increasing concentration of nickel in the environment led to the increasing bioaccumulation of nickel in *A.urmiana* and *A.franciscana*. There was a significant difference between control group and treatments ($p<0.05$). Our results indicated, with increasing of the concentration of Ni, the accumulation and concentration of this metal also increased in Artemia's body. Compared to the adults, older species had more nickel in their bodies. Hadjispyrou *et al* (2000) proved that Nauplius of *A.franciscana* had an ability to accumulate of tin, potassium, cadmium and chrome[11]. They also proved that *Artemia* is more resistant to the heavy metals. They compared the amounts of bio-accumulation of those metals in nauplius of *A. franciscana* with fish, they results indicated that metals` bio-accumulation in *Artemia* was more than in fish and this causes high resistance of this animal against heavy metals.

The processes through which different aquatics can regulate the concentrations of different metals in their bodies are quite diverse and complicated. For example, accumulators are creatures that store the metals on a non-toxic basis in high amounts. These creatures change the metals somehow to a non-toxic form and store them by granulating them and combining them with metallothionein. Metallothioneins are a class of low- molecular-weight, cytoplasmic, metal-binding proteins, that have a high affinity for various toxic heavy metals. Elevated levels of such proteins have been suggested as indicating involvement in uptake, storage, transport, and elimination of toxic metals and in the routine metabolism of metal. Del Ramo *et al* (1995) showed the MT content in *Artemia* increased in a time- dependent fashion[14]. Metallothionein synthesis in

Artemia is very high and one of the reasons of high resistance of this creature to pollutants is attributed to this issue. The other mechanism in crustaceans is increasing the excretion of heavy metals as the concentration of the metals increases in the environment. These mechanism acts only in sub lethal concentration of metal and any disorder in these mechanisms may lead to the death of animals. Also, there are a variety of mechanisms may be involved in the effects of metals exposure, such as temperature, sex, salinity and other compounds [15]. To sum up, nickel is toxic to *A.urmiana* and *A. fransicana*, so that they can influence the species' lifespan and growth rate. However both species especially *A.urmiana* is resistant to heavy metals.

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