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Role of Lemna minor (L.) plant in change of pH values of Aquatic system

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Abstract

The current study documented the ability of Lemna minor plants floating in the Shatt Al-Kufa / Euphrates River and grown invitro to affect in pH water, as the results showed wide variation in readings. Highest value recorded in the 1st week with 8 at T2 and T3, while the lowest value was in the 2nd and 3rd week with only 6.9 at T3 and T1 respectively. The T1 treatment of understudy plant was unique from the rest of the treatments, by continuing in decline the water pH values until the end of the experiment. The reasons for the increase or decrease pH values of water are attributed to the Lemna minor content of some minerals and the absence of other minerals.

Introduction

Lemna profile

Lemna is a global free-floating flowering plant (Hilman, 1961). The plant body includes of obovate-single oval or oval thallus, it is size estimated at approximately 1.5 to 3.5mm across and 2 to 5mm long. This plant has a smooth edge and a slightly succulent texture. The upper surfaces of the plant are slightly convex, medium green in color, arranged next to each other, forming a long pale chain, the lower surface is also smooth, but little green and flat. The rootlet develops from the lower part of the plant body and reaches 2cm in length. The rootlet is thin, white, with a short cylindrical sheath at the base and a sharp obtuse apex. This plant usually doesn't produce flowers, but in rare cases it forms a single, small flower whose width doesn't exceed 1 mm, its shape is membranous, scaly, and cup-like contains two stamens and one pistil, which develops into a single fruit whose length doesn't exceed 1 mm, containing a single polygonal seed inside it. However, this plant reproduces mainly through the budding process through two lateral reproductive sacs (Vegetative reproductive) (Ebrahimi et al., 2024).

Daughter plants produced by budding are genetically identical to the parent plant and it's connected to the mother plant by a thin white string that quickly fades. Seasonal variation affects the condition of common Duckweed, in the autumn, this plant produces turions, which are small young buds that remain swimming at the bottom throughout the autumn, with the arrival of spring, as the water becomes warmer, these turions float to the surface and grow again, until it forms dense colonies of buds during the summer (Jacobs, 1974; Ziegler et al., 2023). Duckweed has side effects on human health due to it containing a high percentage of calcium oxalate, the main contributor to the formation of kidney stones. This plant is also characterized by its ability to accumulate toxins inside it, so it's recommended not to collect it from highly polluted water. As for using it as a medicine in small, specific doses, studies have indicated that it's a safe herb with no harmful side effects (Hasani-Ranjbar et al., 2009; Liheluka et al., 2023).

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Lemna minor contained carbohydrates, proteins, flavonoid, lipids, trace elements and several other contents (Vickers et al., 2006). The pharmacological researches referred to that it, own antimicrobial, antioxidant, cytotoxic and immune-modulatory effects. So was used in the past of treatment oedema, colds and difficulty in urination. It was also used to treat measles, depurative, antipruritic, astringent, antiscorbutic, diuretic, soporific and febrifuge (Al-Snafi, 2018; Ganchev, 2023).

Aquatic system

Rivers are considered among the oldest bodies of water on earth (Dooge, 2009). Rivers are among the water bodies most interacted with humans, and characterized by having the highest biological diversity in the ecosystem (Ward & Tockner, 2001) Rivers are the most vulnerable to pollution due to waste from human activities leaking directly into them. Such as the intensive agricultural use of fertilizers and pesticides, industrial wastes, sewage, saltwater intrusion, and soil erosion, this causes high levels of pollution in rivers (Akhtar et al., 2021). The relationship of aquatic plants to water is like the relationship of humans to the air. When human health is affected by polluted air, the life of aquatic organisms is affected by polluted water; Therefore, the sustainability of aquatic life is linked to the quality of the water. In Accordance with Lohdip (Lohdip, 2013). The biological, hydrological, physical and chemical properties of water and their interrelationships with each other (such as dissolved oxygen ratios, nutrient concentrations and others) are the essentially determinant of water quality and the spread of plankton. Any change that occurs in these properties has a direct impact in the life of all plankton. The presence of phytoplankton and zooplankton is considered one of the most important biological indicators of water quality (Pal & Chakraborty, 2014; Singh et al., 2013). The growth of phytoplankton (swimming aquatic plants, algae and lichens) is inferred by the presence of nitrate and phosphate, the basic nutrients for those plankton. Zooplankton feed in the early stages of their lives on phytoplankton, so it is inferred that the presence of phytoplankton is an indication of the presence of zooplankton (fish larvae, aquatic animals invertebrates and others) (Morgan, 2020).

pH water

It is the negative of the ten logarithm of the hydrogen ion concentration of any solution. When the pH value (= 7), the solution is neutral and the water is pure. When it's value >) 7) it indicates the acidity of the solution, and if it (<7) it indicates the alkalinity of that solution. It is preferable that the pH value of the water be close to 7, because if it's too high or too low an indication of a change in the physical properties, this means that the water is polluted, as it's normal value in water ranges between 7 - 8.5, depending on the balance of the concentration of dissolved CO2 in water; therefore, we find that the pH value in distilled water is low to 6.5 or less, due to the presence of high percentages of CO2 (Lal, 2009). Many studies have indicated an increase in the biodiversity of aquatic plants and their spread in aquatic systems, depending largely on the increase or decrease of pH values in the water (Hamdan et al., 2010). This has been confirmed by other studies mentioned (Saygideger et al., 2004), water with a (pH = 5 or 9) causes problems for aquatic plants in their ability to absorb and transport nitrogen.

Methods

Field location to collect and bring samples

Identified the Shatt al-Kufa, one of the branches of the Euphrates River (at Al-Zarqa region in Kufa city) to collect of *Lemna minor* plants (Map 1). The experiment was conducted invitro, within the laboratories of the Department of Biology / College of Education for Girls / University of Kufa, Iraq, during the time period from October to November of 2022.

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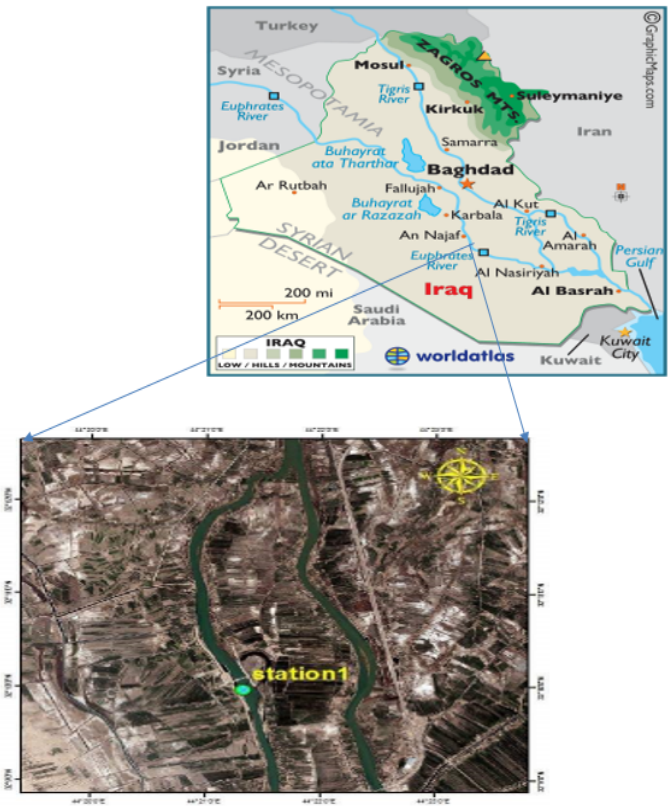

Figure 1. Map Site of L.minor collection from Shatt al-Kufa

Path of experiment

The samples collected in cups and washed well several times, first with river water, then with tap water, then with distilled water to remove attached zooplankton, phytoplankton and clean it of river mud and suspended dirt. Then, it was placed in containers (plastic tank) with known dimensions (12 liters of water for each container of tap water) and left for 7 days to acclimate, while maintaining the water level for all containers throughout the experiment. Experiment designed in 18 containers. divided into five unit experiments and control with triplicate for each unit (Table 1). Our experiment were organized in a Randomized Design Completely for effect of *L.minor* in pH values of water, were recorded weekly for 3 weeks. Results were analyzed using SPSS statistical software (version 25).

Table 1. Number of *L.minor* per container in all unit experiments

Treatment	Number of *L.minor* / Container
C	0
T1	5
T2	10
T3	15
T4	20
T5	25

Data analysis

Used digital portable multi meter; model 340i/SET, WTW which is made in Germany, after calibration by standard solutions at (9,7,4 pH), to read pH water of containers. Statistical analyses were performed by using IBM SPSS program, the free software (version; 25) under a

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oneway variance analysis (ANOVA) and Tests of between subjects effects (LSD=1.86 at: $p < 0.05$) showed a non-significant differences between all treatments (Table 1, Appendix 1).

Results and Discussion

Results about *Lemna minor* has been documented a vary widely in pH water values, highest value recorded in the 1st week with 8 at T2 and T3, while the lowest value was in the 2nd and 3rd week with only 6.9 at T3 and T1 respectively. (LSD=1.86 at $p>0.05$) non-significant differences between all overlaps.

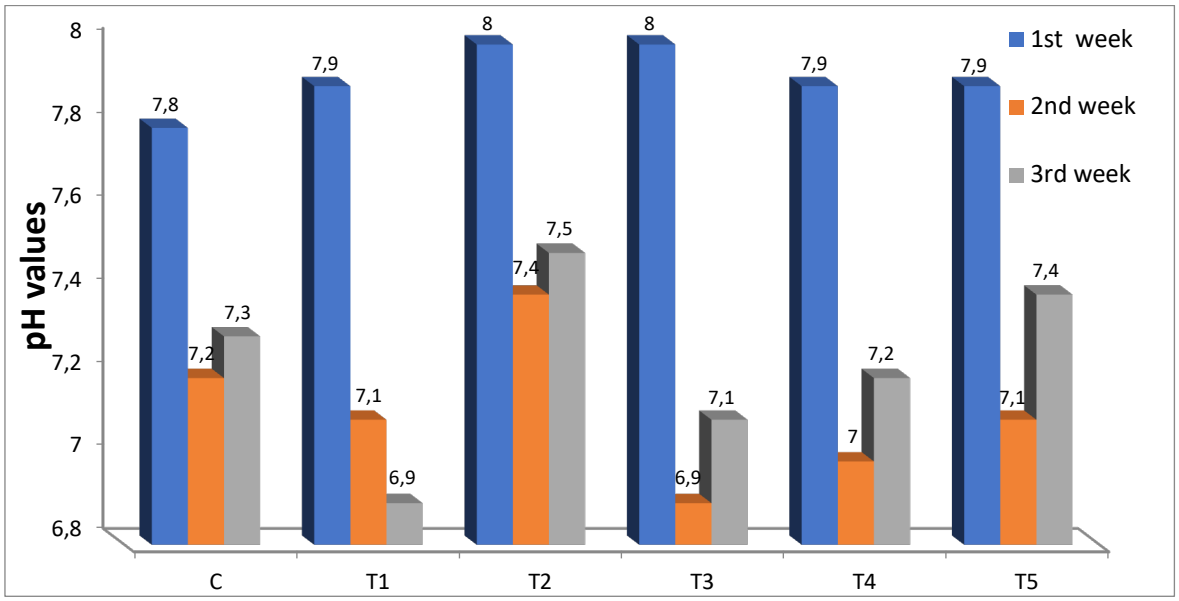

Figure 2. Explain the effect of the Lemna minor on the pH values of water in all treatments during the experiment

Control basins (C) of plant under study showed the highest value in the 1st week with 7.8, the lowest value was in the 2nd week with only 7.2

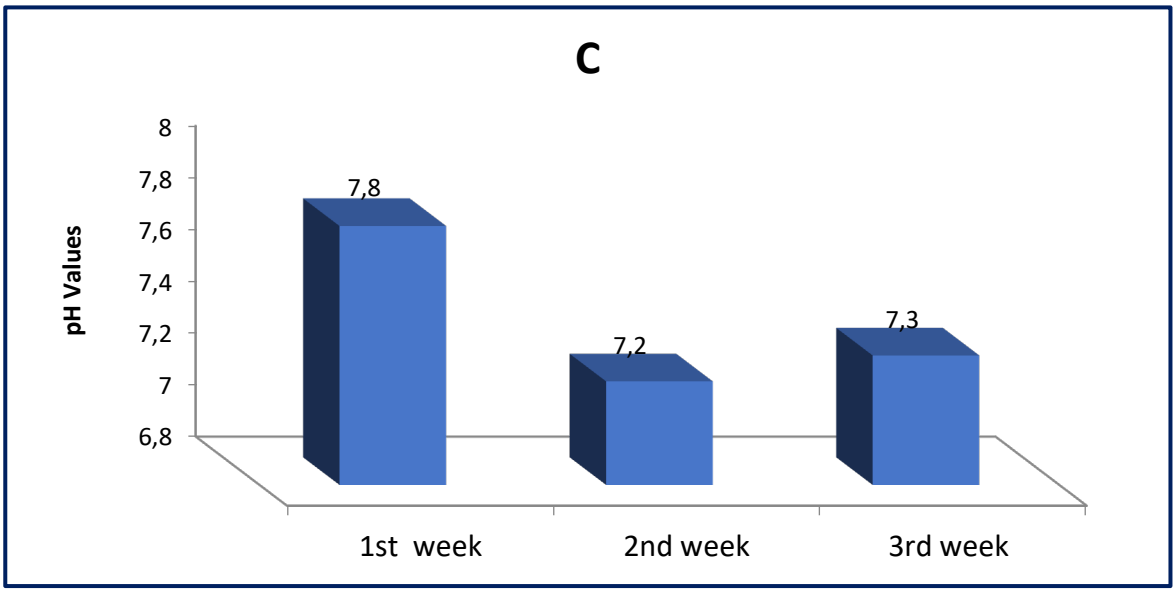

Figure 3. Explains the pH values of water in the control enclosures (C) during the experiment period

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First treatment (T1) recorded the highest pH reading in 1st week with 7.9, the lowest value was in 3rd week with 6.9

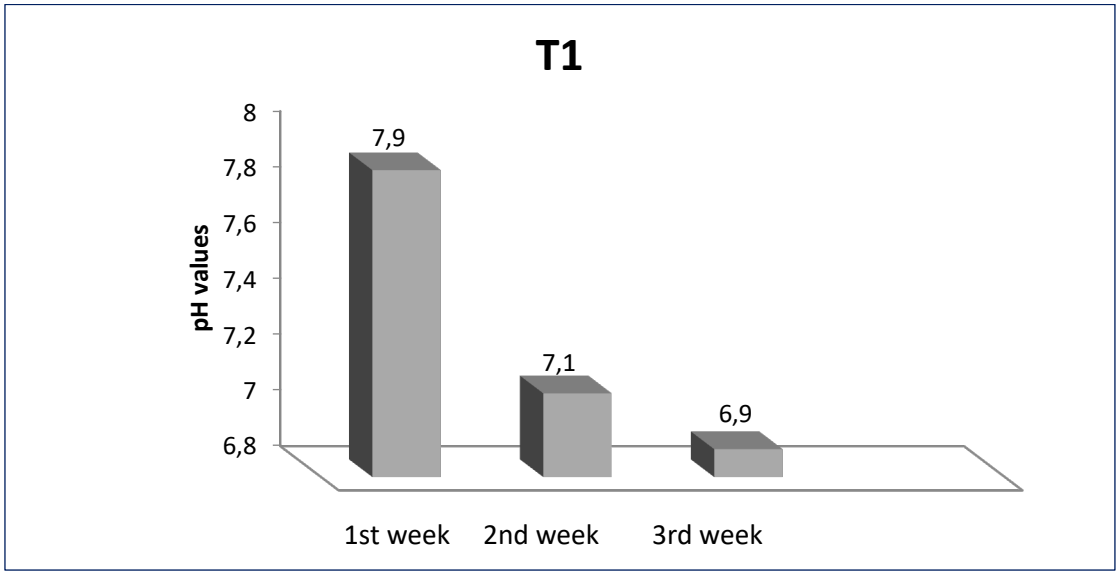

Figure 4. Explains the pH values of water in the first treatment (T1) during the experiment period

The results shown in the T1 treatment of the *Lemna minor* plant were unique from the rest of the treatments by the continued decrease in water pH values until the end of the experiment. This may be due to the lack of biomass of *Lemna minor*, which makes it unable to create a alkaline medium, and this is referred by (Iqbal & Baig, 2016), higher pH (above 7) is directly proportional to increased growth rate.

Second treatment (T2) of the plant under study showed the highest value of pH in the 1st week reaching to 8, and it decreased to the lowest value in the 2nd week, with 7.4

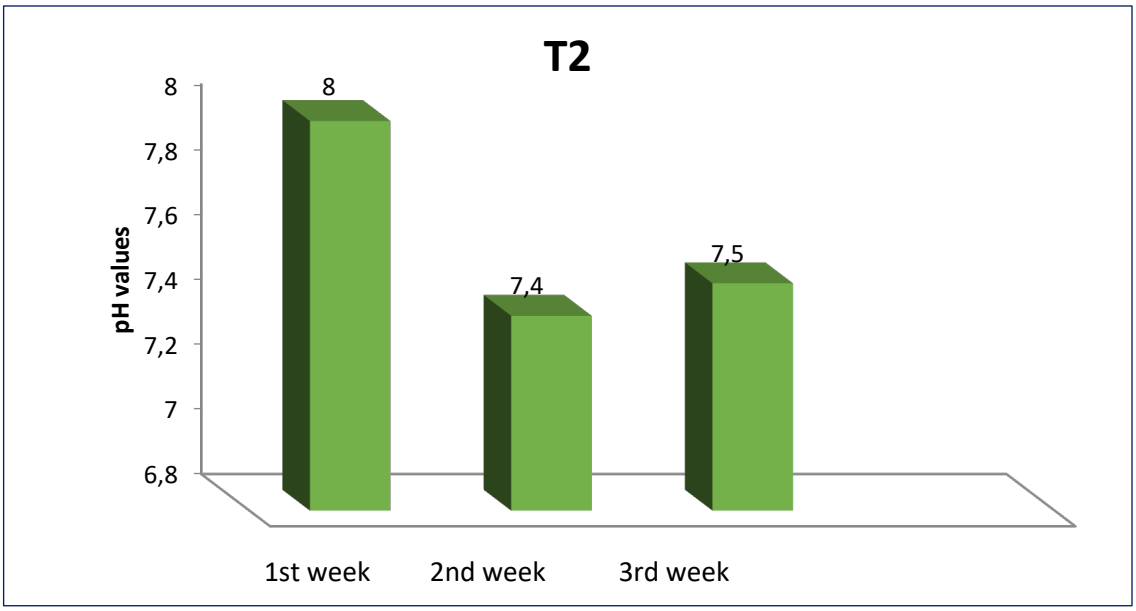

Figure 5. Explains the pH values of water in the second treatment (T2) during the experiment period

In third treatment (T3) the highest value of pH showed in the 1st week with 8, but it decreased to the lowest level in the 2nd week with 6.9

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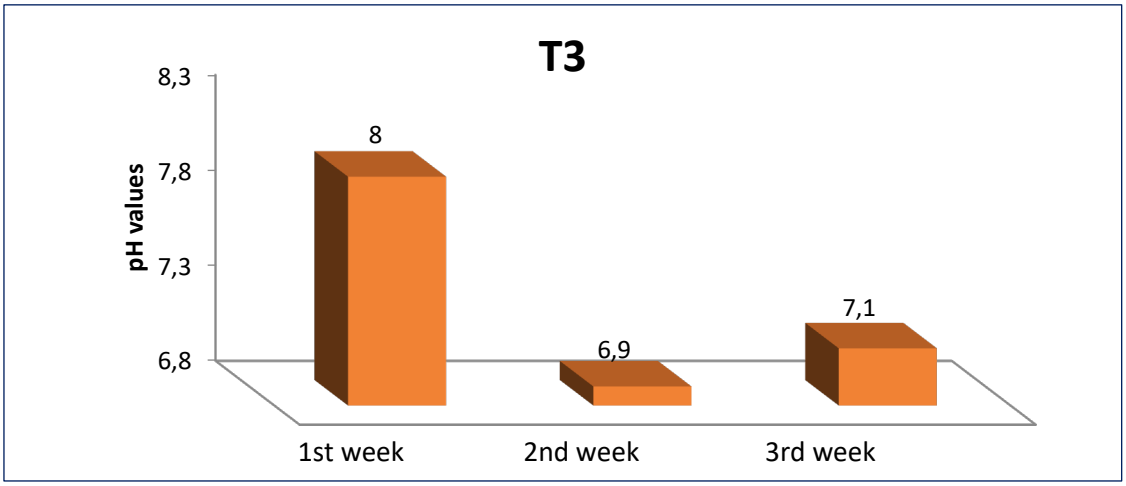

Figure 6. Explains the pH values of water in the first treatment (T3) during the experiment period

The fourth treatment (T4) recorded the highest value of pH at the 1st week with 7.9, the lowest value in the 2nd week with only 7

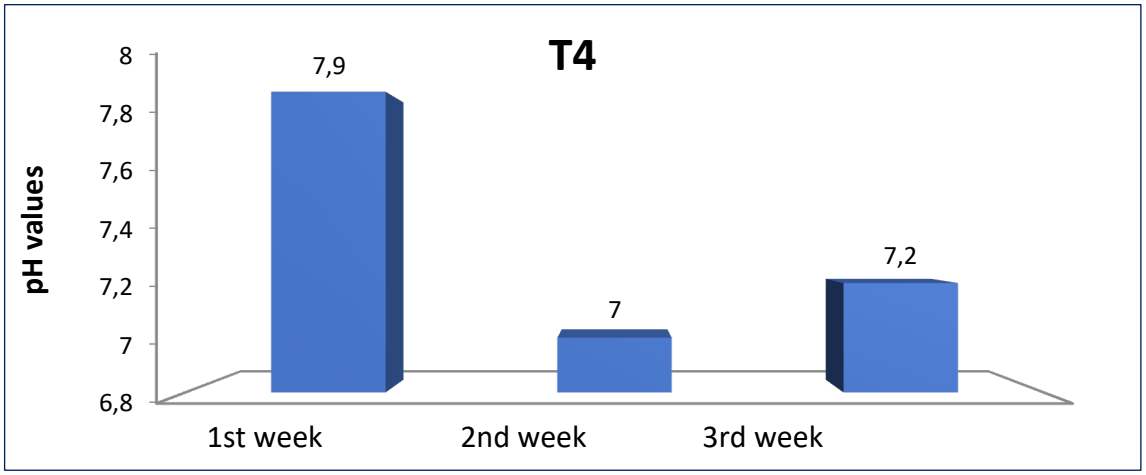

Figure 7. Explains the pH values of water in the fourth treatment (T4) during the experiment period

But in fifth treatment (T5) the highest reading of pH was recorded at the 1st week with 7.9, the lowest reading in the 2nd week with 7.1

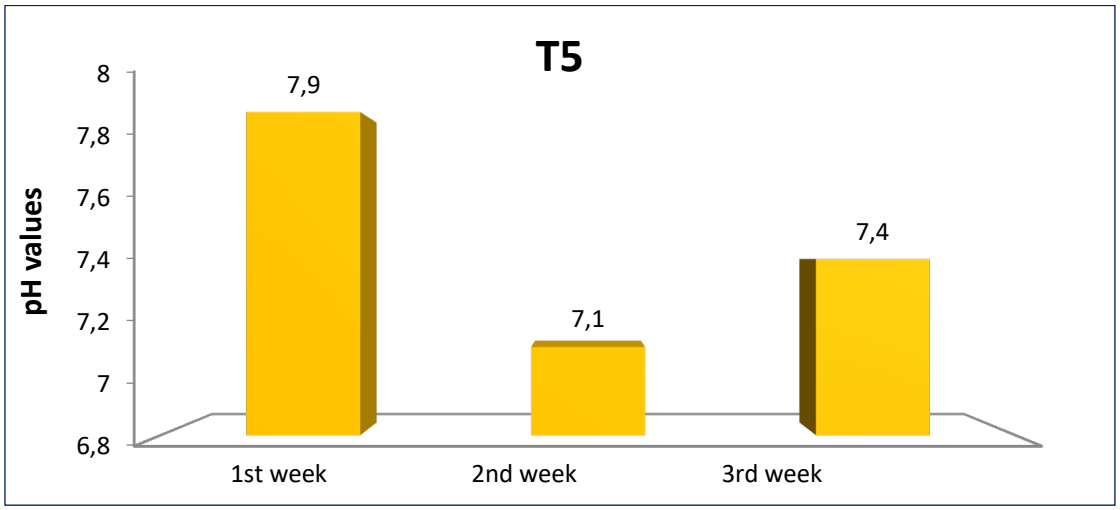

Figure 8. Explains the pH values of water in the fifth treatment (T5) during the experiment period

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May explain the increase or decrease pH values, as explained by (Ullah et al., 2022) to the plant's content of some minerals and the absence of others, as the acidity of the aqueous medium increases with increasing concentrations of the minerals Zn, Mn and Ca in the plant, while alkalinity increases with increasing concentrations of other minerals such as Fe and Mg.

Conclusion

Results of the current study and correlation it with previous studies, led us to conclude that the most important reason behind the increase or decrease pH values belong to the fact that *Lemna minor* contain some minerals and lack other minerals, as the acidity of the aqueous medium increases with high concentrations of Zn, Mn and Ca in plant, while the alkalinity increases with high concentrations of other minerals such as Fe and Mg. There for, we recommend conducting a Biochemical study to detect the concentrations of these elements in plant under study.

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