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THE ROLE OF FOLIC ACID IN AQUATIC SYSTEMS' CHEMICAL SELF-PURIFICATION PROCESSES

Angela Lis[1], Viorica Gladchi[1], Gheorghe Duca[2]

[1] Faculty of Chemistry and Chemical Technology, Moldova State University, 60 A. Mateevici, Chisinau MD-2009, angela.lis@usm.md, Republic of Moldova

[2] Institute of Chemistry of Moldova State University, 3, Academiei str., Chisinau MD-2028, Republic of Moldova

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Introduction

Vitamin B9 is one of the eight B vitamins, often known as folate or folic acid (FA). All B vitamins assist the body's process of converting food (carbohydrates) into fuel (glucose), used in energy production. FA is a water-soluble vitamin B9 essential for most aquatic creatures' amino acid and nucleotide metabolism, growth, and health. Additionally, folic acid is essential for supporting aquatic species' immune systems, antioxidant defenses, and resistance to bacterial illness.

It can be expected that FA exists in natural waters as a result of algal exudation or involuntary releases as a result of cellular damage because of its widespread occurrence in biological systems. At the same time, FA can penetrate natural aquatic systems with industrial wastewater and household water. But surprisingly little is known about the presence and distribution of dissolved FA in natural waterways from what is discernible, presumably because there are no methods to measure the low ambient quantities. Based on this, the aim of the work is to evaluate the self-purification capacity of aquatic systems in the presence of FA.

Materials and methods

In this paper, the self-purification capacity of aquatic systems in the presence of FA was evaluated by kinetic parameters including the inhibition capacity (∑kiOH[SiOH]) and the stationary concentration of OH• free. The determination of the aquatic environment inhibition capacity in relation to redox agents is based on the comparison of the discoloration speed of the dye 4-nitroso-N, N-dimethylaniline (PNDMA) under the action of OH•, in distilled water, in the absence and presence of FA. OH• are formed as a result of the hydrogen peroxide photolysis under irradiation with the Solar Simulator Oriel 9119X model. The dye PNDMA was chosen as an indicator since it acts as a trap of OH•, formed during the photolysis of hydrogen peroxide. If (∑kiOH[SiOH])<104 s-1 - the waters are very clean, if (∑kiOH[SiOH])>106 s-1 - the waters are highly contaminated, and if (∑kiOH[SiOH])≈105 – the waters are in a normal state. In order to determine the role of FA on the self-purification process of aquatic systems, were employed the following model systems: PNDMA–H2O2-FA-hʋ and PNDMA–H2O2-FA-Cu(II)-hʋ.

Results and conclusions

The results obtained for the inhibition capacity and OH• concentrations, in both systems, are shown in Figure 1 A and B.

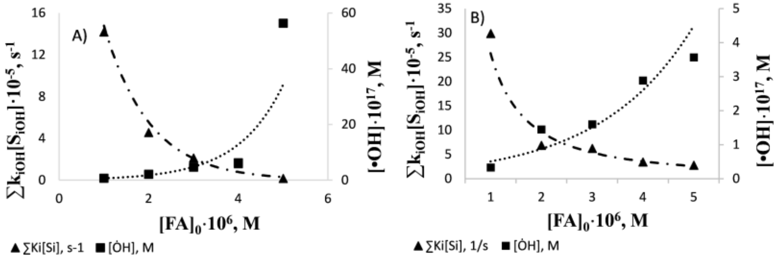

Fig. 1. The inhibition capacity and OH• concentration versus FA initial concentration added, in the systems: A) *FA-H_2O_2-PNDMA-hν, B) FA-H_2O_2-Cu(II)-PNDMA-hν*. E*xperimental conditions: $[PNDMA]_0 = 2\cdot 10^{-5}$ M, $[H_2O_2]_0=1\cdot 10^{-2}$ M, pH=8.7, t=20 ºC), $[Cu(II)]_0=2\cdot 10^{-6}$ M.*

From the results presented, it is found that the increase in the FA concentration leads to the decrease of the inhibition capacity and the values fall within the limits $1.8\cdot 10^4$-$2.9\cdot 10^6$ s^{-1}, and suggests that the waters are in a normal state. At the same time, Figure 1 shows that the increase in FA concentrations contributes to an increase in the stationary concentrations of OH• in the system, which are of the order of 10^{-16}-10^{-17} M, values found in natural waters. So, it is concluded that FA leads to the regeneration of an additional amount of OH•, that occurs to the intensification of the self-purification processes of aquatic systems.

When the results for the system with Cu(II) ions present (Figure 1 B) and the system with them absent (Figure 1 A) are compared, it is discovered that the inhibition capacity values increased 2–15 times. This shows that FA initially forms more stable complexes upon contact with Cu(II) ions, consequently slowing the rate of photodegradation. The results of this study demonstrate that Cu(II) ions have a positive impact on aquatic ecosystems by slowing down FA's rapid transformation, which is crucial for the metabolism, growth, and health of the majority of aquatic animals.

FA is an indispensable vitamin, of group B, both for the growth and development of aquatic animals, but also, for the decrease of inhibition capacity, respectively to an increase in the concentrations of OH•. Thus, FA has a positive role, because it leads to the intensification of the self-purification processes of aquatic systems.

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