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Application of an Organic Coagulant (Polydialdimethylammonium Chloride) for the Treatment of Water from Otuoke, OX-Bow and Swalli Rivers in Bayelsa State

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Abstract: *The effectiveness of polydialdimethylammonium (PDC) as a coagulant in the improvement of chloride the physicochemical quality of water from Otuoke, Ox-bow and Swalli Rivers was investigated concerning temperature, phenolphthalein/total alkalinity, turbidity, pH and hardness. These parameters were determined in the original samples and after treatment with PDC. The results obtained indicated higher efficiency at a higher period of contact, concentration, PDC's dosage and temperature. However, the conductivity and pH were found to increase with an increase in temperature. The results obtained indicated that water samples from these Rivers can be modified by PDC.*

Keywords: water, contamination, coagulation, polydialdimethylammonium , water quality, River physicochemical quality,

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1.0 Introduction

Quality water is most needed in life for several domestic, agricultural, industrial and other sectors (Eddy and Garg, 2021). However, one of the global challenges is the alarming volume of waste or contaminated water compared to potable water. Consequently, current mitigation measures are the development or improvement of water treatment technologies such as adsorption, photocatalysis, coagulation, dialysis, reverse osmosis, etc (Coulliette and Arduino, 2013; Eddy *et al*., 2022a,b; Simonič, 2021; Trishitman *et al*., 2020). The technology of water treatment by coagulation has been considered an effective preliminary measure in the treatment of contaminated water and wastewater. It is based on the addition of a substance that can form larger particles (flocs) from a combination of smaller particles (Jiang, 2015). Several salts of iron and aluminum have been tested and accepted to be good coagulants for the treatment of contaminated water (Cui *et al*., 2010; Nimesha *et* al., 2022; Precious *et al*., 2021). However, in recent times, research interests are pursuing natural coagulants, most of which are organics because of some remarkable toxicity of the inorganic coagulants (Lulesa *et al.*, 2022). For example, Azamzam *et al*. (2022) noticed that banana peel powder was effective in the coagulation treatment of some contaminants in turbid and river water. Muruganandam *et* al. (2017) reported that moringa oliefera , aloe vera, and cactus plants were effective in directional improvement of the physicochemical parameters of wastewater towards a better potability profile. The significantly presented a better improvement

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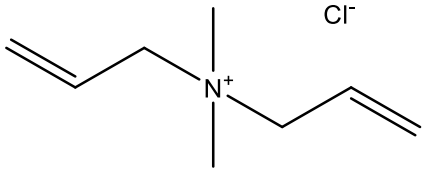
of the pH, turbidity and chemical oxygen demand (COD). Soros *et al*. (2019) also reported that chitosan-polymer of marine shell origin was very effective in the reduction of the turbidity of wastewater. They comprehended that the effectiveness of the coagulation process was a function of the functional group, materials type, molecular weight and dosage. Given the current search for organic coagulants with efficient performance, the present study is aimed at investigating the performance of polydialdimethylammonium chloride (PDC) as a coagulant for some contaminated water in Otuoke. The chemical structure of PDC is shown below



Chemical structure of PDC

2.0 Materials and Methods

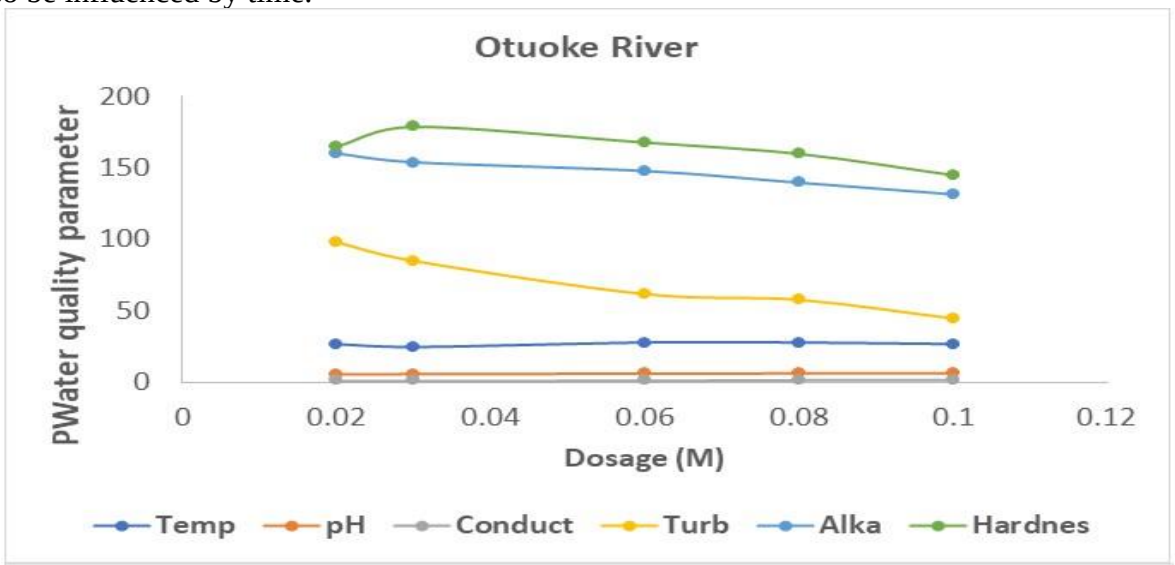
Water samples from Otuoke, Ox-bow and Swalli Rivers were collected monthly between January and May. The samples were analysed in situ for their temperature, pH (using Orion star A211 pH Meter), conductivity (using hand-held conductivity meter) and turbidity (using a turbidity meter). The alkalinity and hardness were determined using chemical methods (Eddy and Ekop, 2007). The water samples were treated with various masses of PDC (to the established effect of dosage) at various times (to the established effect of contact time) and at various temperatures (to establish the effect of temperature). After each set of treatments, the samples were re-analysed for similar parameters.

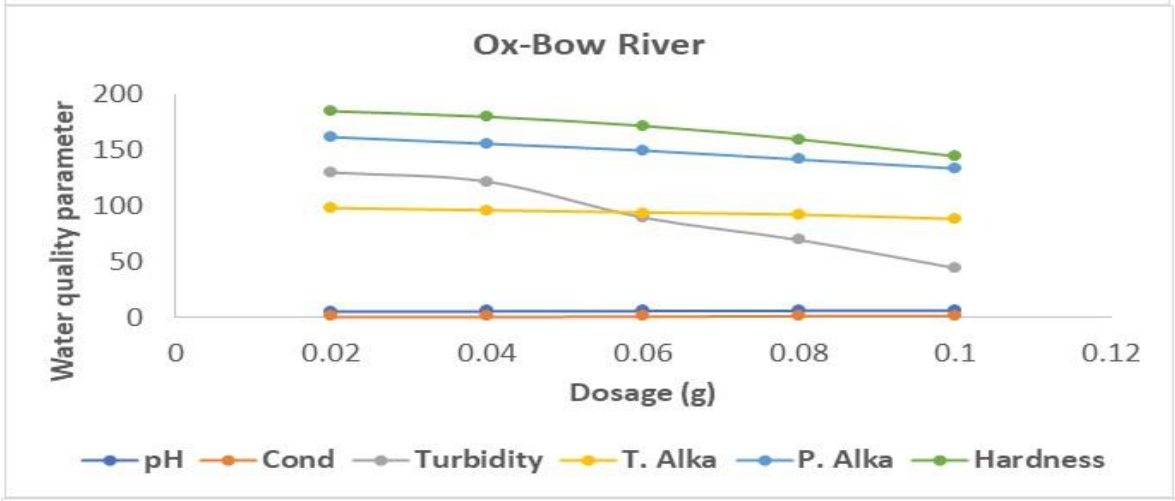
3.0 Results and Discussion

Fig. 1 shows graphs for the variation of the mean turbidity, temperature, hardness, alkalinity and pH of water samples from Otuoke, Ox-bow and Swalli Rivers after treatment with different concentrations of PDC (ranging from 0.02 to 0.1 g). The plots display similar patterns and reflect the tendency of the PDC to lower the analysed parameters of water. The lowering of pH, turbidity, hardness and alkalinity is due to the coagulation ability of the PDC to withdraw ions and substances that were responsible for their higher values. When the experiments were conducted at different temperatures, significant lowering trends were observed as shown in Figs. 1 to 3. This suggests that the coagulating ability of the PDC increases with an increase in temperature. A combined impact of temperature and concentration of the PDC is also reflected in Figs. 2 to 4. Consequently, the plots also indicate that at a given temperature, the concentration of the PDC increases with the respective physicochemical parameters become lowered. The turbidity and alkalinity also showed a direct decreasing trend as the temperature increased (Figs. 2 to 4). Temperature is known to affect the rate of various reactions, including coagulation due to its influence on the enhancement of diffusion and the consequence coming together of the particles (Eddy *et al*., 2022a). However, the conductivity and pH were found to increase with an increase in temperature (Figs. 2 to 4). The consequence may be attributed to the availability of more free ions at higher temperatures, and hence the observed increment in conductivity. Such influence will also increase the pH.

A decrease in the analysed physicochemical parameters with time was also observed for all the water samples (except for pH and conductivity) as shown in Figs. 5 to 7. This indicates that the ability of the coagulants to be active is a function of time and tends to become more effective as the period of contact increases. This also implies that sufficient time is needed for the coagulants to interact with the particles to be coagulated.

Other factors such as required solubility can also be influenced by time.





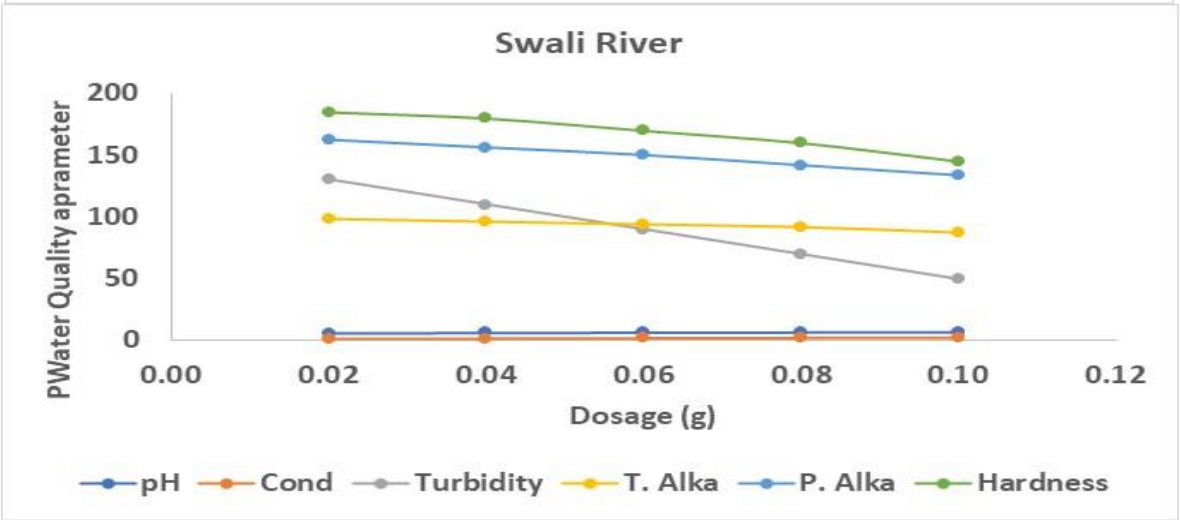


Fig. 1: Variation of the same water quality parameter of water from Otuoke, Ox-Bow and Swali Rivers with various concentrations of PDC

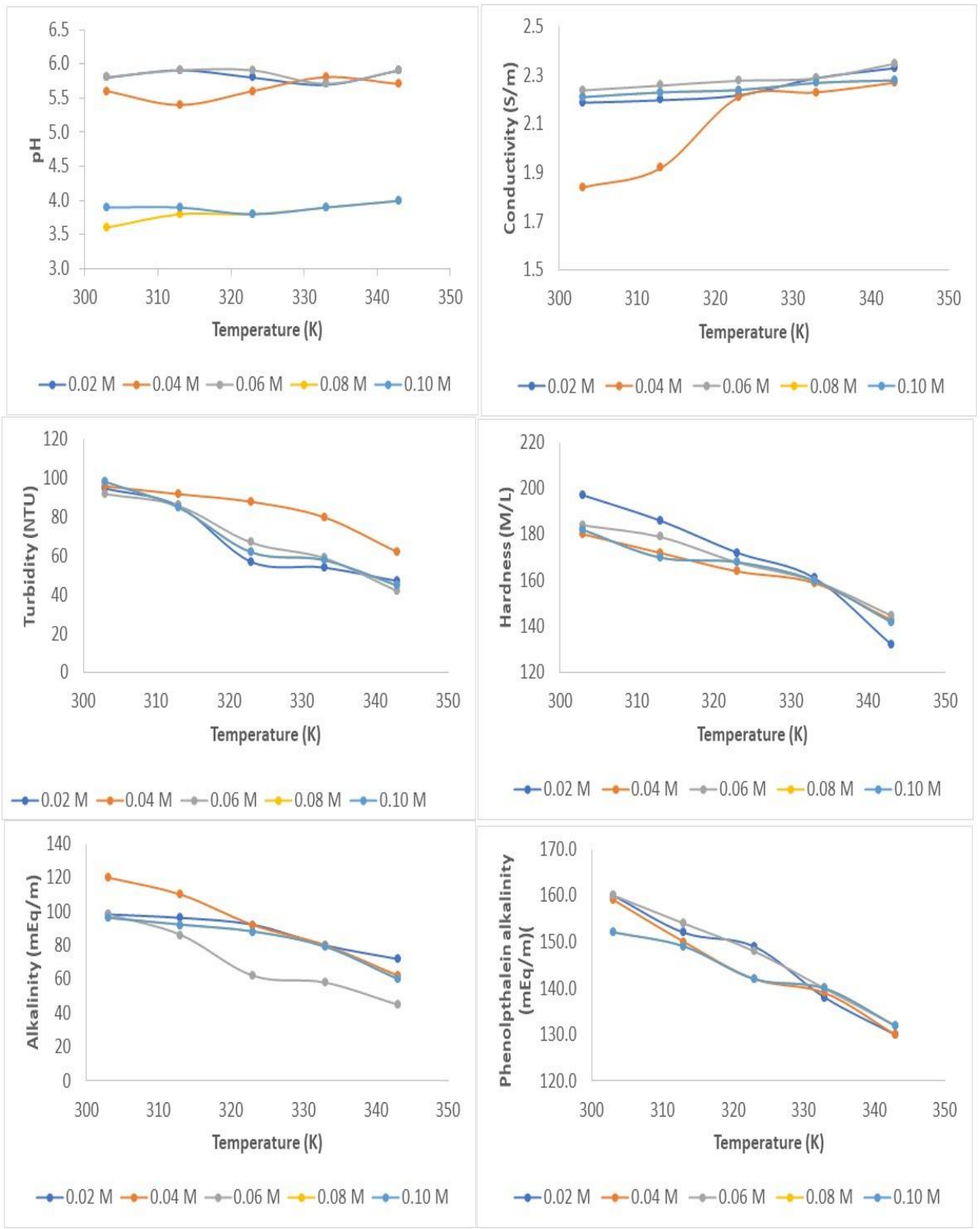


Fig. 2: Variation of some water quality parameters of Otuoke River with temperature in the presence of various concentrations of PDC

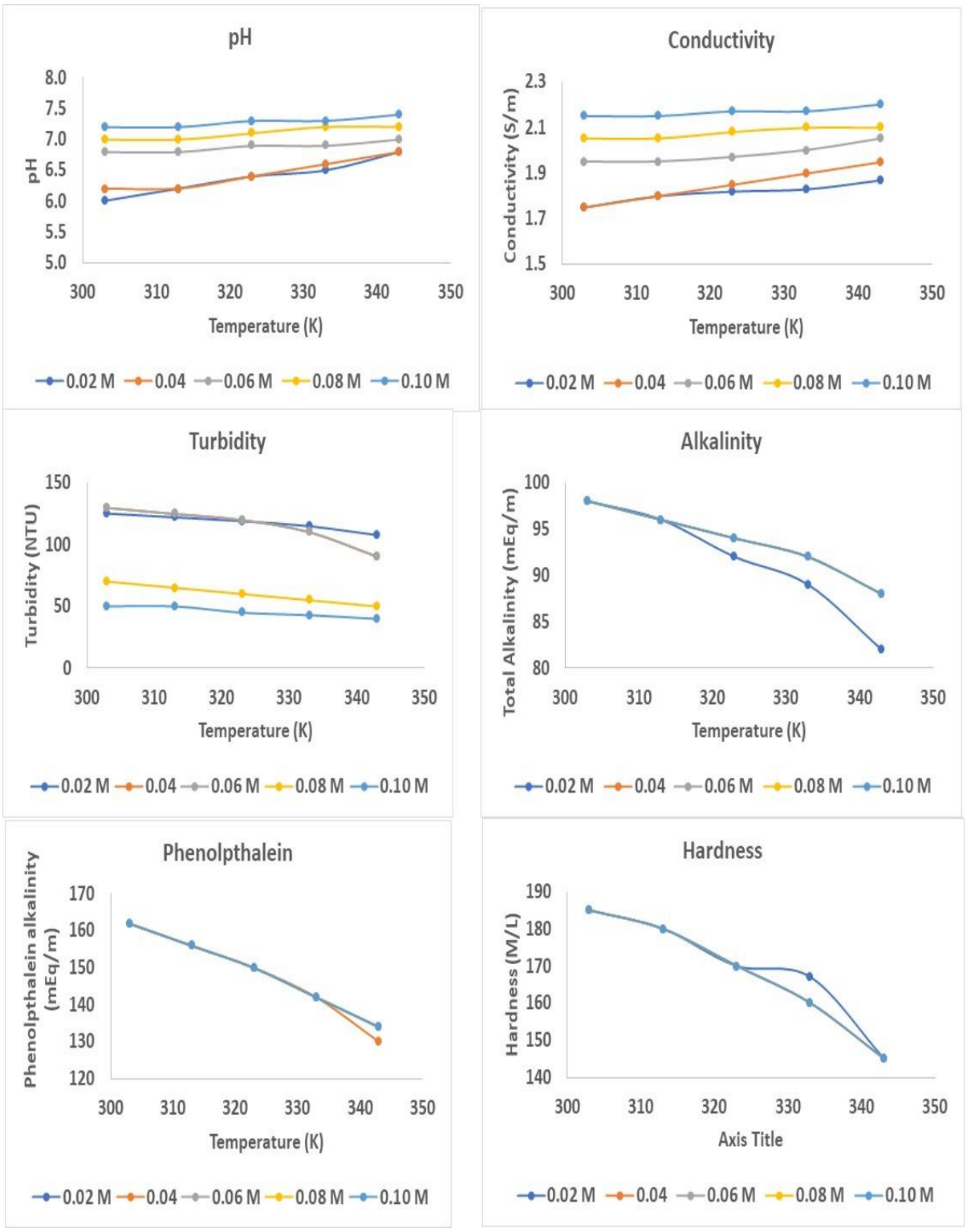


Fig. 3: Variation of some water quality parameters of Ox-Bow River with temperature in the presence of various concentrations of PDC

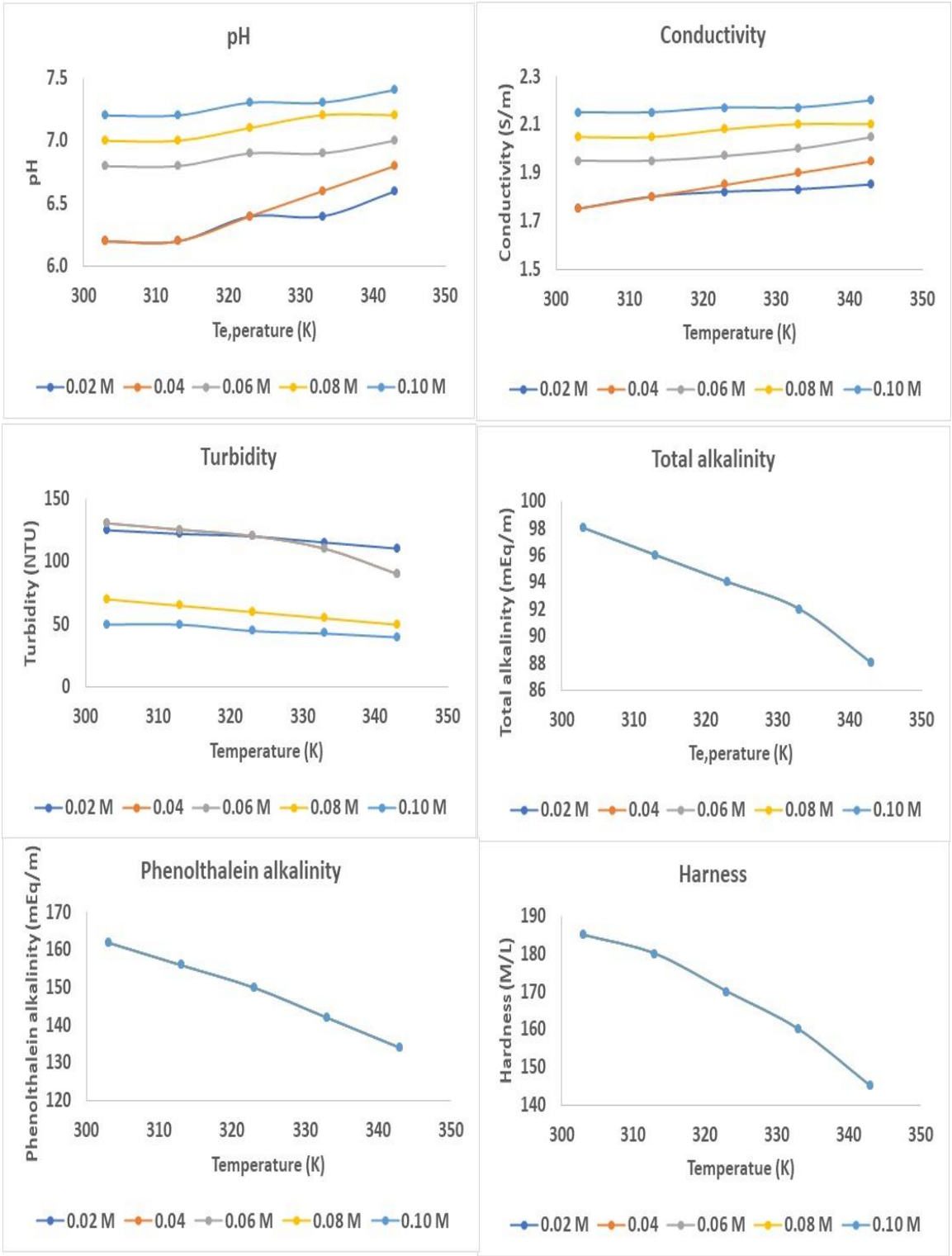


Fig. 4: Variation of some water quality parameters of Swali River with temperature in the presence of various concentrations of PDC

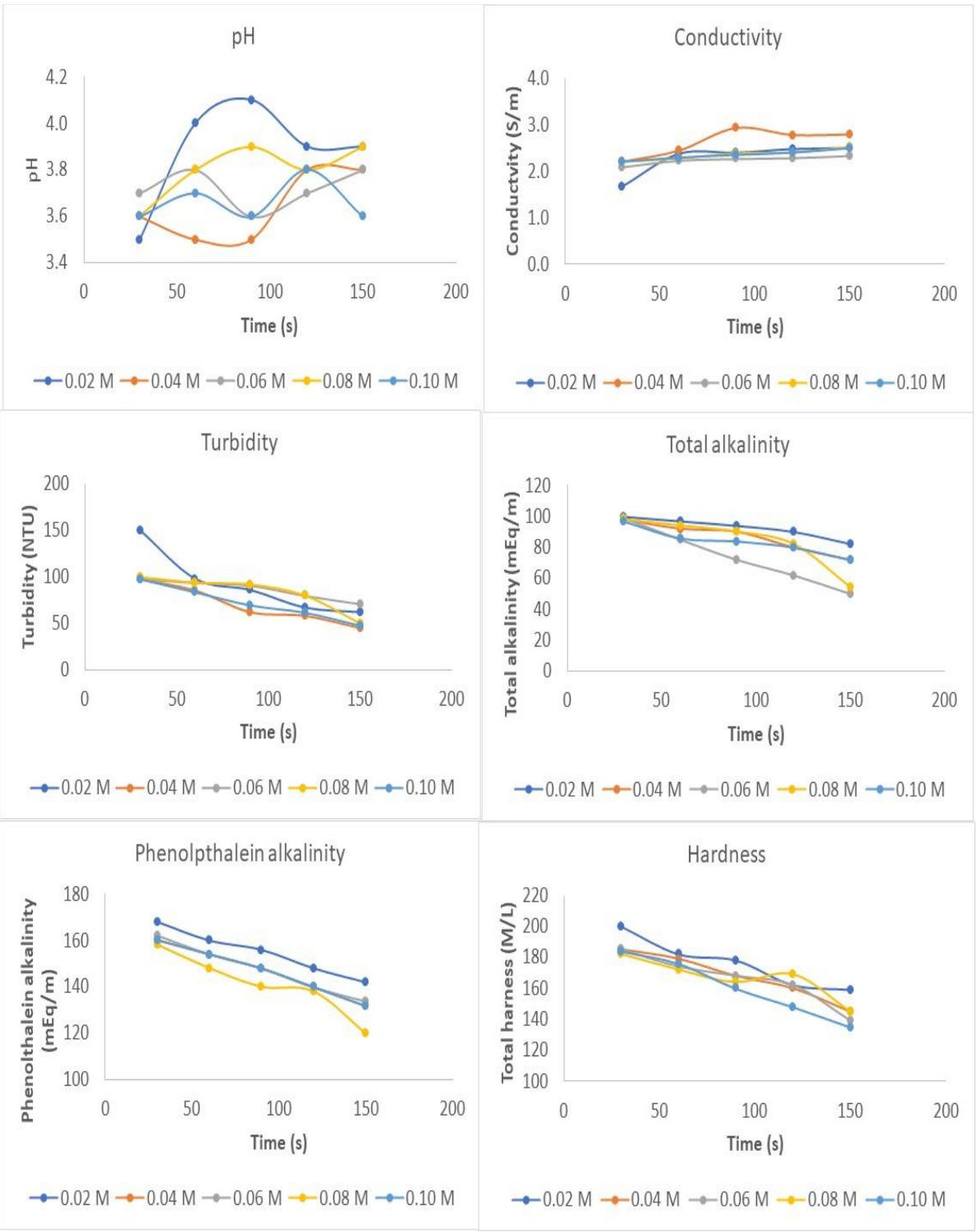


Fig. 5: Variation of some water quality parameters of Otuoke River with time in the presence of various concentrations of PDC

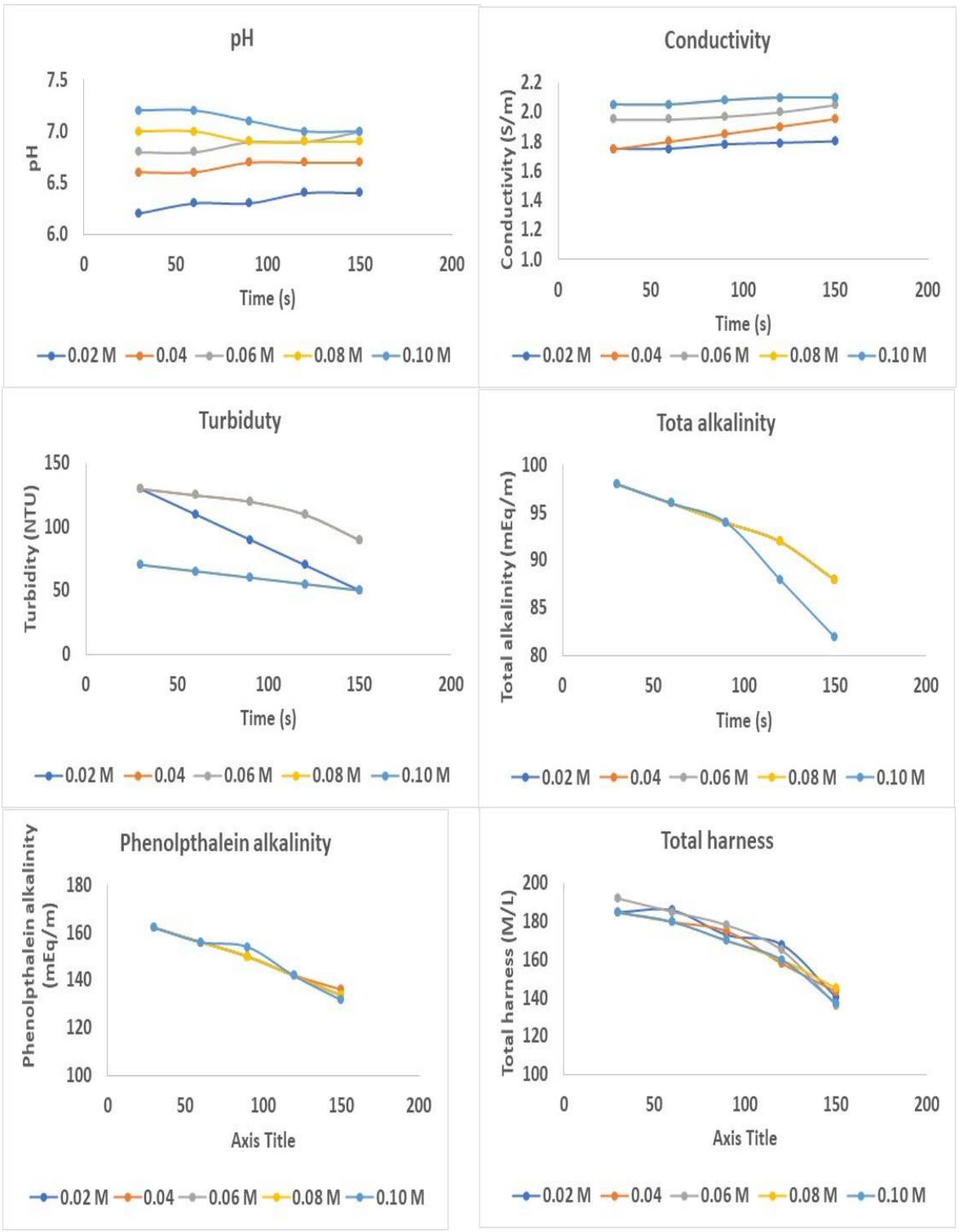


Fig. 6: Variation of some water quality parameters of Ox-Bow River with time in the presence of various concentrations of PDC

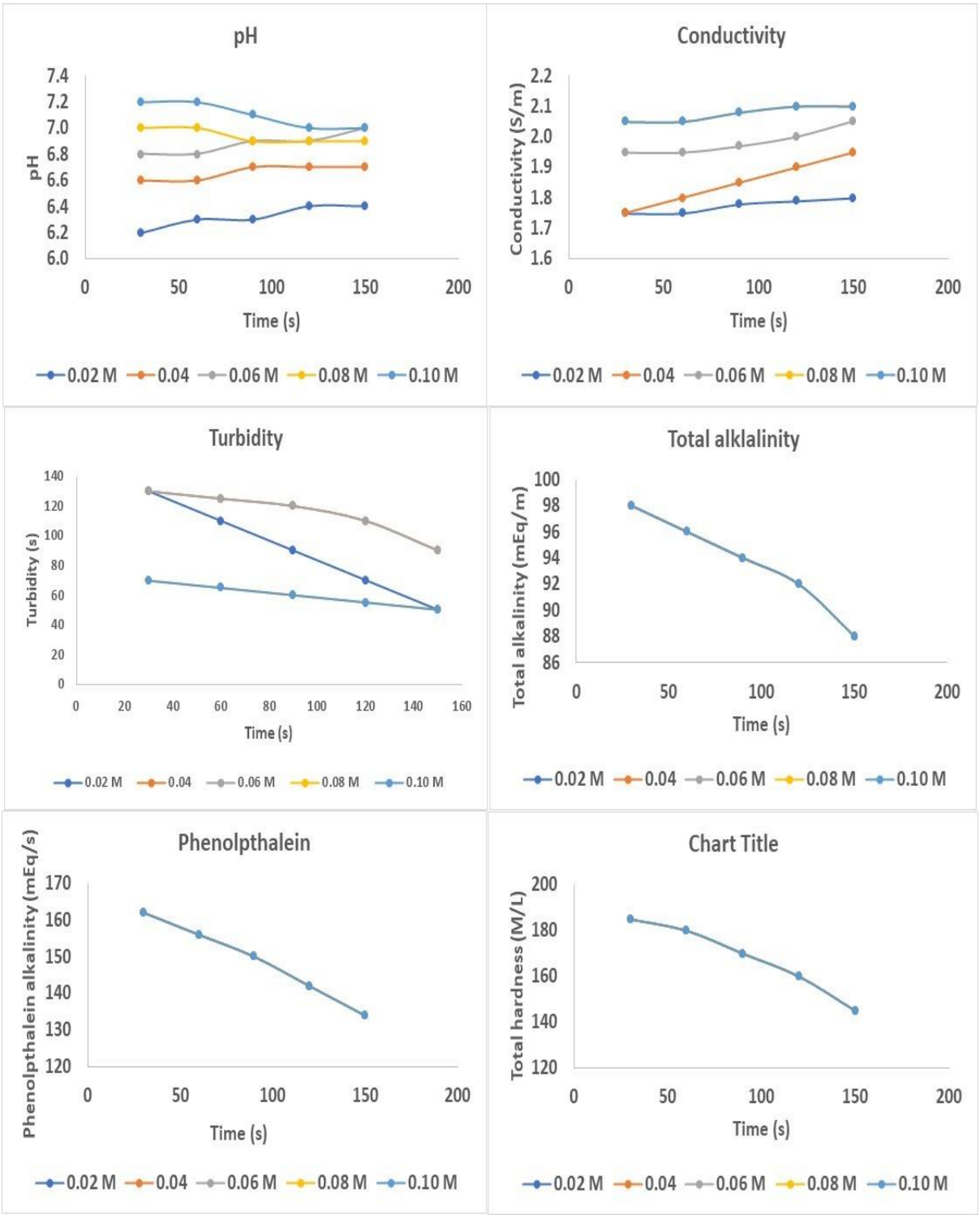


Fig. 7: Variation of some water quality parameters of Swali River with time in the presence of various concentrations of PDC

4.0 Conclusion

The present study was conducted to evaluate the capacity of PDC to modify the pH, conductivity, hardness, turbidity, alkalinity and temperature of soluble contaminants from Ox-Bow, Swalli and Otuoke Rivers (in Bayelsa state) through the process of coagulation. The results and findings of the study lead to the following conclusions,

(i) PDC tends to withdraw active soluble material in water samples from the three Rivers.

(ii) The response of the various water samples toward the addition of PDC seems to be similar

(iii) At room temperature, the conductivity, alkalinity, turbidity, alkalinity and pH of the water are lowered by the presence of PDC but at higher temperatures, only the conductivity and pH were observed to increase while the other variables were significantly reduced more than the performance at a lower temperature.

(iv) An increase in the dosages of PDC enhances the reduction in the tested variables

(v) The optimum conditions that mark the performance of the PDC as coagulants, based on the tested variables are high temperature and higher dosages of the PDC.

5.0 References

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Consent for publication

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Both authors contributed to the work Dr. Rchard Ukpe collected the water samples while Dr. Ukpe and Dr. Udo carried out the analysis, and interpretation and report the work for publication.