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Acute Toxicity of Silver Nanoparticles in Roach (*Rutilus rutilus*) and Goldfish (*Carassius auratus*)

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Abstract

Aquatic Ecosystem pollution, due to the diversity in users of aquatic environment has become to one of the serious challenges biotic community. Study of fish in aquatic ecosystems can be to lead better understand and more comprehensive ecological analysis about aquatic ecosystem. Heavy metals such as silver are one of these pollutants. They can accumulate in living tissue and lead to poisoning. Also, these compounds have the ability to pass along the food chain. For this purpose 147 were in a range of different concentrations of silver nanoparticles (0, 0.2, 1, 2, 6, 10 and 15 ml/L). The mortality of treatments was calculated at intervals of 24, 48, 72, 96 hours. The result of present study showed, between toxicity of silver nanoparticles for Roach (6.590 ml/l) compared with Goldfish (11.2 ml/l), there was significant difference ($p<0.05$). Also the results showed that silver nanoparticles are highly toxic for fish species.

Keyword: Toxicity of silver nanoparticles, Freshwater Fishes, 96h LC_{50}

1 Introduction

Group of metallic elements for example Cu, Fe, Mn and Zn are necessary for the survival of living things. Another group of metals, are heavy metals; this group of metals, unlike the other group are the non-essential [1, 2]. The heavy metals such as Ag combined with the organic molecules and will accumulate in the tissues. This process eventually leading to contamination of food and destruction of food chain [3]; the heavy metal accumulates in the tissue of living organisms and moving them along the food chain is causing a threat to food safety. Previous studies have shown that some of the human activities such as the oil extraction dispose industry and hospital waste, leading to increased concentrations of heavy metals such as Ag, Hg and Cd in the environment [4].

Age, height and weight, gender nutritional habits, the environmental requirements, the concentration of heavy metals in sediment and water, an important determinant of the organs accumulation of heavy metals in fish [5]. As well as, Roach and goldfish are omnivorous fish; they eat their foods from the water surface and bottom sediments [6]. Also goldfish used as an object of laboratory research [7].

Nano-technology is human new achievements, which in recent years has grown dramatically. Although many benefits to the use of nanoparticles described; such as the silver nanoparticles can be used in agriculture for fight and prevent disease [8]. However, There are concerns about emissions of these substances and their wide distribution in nature [9, 10, 11].

Several studies have been conducted on the toxicity of heavy metals. Such as Caring [12]; Jezierska and Witeska [13]; Senthil Murugan *et al.* [14]; Subashkumar and Selvanayagam [15]. Their study results showed that the nanoparticles are toxic to aquatic species and can lead to poisoning and death of fish.

The 96h LC_{50} tests is a method for finding the toxicity of various elements; Other words, with the this method can be found out the amount of strength and survival of different species, in face of different concentrations of pesticide and other risk factors [16, 17, 18]; Whatever the concentration of 96h LC_{50} is lower, the toxicity is further. Heavy metals have a low 96h LC_{50} [19, 20].

Attention to emissions of heavy metals as one of the important pollutants in the aquatic environment and considering the replacement of heavy metal with nanoparticles, understanding the function of nanoparticles on the health of animals is necessary. Since aquatic environments are the ultimate destination of toxins and sediments [21, 22]. The study of aquatic species can be useful. Roach and goldfish are important fish in in their environment and they have a special place in the food chain of aquatic ecosystems. Accumulation of heavy metals and

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their compounds, in the body of these fishes, can have a huge impact on their survival chances.

2 Materials and Methods

According to primary survey and laboratory facilities, 250 250 Roach (weight 12±2.6 gr) and Goldfish (weight 6±1 gr) Prepared from the fish farms in Golestan Province and moved to the laboratory (Veniro Hall, Department of Fisheries, Gorgan University of Agricultural Sciences and Natural Resources). After the transferring the fishes to the lab, in order to adapt of fish to lab condition, they kept in the 280 liters tanks for the two week (250 liters filling volume). During this time the fish feeding three meals a day and equivalent to 3% of the weight of the fish (food was Biomar). Density of fish in each tank was 50 per tank and physicochemical conditions were similar in all tanks (water temperature 24±2 ˚C, 7-8 ml/l dissolve Oxygen, 7/4 to 8/1 pH and Ammonia 0/04±0/03 ml/l).

After adaptation time, 147 fish were selected exactly randomly and were split into 7 treatments (0, 0.2, 1, 2, 6, 10 and 15 ml/L silver nanoparticles) and 3 repetitions (number of fish in each treatment was 21). Fish for 96 hours were exposed to different concentrations of silver nanoparticles. The death count in intervals of 24, 48, 72 and 96 hours and the dead were removed from the tanks of test. The fishes were not feeding 18 hours before the main test and over time of the main test. Physicochemical condition of the water at the time of testing the toxicity of silver nanoparticles, minus the concentration of silver nanoparticles was similar the previous stage (Stage adaptations).

Acute toxicity of silver nanoparticles was estimated based on Hotos and Vlahos; lethal concentration of silver nanoparticles (For 50% of the population) in intervals of 24, 48, 72 and 96 hours (24 h LC_{50}), 48 h, 72 h and 96 h were estimated through probit test with a 95% confidence. To find the Correlation between different concentrations of silver nanoparticles on mortality was used Spearman test (2-tail).

3 Results and Discussion

Analysis of the data showed between the concentration of silver nanoparticles and mortality a significant correlation (Correlation is significant at the 0/01 level); with increasing concentrations of silver nanoparticles, mortality rates increased in both groups (Table 1).

Table 1: mortality of Roach (R) and Goldfish (G) in face of silver nanoparticles (n=21, each concentration)

	No. of mortality							
Concentration (ml/l)	24h		48h		72h		96h	
	R	G	R	G	R	G	R	G
0	0	0	0	0	0	0	0	0
0.2	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
6	0	0	1	0	3	0	6	0
10	5	1	9	3	13	6	21	10
15	10	6	15	8	21	10	21	19

Also, the results showed 96 h LC_{50} of silver nanoparticles for Roach was 6/590 mg/L and for Goldfish was 9.781 ml/l (Table 2); between 96 h LC_{50} of silver nanoparticles in the Roach compared to Goldfish, there was significant difference (P <0.05).

4 Conclusion

Toxic heavy metals are the main groups of pollutants in aquatic environments; a large portion of this metal enter aquatic environment due to the human activities [23]. Monitoring of the toxic heavy metals was important for scientists, nutrition, medical and environmental researchers. The results of this study showed that a silver nanoparticle was toxic for Roach (*Rutilus rutilus*) and Goldfish (*Carassius auratus*). The Lethal Concentrations of silver nanoparticles (96h LC_{50}) for Roach was less than Goldfish; this difference may be due to differences between species for resistance to environmental changes.

Pandey and Madhuri [24] examined heavy metal toxicity in animal and fish; for this aim they studied on Hg, Pb, Cu and Cd concentrations in the environments, fishes and other animals. They said that heavy metal toxicity depends on the fish species and their habits. This section of their results was similar to present study.

Table 2: Lethal concentration of silver nanoparticles (96h LC_{10-95}) for Roach (R) and Goldfish (G). Fish in various concentrations of silver nanoparticles had symptom of poison with Cadmium, such as anxiety, color vision, increased mucus secretion and they death with the open mouth.

	Concentration (mg/L)							
Point	24h		48h		72h		96h	
	R	G	R	G	R	G	R	G
LC_{10}	8/628	10/187	6/795	8/193	5/791	8/091	5/296	6/024
LC_{20}	10/887	14/238	8/567	11/177	6/889	9/898	5/740	7/114
LC_{30}	12/324	18/126	9/844	13/082	7/680	11/447	6/060	8/021
LC_{40}	13/551	22/279	10/935	16/930	8/357	12/962	6/334	8/888
LC_{50}	**14/698**	**27/017**	**11/955**	**20/245**	**8/989**	**14/558**	**6/590**	**9/781**
LC_{60}	15/845	32/762	12/975	24/209	9/621	16/350	6/846	10/765
LC_{70}	17/072	40/269	14/066	29/313	10/297	18/513	7/119	11/928
LC_{80}	18/508	51/265	15/343	36/670	11/088	21/411	7/440	13/449
LC_{90}	20/500	71/653	17/114	50/023	12/186	26/194	7/884	15/884
LC_{95}	22/145	94/475	18/577	64/645	13/092	30/940	8/250	18/224

Studies Chakeri *et al.* [25]; Vinodhini and Narayanan [26] and Spehar [27] Found that heavy metal poisoning causes anxiety, increased mucus secretion and eventually death. Also, they said Different fish species, had different sensitive to face of heavy metals. The results of their study were similar with our study.

Level 96h LC_{50} of heavy metal for aquatic species depending on the aquatic species type or metal type is different; for example, Spehar [27] Level 96h LC_{50} of Cadmium for *Mugil cephalus* and *Jordanella floridae* had set 28.0 and 2.5 ml/l, respectively. Das and Banerjee [28] reported 300.0 and 175.0 ml/l Cadmium for *Lebio rohita* and *Heteropneustes fossilis*, respectively. Eventually, Smet and

Blust [29], Expressed, after four weeks, the whole population of common carp that were facing to Cadmium (2 ml/l) for 96 hours, died.

The use of nanoparticles for the achieving the objectives of industrial, agricultural or health, alongside its advantages, it can be a hazardous. the results of this study and some previous studies clearly showed nanoparticles was The results of the present study and previous studies showed different concentrations of nanoparticles can be highly toxic to aquatic species and some species may be sensitive to occurring in trace quantities, such as *Corophium Volutator* [30, 31, 32, 33] with attention to this issue, can be use some of aquatic species as biological indicators. This aim requires to more study and higher pervasive. Assessment toxicity of other heavy metals is the field of next study. On the other, previous study showed, usually several heavy metals at the same time pollute the environment [24, 34, 35, 36]. Effect of two or more heavy metals on the health of fish and toxicity of heavy metal could be the fields of next study.

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