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Measuring the Levels of Heavy Metal Pollution in Al - Diwaniyah River Water Using Oomycetes Fungus

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Abstract

The research included, for a period of 6 months, a study of two aspects. The first was the isolation and diagnosis of oomycetes in the water of Al-Diwaniyah River in five sites. The sites where pollution increased were chosen, namely textile, rubber factories, and sites before water treatment, compared to two sites: Sadr Al-Daghara and a site under Al-Diwaniyah Bridge, which had little pollution, as the percentage of pollution increased. Ovomycetes in pollution sites in order to increase the organic matter in them and to provide many nutrients, knowing that these fungi were isolated from control areas, but in small proportions, in addition to other groups of non-oomycetes and the previously dominant types of Oomycetes. Some physical tests were conducted on the water of the Diwaniyah River in the study sites to observe the suitability of the physical characteristics for the presence of these fungi, namely temperature, PH, alkalinity, hardness, and others. The second aspect is to consider these fungi as indicators of pollution in the river water when they are present in polluted areas by analyzing the enzymatic filtrate to measure The percentages of presence of heavy metals, such as cadmium, mercury, lead, and selenium, which appeared in high percentages that exceeded the permissible limits for their presence, whether in river water or in the bodies of living organisms. The percentages of cadmium were (0.012)% in Saprolegnia sp. and Pythium sp., while the percentages of lead were (1.5, 1.3).)% in Saprolegnia sp and Fusarium sp, while mercury recorded a percentage of (0.3, 0.05, 1.2)% in Achlya., Apodachlya sp.,. Fusarium sp. Selenium appeared at a rate of (0.2)% in Apodachlya sp, Arsenic in Pythium sp. At a rate of (0.02%) also for the purpose of comparison of these results, tests were conducted for heavy metals in the water at the selected sites (L3, L2, L1) (fabric, rubber, and site before treatment) respectively. The results showed the appearance of heavy metals (cadmium, lead, mercury, arsenic, selenium). In high percentages compared to sites L4 and L5, their percentages were very small, almost reaching zero.

Keywords: Oomycetes, Mercury, Pollution, Selenium.

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Introduction

Oomyceteces are among the important fungal species in water and are called water molds. Some of them live savagely on animal and plant remains, some of them parasitize on algae, and some are obligate parasites that cause many diseases to plants such as White rust disease and Downy mildew disease (Slater et al., 2015). They differ in their composition and shape compared to other fungi in terms of vigorous growth, the formation of spores, their ways of living, and their method of parasitism (Slater et al., 2015). The accurate description of these fungi from a diagnostic standpoint is that their spores contain flagella that differ in terms of location, helping them to move in the environment in which they live. These fungi are considered dangerous pathogens for humans, animals, and plants, provided that moisture is available, because they prevail and thrive in humid places. They differ in terms of infection, and they may have a wide range of infection with fish, such as the Saprolegnia sp. and algae. These fungi are also characterized by the presence of vesicles as one of the diagnostic characteristics (Corredor-Moreno & Saunders, 2020). Most Oomycetes produce their reproductive structures, and the mycelium still continues to perform its vegetative functions, that is, they are true fruits. However, in some of their species, the entire thallus turns into one or more reproductive structures, that is, they are total fruits (Li et al., 2010).

Many studies were looking at the negative side of these fungi, meaning that they are only pathogens and how to treat and prevent them, without looking at the bright side, which may be more important, for example, in using their metabolism or introducing some modifications to them to be more positive and friendly to the environment instead of being one of its enemies (Avila et al., 2017).

There are a group of studies in which some microorganisms were used as evidence of pollution in the water or in the soil (Lévesque, 2011). The study he conducted in which he used few-ciliated worms as biological evidence to evaluate pollution in the Diwaniyah River. Some types of algae and phytoplankton were also used as evidence of the pollution of the Euphrates River in some areas (Judelson & Ah-Fong, 2019).

Some studies have confirmed the presence of some fungal species in river water sites and not in other sites, they can be considered as determinants of the presence of one of the elements (Nair et al., 2022). The concept of pollution stems from the principle of the presence of an unwanted substance in one of the systems, such as water, for example, the presence of a heavy metal in the water as a result of factory waste, etc which are thrown in Al-Diwaniyah River, which is 123 km long, and which has become one of the most important pollutants that the Diwaniyah River suffers from, as well as municipal waste (Al Asadi et al., 2023).

The study aimed to:

1. Study of oomycetes (isolation and diagnosis) in a number of stations selected for study.
2. Using oomycetes identified at the study site as evidence of heavy metal pollution in the Diwaniyah River.

Materials and Methods

1. Sample collection:

A. The river was divided according to the industrial areas that throw their waste into it, which are the textile factory, the rubber factory, a site before Al-Diwaniyah sewage treatment plant, and another site considered as a site of control, which is under Al-Diwaniyah Bridge and another at the beginning of Sadr Al-Daghara, and the sites were marked (L1, L2, L3, L4, L5) respectively.

L= Location

B. Samples were brought to the laboratory, in duplicate for each location, using polyethylene bottles 0.5 liter. Samples were taken continuously over the course of the six months of the study. Chemical and physical tests were conducted for that water to determine its characteristics using special equipment for these tests (APHA American Public Health Association).

2. The PDA media was prepared, the fungi were isolated, and the bait method was used to catch these fungi (APHA American Public Health Association; Mishra et al., 2023). Then the fungal enzyme was prepared using method 9, and the enzymatic filtrate was quantitatively analyzed using FAAS.

Results and Discussions

Table 1: Some Parameters in Study Stations

parameters	L1	L2	L3	L4	L5	Permissible limits international and local
temperature	17.3-20	15.5-22	17.2-35	13.7-25	18.3-25	-
pH	7.2-8.6	7.3-8.5	8.5-8.7	7.3-8.9	8.1-8	6.5-8.5
EC µs/cm	892-1622	934-1586	860-1598	792-1442	853-1553	1500
DO mg/l	3-5.1	3.2-4.3	3.5-4.2	5.5-8.7	4.6-9.8	≤ 5
Salinity ‰	0.43-0.92	0.43-0.92	0.55-0.88	0.27-1.05	0.13-0.30	-
Total hardness mg/l	392-560	332-527	443-587	290-410	282-374	500
Alkalinity mg/l	92-183	83-189	93-244	70-146	68-135	200
Ca mg/l	95-133	82-108	72-112	74-110	60-106	200
Mg mg/l	45.3-60.8	22.4-53.2	18-72.2	28.4-58.1	20.1-40.1	150
PO4 mg/l	4.5-10.2	3.1-4.2	2.2-5.1	2.1-4.5	1.6-3.2	-

The physical and chemical factors are among the important factors affected by the presence of a living organism or element in the water body. These factors are related to one another. There may be a direct or inverse relationship between them, and these are affected by the rise or fall of the water level or its exposure to cases of evaporation. The more it increases Pollution rates increase as the disturbance of living organisms present in the water body increases (Mishra et al., 2023; Behailu et al., 2018).

It is clear from the table that some of the physical parameters of water within the limits permissible for their presence in water, and others have increased due to the presence of industrial areas that dump their liquid waste into the water, which may contain chemicals, dyes, etc., and this was in (L1, L2, L3). At station (L3), some properties increase because it is a place where water collects with the materials it contains, and this affects the presence of some properties, such as a rise in temperature, alkalinity and hardness, the presence of magnesium and calcium elements. Also, the percentage of dissolved oxygen in the water has decreased as a result of the increase in the concentration of organic pollutants, as If the percentage of dissolved oxygen decreases, it negatively affects the presence of aquatic organisms in it, while we notice the dominance of some anaerobic organisms such as bacteria (Rajendiran et al., 2023). It was also observed that the percentage of phosphate in the river increased due to the cleaning materials and fertilizers that contain phosphate being discharged into the river, which increases the foaming that occurs in the water, and this is reflected in the amount of oxygen dissolved in the water, causing its quantity to decrease (Badamasi et al., 2019).

Table 2: Quantitative Analysis of Heavy Metals in Enzymatic of Fungi

Fungi	Metals in fungi enzyme	Concentration of metals %	Permissible limits international and local
Saprolegnia sp.	Cd + Pb	0.01 +1.5	0.03 + 0.01
Achlya sp.	Hg	0.3	0.001
Pythium sp.	As + Cd	0.02 + 2	0.01 + 0.03
Apodachlya sp.	Hg + Si	0.05 + 0.2	0.001 + 0.01
Fusarium sp.	Pb + Hg	1.3 + 1.2	0.01 + 0.001

Natural and man-made processes lead to the introduction of heavy metals into the aquatic environment. Entry can occur directly or indirectly. Potential sources of heavy metal pollution in the aquatic environment include waste from human activities, geochemical structures, and mining effluents. Minerals can be found in the aquatic environment in the form of dissolved or particulate matter. The primary mechanisms controlling the distribution of heavy metals in aquatic ecosystems are sedimentation, adsorption, dilution, and dispersion. The concentration of heavy metals in organisms may rise due to their absorption by aquatic bodies. Slow evacuation can lead to bioaccumulation, a phenomenon that can contaminate the aquatic food chain (Gulati et al., 2022).

For the purpose of studying the concentration of heavy metals (lead, cadmium, mercury) in the enzymatic extract of the isolated fungi and studying the relationship between the concentrations of heavy metals in the enzymatic extract of the fungi and their presence in the areas selected in the research, whether they are industrial areas and in comparison with non-industrial areas, which we can consider as a biological indicator that enables which we know the extent of contamination of the river environment with metals by comparing the metal concentration with the permissible limits in the water from the percentages shown in the table. We note that some sites, especially industrial sites (L1, L2, L3), from which the above-mentioned fungi were isolated. The proportions of heavy metals in the study sites include the use of special concentrations of fungal enzymes and the presence of a certain concentration of lead, cadmium, and mercury. A high percentage of cadmium and lead (0.01, 1.5) was observed, respectively, in the enzymes of the fungus Saprolegnia sp. We also note that the fungus Achlya sp. In whose enzyme extracts the concentrations were used in the presence of the modifier (or mercury concentrations), as this fungus contains within its composition the element mercury at a rate of 0.3, compared to the permissible limits (0.001). This agrees with study (Annika et al., 2023).

We also find that the quantitative analysis of the enzymes of the fungus Pythium, which is considered one of the most important fungi, showed a predominance of the element arsenic, with a percentage of 0.02 compared to the permissible limits (0.01). Likewise, in some enzymes of the selected isolates of that fungus, the presence of the element cadmium appeared in a percentage of (2) compared to its limits (0.003). This agrees with (Wani et al., 2020).

As for the enzymatic extracts of the Apodachlya, which were analyzed with an atomic spectrometer, the presence of mercury at a rate of (0.05) was found in some of the isolates that were selected from that fungus, compared to the permissible limits (0.01). Likewise, another analysis of fungus enzymes showed the presence of selenium at a rate of 0.2, compared to the permissible limits for its presence in Water (0.01). As for the Fusarium isolates that were isolated from industrial sites, their enzymatic extracts contained lead at a rate of (1.3)% compared to the limit of (0.01)%. Also, there were isolates of that fungus that contained mercury at a rate of (1.2)% compared to The permissible limit for its presence in water is 0.001. This agrees with (Ayat et al., 2023).

In this study there is an increase in some heavy metals, noting that their density increases in areas polluted with waste from industrial areas (L1, L2, L3). This is consistent with what was found that many microscopic organisms and a group of invertebrates Its density increases in polluted water in places where industrial water meets river water or drains (Ali et al., 2019).

To demonstrate the dangers of these metals and their interference within the bodily structures of fungi, some sources indicate that some metals, such as cadmium, mercury, and lead, replace one of the elements involved in the composition of a living cell, such as calcium or magnesium (Ali et al., 2020; Bahafid et al., 2017; Duryal Barrech et al., 2018.

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