SUMMARY

Industrial human activity together with discharges of treated and untreated wastewater results in the emission of toxic and difficult-to-biodegrade substances into the environment. The presence of contaminants in the environment is also a growing problem due to the shortcomings of conventional water and wastewater treatment methods. Moreover, new groups of pollutants in water and wastewater, including micropollutants, are constantly being identified in water and wastewater. Due to the specific properties of micropollutants, such as toxicity, resistance to biodegradation, and carcinogenic and mutagenic nature, they are very often poorly eliminated from municipal wastewater, surface water, and groundwater. Substances classified as micropollutants include, among others, dyes, e.g. methylene blue and rhodamine B, and pesticides, e.g. chlorfenvinphos. Due to the risks to humans and the high resistance to biodegradation, there is a need to investigate new technologies to eliminate dyes and pesticides from wastewater. Methylene blue can affect asthma symptoms and also cause uterine contractions in pregnant women. Symptoms of adverse effects of rhodamine B are irritation of the skin, eyes, and respiratory system. Chlorfenvinphos has negative effects on the peripheral and central nervous systems. In recent years, advanced oxidation processes in water and wastewater have played a crucial role. Advanced oxidation processes enable both the recovery of water and their use reduces the risk of micropollutants occurrence in the recovered water. A common feature of advanced oxidation processes is the chemical reaction between organic contaminants and oxidation radicals: hydroxyl or sulphate. Hydroxyl and sulfate radicals, compared to other commonly used oxidants, are characterized by their high oxidizing potential. The most intensively studied advanced oxidation processes are photocatalysis (oxidation reactions using light). Oxidation processes based on reactive sulphate radicals (oxidation reactions using persulphates and mono-oxysulphates) are becoming particularly important. Despite the numerous advantages, a disadvantage of photocatalytic processes involving, among others, titanium (IV) oxide is its activation by radiation at wavelengths below 400 nm, so expensive lamps emitting ultraviolet radiation must be provided. This justifies the need to search for “green photocatalysts” i.e. semiconductors that absorb visible radiation (wavelength above 400 nm) under the influence of applied modifications. To generate sulphate radicals, the sulphate radical precursor (e.g. persulphate) needs to be activated, since, when not activated, it can only react with some organic compounds and the process yield in this case is much lower. Expensive, energy-intensive, and complicated activation methods are often used to activate persulphates. For the practical application of advanced oxidation processes (photocatalysis, sulfate radical oxidation), it is important to modify the ways of producing oxidizing radicals to enable the process to be carried out under visible light (Vis). Based on the literature review, I found that there is an

important need to develop research on the use of sugars and organic acids as naturally available substances for the activation of photocatalysts and oxidants such as titanium (IV) oxide and sodium persulphate. The scientific objective of the dissertation is to evaluate the applicability of organic substances for the activation of catalysts and oxidisers for the advanced oxidation of micropollutants. The subject of this dissertation was to investigate the degradation of the dyes methylene blue (MB) and rhodamine B (RhB) and the pesticide chlorfenvinphos (CFVP) in advanced oxidation processes carried out in the presence of visible radiation. To confirm the activation of titanium (IV) oxide by visible light, I used the organic acids succinic and pyruvic acids as modifiers of titanium (IV) oxide. I used the sugars: glucose and sucrose for the activation of sodium persulphate with visible radiation (Vis). Based on my research, I have shown that there are organic substances that cause the activation of titanium (IV) oxide and sodium persulphate under visible light. The modifications that I applied facilitated shifting the absorption bands of TiO_2 toward visible radiation, which was confirmed by spectrophotometric studies and scanning electron microscopy analysis. The use of glucose and sucrose enables the activation of sodium persulfate under visible light and the generation of oxidative radicals, which I confirmed by the radical scavenger test. The studies carried out allowed me to conclude that the modification of the advanced oxidation processes makes it possible to obtain a higher degree of removal of chlorfenvinphos, methylene blue, and rhodamine B, which I found based on the analysis of the degree of removal of micropollutants and the kinetic parameters of the oxidation reaction. On the basis of the conducted research and the obtained results, I confirmed the research hypothesis that it is possible to degrade micropollutants as a result of advanced oxidation processes carried out under the influence of visible light.