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The methodological analysis of sediment phosphate research on the coast of Indonesia: a short review

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ABSTRACT

The Atomic Absorption Spectrophotometer method (AAS) and UV-Vis Spectrophotometer method are often used in analyzing elements and compounds in water and sediment. The comparative method of AAS and UV-Vis analysis in sediments in this article is studied to see the accuracy of the equipment used and the efficiency of the resulting analysis. Analysis of the comparative method of phosphate analysis in coastal sediments shows differences and similarities in the use of the two instruments used even though the methods used based on the results of the review do not show significant differences. Methodologically, various types of methods can be carried out to analyze coastal sediment phosphates. The UV-Vis spectrophotometric method is generally more widely used than the AAS method. For a small number of sediment samples, the ASS method is more efficient than the UV-Vis method; however, UV-Vis is more accurate for dissolved samples because less phosphate is released when identified than the AAS method. Based on this, the AAS method is more effective in analyzing phosphate sediments in coastal areas than the UV-Vis method, but the UV-Vis method for wet samples is more accurate.

Introduction

Nitrates and phosphates and other organic elements are needed nutrients and influence the growth and development of living organisms in the waters (Arizuna *et al.*, 2014). Nutrient enrichment in the aquatic environment has both positive and negative impacts. The positive impact is to increase the production of phytoplankton due to the increase in the concentration of nitrate and phosphate, while the negative impact is that it can reduce the dissolved oxygen content in the waters and increase the potential for the emergence and development of harmful phytoplankton types (Risamasu and Prayitno, 2011).

Coastal areas and river estuaries are waters that allow fresh water and seawater to mix through runoff, tidal canals, and estuaries (Roswaty *et al.*, 2014). In this area, the organic matter affects the sedimentation content and causes the continuous movement of organic material transport. In this environment, sediment is dynamic because the sediment will experience erosion, transportation, and deposition to affect the physical condition of the surrounding environment. This situation indirectly makes this area a place for river and sea nutrient traps (Rizal *et al.*, 2017).

Furthermore, increased human activities in coastal areas will also trigger an increase in the amount of organic matter entering the waters in sediment (Arizuna *et al.*, 2014). The bottom and suspended sediment contains major and minor O_2, CO_2, N_2, H_2, CH_4, and P elements (Golterman, 2004; Campbell and Reece, 2012). Therefore, it is necessary to consider the best method to analyze the content of phosphate and other organic matters in the sediment. For this reason, a comparison of methods for

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analyzing phosphate, especially in sediments in coastal areas, will help in terms of efficiency, both in terms of time and costs.

The increasing activity on the coast gives researchers room to look at accurate and effective methods for analyzing phosphate in coastal sediments (Rubinos *et al*., 2011; Stockdale *et al*., 2010; Lourino-Cabana *et al*., 2014). Methodologically, various methods can be carried out on phosphate analysis of coastal sediments. Therefore, the amount of phosphate in the sediment must be determined by an appropriate method. Several phosphate test methods on sediments include; Bray and Kurtz, Olsen method, an ascorbic acid method using UV-Vis spectrophotometer, and the Spectrophotometry method (Menon, 2012; Ilahi, 2011; Rohman, 2014).

The comparative method of phosphate analysis can affect the study results indirectly on aquatic ecosystems, both freshwaters and sea waters (Vizza *et al*., 2017; Maltby *et al*., 2018). Reviews comparing sedimentary phosphate methods in coastal areas are still very limited.

The comparative method of phosphate analysis in sediment aims to see the accuracy and effectiveness of the results obtained from each tested method. Analysis of this comparative method will show the accuracy and efficiency of the analysis results obtained. Furthermore, the comparison of phosphate analysis methods in sediments presented here is based on the results that have been studied by several researchers to see the phosphate content in sediments using two methods, namely the Atomic Absorption Spectrophotometer Method (AAS) and the UV-Vis Spectrophotometer Method (Chazottes *et al*., 2018; Giniestra *et al*., 2011). Therefore, this paper aims to find the best method for analyzing coastal phosphates. In this paper, we review two methods, namely: the atomic absorption spectrophotometer (AAS) method and the UV-Vis spectrophotometer method.

AAS Method

AAS is a tool used in analytical methods to determine metallic elements and metalloids whose measurements are based on light absorption with a specific wavelength by metal atoms in a free state (Skoog *et al*., 2000). This method is very appropriate for the analysis of substances at low concentrations. This technique has several advantages over conventional emission spectroscopy methods.

Apart from the atomic absorption method, elements with low excitation energy can also be analyzed by flame photometry, but flame photometry is not suitable for elements with high excitation energy. Flame photometry has an optimum measuring range at a 400-800 nm wavelength, while AAS has an optimum measuring range at a wavelength of 200-300 nm (Skoog *et al*., 2000). The flame photometric method is preferred over AAS for qualitative analysis because AAS requires a specific cathode lamp (hallow cathode). Automated chemonochrome in AAS is the main requirement. A change in flame temperature will disrupt the excitation process so that the analysis of the flame photometry is filtered. It can be said that the flame photometric method and AAS complement each other.

The spectrophotometer method has advantages and disadvantages in analyzing phosphate sediments in coastal areas. The advantages of atomic absorption spectrophotometry are the speed of analysis; it can be used to determine the concentration of all elements at trace concentrations (accuracy to trace levels); and it is not necessary to separate the specified elements as it is possible to determine one element in the presence of another element provided (Karil *et al*., 2015). The disadvantages of atomic absorption spectrophotometry are that it is less sensitive for measuring non-metallic samples. The presence of interferences are events that cause the absorption reading of the element being analyzed to be smaller or more significant than the value corresponding to its concentration in the sample (Khopkar, 2012).

Based on Khopkar (2012), the disturbances that can occur in the spectrophotometer are as follows:

1. Disturbance originating from the sample matrix can affect the number of samples reaching the flame due.
2. Chemical disturbances can affect the number of atoms in the flame due to the incomplete dissociation of compounds and the ionization of atoms in the flame.
3. Disturbance by absorption is caused not by the atom's absorption being analyzed, i.e., absorption by undissociated molecules in the flame.
4. Interference by non-atomic absorption.

Beside Based on Khopkar (2012), research on sediments phosphate using the spectrophotometer method has been carried out by various researchers, including; Amelia *et al.* (2014), Putri *et al.* (2019), and Patty (2015), and all of the found similar result for high efficiency with a small number of samples but easily to interfere with the environment.

UV-Vis Spectrophotometer Method

A spectrophotometer is a tool to measure the transmittance or absorbance as a function of wavelength. The spectrophotometer combines optical and electrical equipment and physical-chemical properties consisting of a spectrometer and photometer. A spectrometer produces light from a spectrum with a particular wavelength, and a photometer is a device for measuring the intensity of light transmitted or absorbed. Spectrophotometers are used to measure the relative energy of light when it is transmitted, reflected, or emitted as a function of wavelength.

Uv-Vis spectrophotometer is a spectrophotometer used to measure the ultraviolet and visible regions. The UV-Vis (Ultra Violet-Visible) spectrophotometer is one of the many instruments commonly used in analyzing a chemical compound. Spectrophotometers are commonly used because of their ability to analyze a wide range of chemical compounds and their practicality in sample preparation compared to several analytical methods. UV-Vis spectrophotometry involves a large amount of electronic energy during analysis, so UV-Vis spectrophotometers are more widely used for quantitative analysis than qualitative.

UV-vis spectrophotometry measures light absorption in the ultraviolet (200-350 nm) and visible (350-800 nm) regions by a compound. The absorption of UV or visible light causes an electronic transition, i.e., the promotion of electrons from a lower energy ground state orbital to a higher energy excited state orbital. Where the detector can measure the intensity of the light emitted indirectly by the absorbed light. Each medium will absorb light at a specific wavelength depending on the compound or color formed. The UV-Vis spectrophotometer method has advantages and disadvantages in analyzing phosphate sediments in coastal areas.

The advantages include: the wavelength of white light can be more selected; can analyze solutions with minimal concentrations. Disadvantages of this method are: absorption is affected by the pH of the solution, temperature and the presence of interfering substances, and the cleanliness of the cuvette; it can only be used in the Ultraviolet region with a wavelength of 185 nm; use only on functional groups containing valence electrons with low excitation energy; The light used must be monochromatic.

Research on the analysis of phosphate in sediments using the UV-Vis spectrophotometer method has been carried out by various researchers, including; Kurnianda and Heriantoni (2017), Simon and Nebuchadnezzar (2019), Patty *et al.* (2015). The results show that in large and large samples, UV-vis instruments do not cause interference with the environment but are not as efficient as the use of the AAS method. However, these two methods (UV-Vis and AAS) have the same accuracy if the sample does not interfere with the surrounding environment.

Comparison of Results

Comparative studies of phosphate research methodologies in sediments have been widely published. Phosphate research was conducted by Putri *et al.* (2019) on the coast of Banyuasin using an ascorbic acid spectrophotometer method (SNI 06-6989.31-2005). The working principle of this method is the formation of a blue-colored phosphomolybdate complex, which is then reduced with ascorbic acid to form a blue Molybdenum complex. The intensity of the resulting color is proportional to the concentration of phosphorus. The resulting blue color was measured by a spectrophotometer at a wavelength of 700nm-880nm. The results showed that the phosphate concentration was 0.011-0.231 mg/L.

Another study was also conducted by Patty (2015) in the waters of North Sulawesi by looking at the characteristics of dissolved phosphate. Phosphate levels were analyzed using the spectrophotometric method using the 'Nicolet Evolution 100' spectrophotometer as described in APHA, AWWA, WEF (2005), and the value was expressed in mg/l. The results showed that the phosphate levels in the surface layer ranged from 0.005-0.011 mg/l, with an average of 0.008±0.002 mg/l.

The distribution of phosphate in Morodemak waters has been studied by Amelia *et al.* (2014) using the Atomic Absorption Spectrophotometry method. Phosphate content was obtained due to phosphate content in the sediment of the Tuntang Morodemak river estuary with a range of 0.06–7.13 mg/gr. Differences in methods Putri *et al.* (2019), Patty (2015), and Amelia *et al.* (2014) lie only in its ascorbic acid. The ascorbic acid spectrophotometer method is more effective in measuring phosphate content in coastal areas.

The Uv-Vis Spectrophotometry method has been studied in Gapang, Sabang, which was researched by Kurnianda and Heriantoni (2017). The results obtained were based on the UV-Vis spectroscopy method. These are: the phosphate content on the coast of Gapang ranges from 64 - 51 g/L. In addition, other studies have also been carried out by Simon and Nebuchadnezzar (2019) in the Bolaang Mongodow Coast, North Sulawesi, using the UV-Vis Shimadzu 1700 spectroscopy method and classified as usual and good for marine life.

Research using sediment phosphate analysis based on the Shimadzu f1700 UV-VIS spectrophotometer method was carried out by Patty *et al.* (2015) on the

Jikumerasa Coast, Buru Island. The method results showed that the phosphate levels ranged from 0.005-0.012 mg/l. The sediment phosphate level on the Jiku coast is considered normal for the fertility of waters and is still suitable for the life of various organisms.

With the comparison of methods, we can see the differences in methods for analyzing phosphate on the coast to use the best method among other methods. The Uv-Vis spectrophotometry method is generally more widely used than the atomic absorption spectrophotometry method. This is because less phosphate is released when identified than using the atomic absorption spectrophotometer method. The best method is an extract that can extract sediment phosphate in coastal areas or is closest to the P absorbed by sediment (Ilahi, 2011). Based on this, the Uv-Vis Spectrophotometry method is the best for analyzing phosphate sediments in coastal areas than using the atomic absorption spectrophotometer method. These two methods can be used as a benchmark for comparing methods based on sediment differences.

Spectrophotometric methods are usually less sensitive than AAS methods, accommodating concentrations of a few nanomoles per milliliter. However, its range of applications is much more comprehensive, including inorganic elements and organic compounds, because UV-visible absorption has more universal properties than fluorescence and AAS. Generally, UV-Vis is used to see the reaction products directly, although it can also be used to see organic compounds.

Conclusion

The method of comparison of phosphate analysis in sediment between the use of AAS and UV-Vis instruments is more likely to have differences, especially with the objectives to be achieved from the analysis results. Both instruments have their respective advantages and disadvantages; however, the AAS instrument has more accuracy and is more widely used in viewing organic content, especially in sediments. However, the determination of the amount of phosphate in the sediment is highly dependent on the purpose of the study and how the sample is treated. Several studies stated that the Uv-Vis spectrophotometry method was better for analyzing phosphate sediments in coastal areas than the Atomic Absorption Spectrophotometer method. This statement is based on less phosphate being released when identified than using the atomic absorption spectrophotometer method. Even so, for small samples, AAS is better than UV-Vis.

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