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INVESTIGATIONS OF DETERGENTS AND METAL COMPONENTS FOR SUPPORTING THE EFFECTIVE TREATMENT OF GREYWATER

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Abstract

The aim of our research was to investigate the detergent content and several micro and macro elements in greywater samples, a necessary step in determining the water quality for the further reuse of the greywater. We determined the anionic detergent content of synthetic greywater with a two-phased titration method prepared in laboratory conditions. The current study leads to a new suggestion for a more accurate and reliable titrimetric method for determination of anionic detergent content of synthetic greywater samples. Following these investigations, we also examined the metal content of synthetic bath water. We wanted to highlight how detergents in greywater influence the micro and macro element content of the given synthetic bath water samples.

Keywords: *greywater, detergents, micro and macro elements.*

1. Introduction

Increasing water supply requirements can cause significant problems in ensuring the quality of water. Therefore, we need to apply alternative sources and reduce water consumption. A possible way to reach this goal is to reuse household greywater, for example, toilet flushing, irrigation or car washing [1, 2]. Greywater is generated as wastewater from the bath, washing, hand washing and dish washing, but does not include the used waters from the toilet flushing [1, 2]. Greywater can contain a large amount of surfactant, which needs to be removed before reuse or placement of this used water fraction. These substances cause the formation of a foam layer on the surface of the water, reducing the dissolved oxygen concentration in the water and disturbing the natural self-cleaning processes. Due to their emulsifying effect, they inhibit the settling of insoluble pollutants, thus making the production of drinking water from surface water more expensive [2]. Detergents can be categorized according to their chemical structure into four groups: anionic, cationic, non-ionic and amphoteric detergents [3, 4]. The release of detergents into the environment may be harmful, for example by inhibiting the diffusion of oxygen in the water can cause algal blooms [2]. They interfere the wastewater treatment, drinking water treatment and as we mentioned impair the efficiency of surface water self-cleaning. Synthetic bathwater has a variety of compositions, and this difference also create the diverse metal content of water. In addition to the presence of detergents, we need to take into account the increase in the micro and macro elemental content of the waters used, since high concentrations of trace elements and heavy metals are present in these fractions, which can cause significant pressures on the ecosystem [1, 5, 6]. Based on this we also investigated the different concentrations of macro and micro elements in the greywater to determine how detergents in greywater influence the concentrations of these elements.

2. Methodology

According to the previous studies at the Department of Environmental Engineering it was proved with adequate measurements, that the quality of real greywater fraction is very variable [5]. For this reason, a synthetic greywater recipe has been developed that represents the average bathwater samples in the region The stabile content greywater obtained with this method is also useful for comparing the results of our experiments aimed at developing methods for measuring detergent content The aim of our research was to investigate the applicability of the two-phased titrimetric method for the determination of the detergent content of greywater, by developing a unique method to measure the greywater detergent content faster, more accurately, and with less pollution, using a simple titrimetric assay. In our experiments, we used a two-phased titrimetric method to determine the anionic detergents (in short, the ANA content), which is based on the ISO 2271: 1989 standard. In our study we used the average results from 5 measurements. For the determination of detergent content, we prepared and analysed 3 water samples. The first one was a laboratory-produced bathwater sample created from tap water, shower gel, shampoo, natural oil and nutrient broth. The ANA content of this sample was 44.427±1.59 mgL^{-1}. The second sample contained only shower gel as a detergent and the ANA content of this sample was 21.726±0.39 mgL^{-1} and the ANA content of the water sample containing only shampoo as a detergent was 24,491±2.00 mgL^{-1} as shown in **Figure 1.**

Having determined the ANA-content of the synthetic bathwater, we observed that the ANA-content of the water that included only shampoo and shower gel approaches the ANA-content value of the synthetic bath water with all ingredients. It revealed the fact that the households' detergent content of the bathwater was derived from mostly cosmetics, shampoo as well as shower gels. Microwave plasma atomic emission spectrometry (MP-AES) was used as a method for determination of elemental concentration of greywater samples. This measurement was performed on an Agilent 4210 MP-AES device at the Department of Inorganic and Analytical Chemistry at the University of Debrecen. This measurement technique can sequentially measure the elements **[7]**. In the machine, the measurement of the elements is carried out in an ascending order by their wavelength. The large number of wavelength databases allows selection of the appropriate wavelength, thus minimizing spectral interference.

3. Result of research

In our research we investigated the micro and macro elemental content of synthetically produced bathwater samples. Our aim was to investigate the extent to which detergents change the concentration values of particular elements. We examined the micro- and macro element content of the drinking water that we used as a control sample since these results were later compared with the results obtained for synthetic bathwater samples.

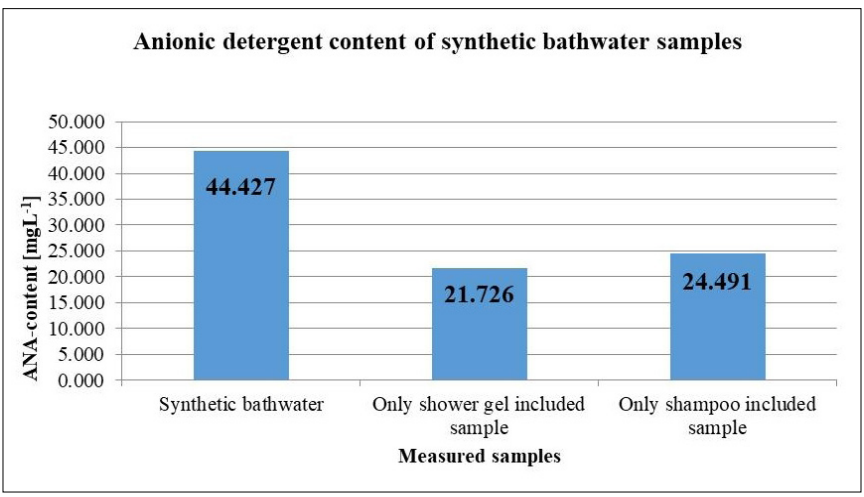

Figure 1. *Anionic detergent content of synthetic bathwater samples .*

Figure 2 illustrates the barium, copper, strontium and zinc contents of greywater samples.

Figure 3 shows the aluminum, cadmium, chromium and iron contents of analysed samples.

Figure 4 for lithium, manganese, nickel, and lead are shown.

Considering micro elements, the concentration of zinc, copper, lead and nickel increased due to the presence of the detergent used in generation of greywater samples. In the case of lead, we found that besides detergents, other ingredients also contribute to an increase in the concentration of micro-elements. Similarly to lead, the iron, aluminium, and lithium content of greywater originating from other constituents of synthetic bathwater can cause concentration changes. We showed that the strontium, barium, cadmium, and manganese content was similar concentration to the composition of control drinking water samples, so the detergent content of greywater did not influence these component concentrations. Chromium content tests indicated elemental contents below each measurement limit for greywater. The chromium content of the samples was less than 0.1 μgL^{-1} since the detection limit for the device used was 0.1 μgL^{-1} for chromium. **Figure 5.** shows the macro elemental contents (calcium, potassium, magnesium and sodium).

Examination of macro elements showed, as expected, that the drinking water already has a significant content of calcium and magnesium. Therefore the presence of these elements is not caused by the detergents but can be explained by the hardness of the drinking water. Due to elevated potassium and sodium concentrations, detergents in bathing waters affect the amount of these elements. Detergents, which enter greywater due to the use of a variety of cleaning products or cosmetic products, may also be responsible for a large part of the concentration of the elements.

4. Conclusions

In our research we aimed at determining the detergent content of greywater with the use of ISO 2272:1989 international standard. Having determined the ANA-content of the synthetic bathwater, we experienced that the ANA-content of the water that included only shampoo and shower gel approaches the ANA-content value of the synthetic bathwater. It revealed the fact that the household detergent content of the bathwater derived from mostly cosmetics, shampoo as well as shower gels. Considering micro elements, the

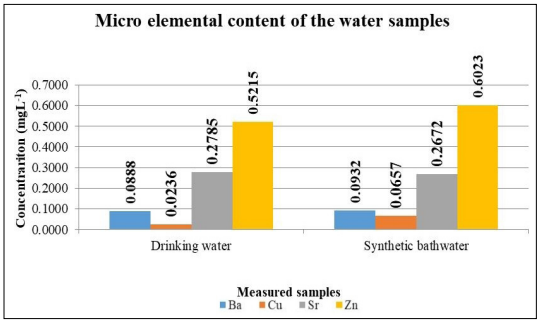

Figure 2. *The barium, copper, strontium and zinc content of the water samples.*

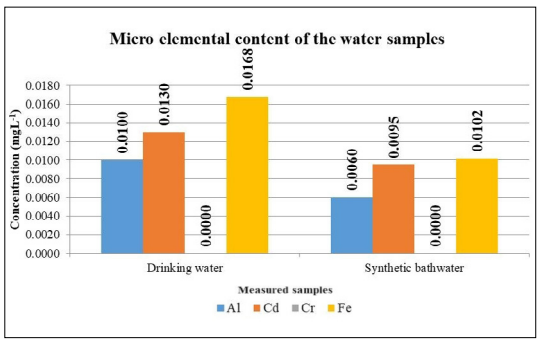

Figure 3. *Aluminum, cadmium, chromium, iron content in synthetic bathwater samples.*

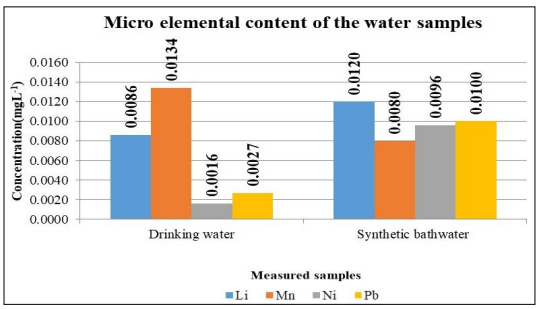

Figure 4. *Lithium, manganese, nickel and lead content in bath water samples.*

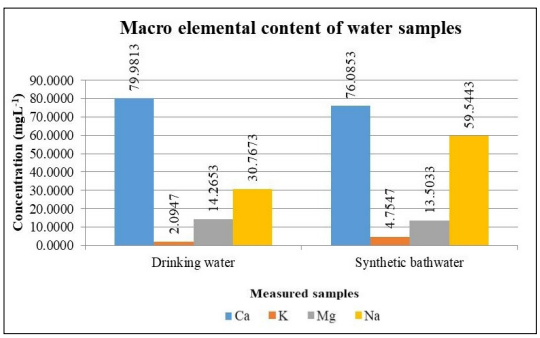

Figure 5. *Macro element content in synthetic bathwater samples.*

concentration of zinc, copper, lead and nickel increased due to the presence of the detergent. The detergent caused an increase in the concentration of zinc (100 %), copper (approx. 80 %), nickel and lead (approx. 30 %). During the examination of macro elements we observed change in the concentration of sodium and potassium. Detergents are partly responsible for the increased concentration: in the case of sodium this value is 30 %, while in the case of potassium, the increase is 60 %.

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