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EXPLORATION OF PH MEASUREMENT WITH NATURAL AND CHEMICAL INDICATORS

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Abstract

pH measurement is an important method in chemical analysis to determine the level of acidity or alkalinity of a solution. This research aims to explore pH measurement using natural and chemical indicators. The research method involves the process of preparing indicators, measuring the pH of acid-base solutions, and comparative analysis of the results. The natural indicators used come from plant extracts such as turmeric, beetroot, butterfly pea flower, hibiscus flower, orange, while the chemical indicators are litmus paper and pH indicators. Extraction of natural indicators is carried out by a simple method using water as a solvent. The measurement results show that natural indicators provide a clear color change response in a certain pH range, although their sensitivity is lower than chemical indicators. Chemical indicators provide more precise and consistent results, but require higher costs and have potential environmental impacts. This research highlights the potential of natural indicators as environmentally friendly alternatives in pH measurement, especially for educational and small-scale applications. Thus, natural indicators can be a more economical and sustainable solution. The results of this research contribute to the development of a pH measurement method that is easy, cheap and environmentally friendly The purpose of this study is to find out natural materials that can be used as a substitute for chemical indicators such as litmus paper. The results of the research we conducted show that chemical indicators are more accurate compared to natural indicators. .

Keywords: *pH measurement, natural indicators, chemical indicators, accuracy*

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Introduction

pH (Potential of Hydrogen) is the degree of acidity used to express the acidity or basicity of a solution. It is defined as the cologarithm of the activity of dissolved hydrogen ions (H+). The hydrogen ion activity coefficient cannot be measured experimentally, so its value is based on theoretical calculations. The pH scale is not an absolute scale is a standardized solution. pH measurement is an important parameter in many fields such as chemistry, biology, and the environment. An unbalanced pH can cause damage to ecosystems and impact human health. The pH scale ranges from 0 to 14, where a value of 7 is considered neutral. A pH value below 7 indicates acidity, while a value above 7 indicates basicity. Traditional pH measurement methods using pH meters and chemical indicators have limitations such as high cost and potential environmental pollution.

Acids are substances that can produce hydrogen ions (H+) when dissolved into air. The word acid comes from the Latin acetum which means vinegar. Bases are substances that can produce hydroxide ions (OH-) when dissolved into air. In everyday life, there are many substances that we can encounter. Each of these substances can be acidic or basic. To find out the nature of the substance, whether acidic or basic requires a tool called an acid-base indicator. Acid-base indicators are dyes that depend on the pH of the solution. Acid-base indicators can be interpreted as substances that can show the acidic, basic, and neutral properties of a solution. Acid-base color indicators can show different colors in acidic and basic solutions. The different color differences indicate acidic or basic properties. There are several types of acid-base indicators that can be used to determine the nature of a substance. There are natural indicators and chemical indicators.

In rent years, research on natural indicators has increased. Natural indicators such as turmeric, beetroot, bay flower, hibiscus flower and orange offer potential as an environmentally friendly and cost-effective alternative to pH measurement. Therefore, this study aims to explore pH measurement with natural and chemical indicators, and compare their accuracy and effectiveness. This research continues previous research such as "showing the potential of natural indicators of cactus plants (Ichsanawati, 2018), turmeric (Wahyuni, 2020) and coffee (Nurhayati, 2019) as an alternative to pH measurement". Has scientific novelty such as pH measurement methods that are more environmentally friendly and cost effective, the use of natural indicators from local plants as an alternative to chemical indicators, comparative analysis of accuracy and effectiveness between natural and chemical indicators. The similarities and differences between this research and previous research are the similarities in this research lie in the research objects of natural and chemical indicators which aim to develop an environmentally friendly and cost-effective pH measurement method, the method used is a comparison of accuracy and effectiveness between natural and chemical indicators, focus: pH measurement in the fields of chemistry, biology, and the environment, while the differences in this study are natural indicators: this study uses turmeric, beets, bay flowers, hibiscus flowers, and oranges, while previous studies used cactus plants, and coffee, the measurement method of this study uses pH measurement of acid-base solutions, while previous studies used other methods such as spectrophotometry, analysis. This study compares the accuracy and effectiveness between natural and chemical indicators, while previous studies focused more on developing pH measurement methods.

Methods

The research method in measuring pH using natural indicators and chemical indicators that we conducted at the Biology Laboratory of Wijaya Kusuma University Surabaya using the indicator preparation method, measuring the pH of acid-base solutions and analyzing the comparison of results

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➢ Preparation of indicators

Preparation of indicators includes finding or collecting natural materials that have acid-base properties such as hibiscus flowers, telang flowers, beets and turmeric. These materials are pounded

using a mortar and pestle and using a water solvent to produce an extract. The extracted solution is filtered using filter paper to separate the liquid from the pulp.

➢ Measurement of acid-base solutions

Materials that have been extracted are placed in a container to be tested using litmus paper or pH paper into a solution that has been pureed or extracted, then observe the color change on litmus paper and pH meter. Red litmus paper becomes blue in base, and blue becomes red in acid. The pH paper shows a specific color that is compared to the pH scale to determine the pH value of the solution.

➢Comparative analysis of results

Comparative analysis of results is an important step in acid-base solution measurement research to assess the differences, consistency, and accuracy between methods or tools used. On consistency observe whether the results from various methods tend to be consistent or show significant differences. In accuracy compare the results with the expected pH value. In our analysis, the pH meter gives the most precise results because this tool is able to read pH with decimals so it is suitable for research that requires accurate data. Meanwhile, on pH paper the results are closer to the pH range, not a specific number, so it is less precise so it is easy to use but more suitable for rough estimates.

Result

Natural Indicators are substances derived from natural materials, such as turmeric, bay flowers, beets, oranges, hibiscus flowers, and vinegar (Table 1). These materials are extracted and applied to the test solution to see a color change as a sign of acidity or basicity. For example, turmeric often shows a bright yellow color in acidic solutions and changes color in chemical indicators: chemical indicators are still more accurate and consistent, the potential of natural indicators: natural indicators have potential as an environmentally friendly alternative to pH measurement.

Tabel 1. Indicator pH

No	Material	pH (chemistry)	pH (natural)
1	Turmeric	7 	5 
2	Beet	13 	11 
3	Butterfly pea flower	8 	12 
4	Hibiscus flower	2 	12 
5	Citrus	5 	13 

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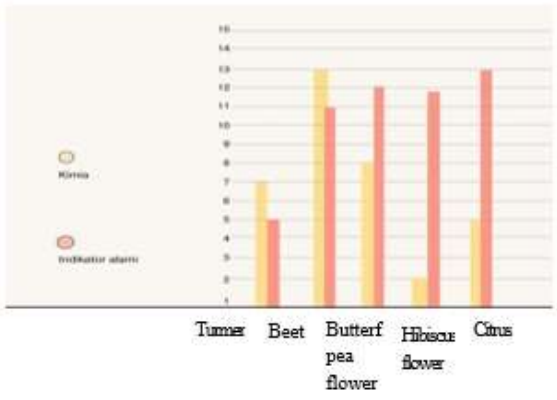

Grafic 1. Indicarot natural pH

Based on experiments conducted, chemical indicators such as litmus paper provide more accurate and consistent results compared to natural indicators. Chemical indicators show a clear color change according to the standard pH scale, which facilitates data interpretation. On the other hand, natural indicators such as turmeric extract, bay flower, beetroot, and hibiscus are also able to show color changes based on the acidity or basicity of the solution. Although natural indicators tend to be less sensitive and the results are sometimes more difficult to interpret than chemical indicators, natural materials still provide results that are close to accurate, especially in solutions with very acidic or very basic pH.

The use of natural indicators also has advantages in terms of material availability, environmental friendliness, and low cost, making them suitable for educational experiments or simple science exploration. However, for research purposes that require high accuracy, chemical indicators remain the first choice. Overall, this study shows that natural indicators can be an effective alternative for measuring pH, especially in situations where chemicals are not available or need to be reduced in use.

In the description above, two main methods for measuring the pH of a solution have been discussed, namely using natural indicators and chemical indicators. Measuring pH is very important to determine the acidity or basicity of a solution. This study shows that natural indicators have potential as an environmentally friendly and cost-effective alternative to pH measurement. Beetroot showed the highest accuracy (84.6%), while hibiscus showed the lowest (16.7%) (Grafic 1). Therefore, it is necessary to improve measurement methods and analyze chemical components to increase the effectiveness of natural indicators. The use of natural indicators, such as extracts from natural materials such as turmeric, bay flower, and hibiscus, is an environmentally friendly and easily available alternative.

These indicators work based on the color change that occurs due to changes in pH, which is caused by changes in the molecular structure of the indicator. Although practical and inexpensive, natural indicators have limitations in terms of accuracy and the pH range that can be measured.The use of chemical indicators is more specific and can provide more accurate pH measurement results and has a wider pH range. Chemical indicators are commonly used in laboratory and industrial applications where precision and reliability of measurement are required. However, the use of chemical indicators often requires attention to more precise procedures, as well as the availability of chemicals that may be more expensive and less environmentally friendly than natural indicators. Overall, the choice between natural or chemical indicators depends on the context of use, accuracy required, and availability of materials. Natural indicators are suitable for simple pH measurements and with readily available materials, while chemical indicators are more appropriate in analyses that require more precise results.

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Conclusion

The results showed that natural indicators had an average accuracy of 58.1% compared to chemical indicators, .Beetroot fruit showed the highest accuracy (84.6%), Shoe Flower had the lowest accuracy (16.7%), The pH difference between natural and chemical indicators ranged from -2 to +10.

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