The Acceptability of Bignay *(*Antidesma Bunius*)* Fruit Extract as an Organic-Based pH Indicator

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ABSTRACT

Nowadays, experts are actively seeking ways to become more eco-friendly in response to the pressing environmental challenges. Similarly, educational institutions are encouraged to implement sustainable practices by promoting the use of environmentally safe materials in scientific activities. The goal of this study was to assess the acceptability of Bignay pH indicator as an alternative to synthetic pH indicators in school laboratories. To achieve this, the study employed an *Explanatory Sequential Research Design*, which combines both Experimental and Descriptive approaches. To obtain the necessary data, the researchers conducted controlled experiments, in-depth interviews with Professional Chemistry Teachers using structured survey questionnaires along with live demonstrations, and the product underwent a phytochemical laboratory test by DOST. Upon analyzing the results, it was revealed that Bignay extract showed potential as a natural pH indicator. This claim was strengthened by the DOST phytochemical test; the test report revealed that Bignay fruit extract pH indicator contained significant constituents such as *Sterols, Triterpenes, Flavonoids, Alkaloids, Glycosides, and Tannins,* which were known to have color-changing properties in response to varying pH levels. Hence, the extract proved to be suitable for use as a natural pH indicator. Moreover, the acceptability phase garnered a mean of *>3.50* for parameters such as Color, Odor, and Accuracy, which unveiled that the Bignay pH indicator was an acceptable alternative to synthetic indicators used in schools its sharp color transitions ranging from *pink, green, blue, and yellow,* its subtle odor, and its accuracy in determining the pH level of substances. In addition, the shelf life extended up to sixty (60) days making it appropriate for use in laboratory activities. To obtain more accurate results, the researchers recommend the use of fully ripened (violet-colored) Bignay *(Antidesma bunius)* fruits.

Keywords: Bignay, Acceptability, pH indicator, Phytochemical, Shelf life

INTRODUCTION

Background of the Study

Accurately measuring a substance's pH level plays an essential part in various fields like education, research, agriculture, and industry. Looking back to the traditional use of synthetic indicators; this kind of material is usually used in laboratories. The commonly used indicators in the market to test the acidity and basicity of a solution are synthetic; in organically made, ex. Phenolphthalein.

While these truly contribute to various fields, it also has its drawbacks. There are clear problems in utilizing a synthetic indicator, including a potential health hazard, a contributor to environmental pollution, and even its availability and cost in the market (Pawar, et.al., 2024).

With these reasons, as the world looks forward to being more sustainable, this urged the researcher to look outside the box and craft an eco-friendly alternative to synthetic indicators, which led to a potential organic pH indicator made from organic materials like fruit and plant extracts that are readily available in the locale. The researchers ended up choosing Bignay (*Antidesma bunius)* as it checks all the ingredients for a potential pH

indicator, especially its active component, Anthocyanin, a water-soluble pigment found in fruits, vegetables, and flowers, a component for developing organic pH indicators.

The fruit locally known as Bignay, scientifically known as *Antidesma bunius*, is an indigenous fruit-bearing tree mainly found in Southeast Asia. Bignay contains a lot of components that can help researchers in using it as an active ingredient in making a pH indicator. It includes phenolics, flavonoids, and anthocyanin that react in acidic or basic solutions (Carbonera., et.al. 2024).

Moreover, its pigment component, Anthocyanin, can react through acidic and basic solutions. Researchers aim to produce an organic pH indicator utilizing the extract of *Bignay* as an active ingredient in making an alternative phenolphthalein, for a low cost and environmentally friendly type of indicator showing accurate and reliable results.

This study investigates the potential of Bignay extract as a pH indicator by evaluating its responses across various pH levels, specifically, its color shifts. The findings of this research could contribute to the development of more sustainable laboratory practices and will promote the use of local resources in doing scientific studies.

Objectives of the Study

The general objective of this study was to determine the acceptability of Bignay (*Antidesma bunius*) fruit extract as Organic-Based pH indicator; in accordance with this, the study sought to accomplish the following specific objectives:

1. Indicate the capability of Bignay fruit extract as an organic pH indicator

2. Assess the acceptability of Bignay fruit extract as active component in indicating the acidity and basicity of solution in terms of:

2.1. Concentration of Bignay fruit extract to alcohol

2.2. Color changes

2.3. Shelf life

Assess the acceptability of Bignay pH indicator as compared to Phenolphthalein in terms of:

4.1. Color

4.2. Odor

4.3. Accuracy

Significance of the Study

In this section, the findings and outcomes of this study are intended to assist the following:

Practice. This study guided teachers, students, and lab users in using Bignay extract as a substitute for chemical pH indicators. It offered a low-cost, eco-friendly option that lessened reliance on synthetic chemicals.

Policy. The results encouraged schools to use natural resources in their labs, helping support eco-friendly practices.

Theory. This research added to the study of using plant pigments like anthocyanins as natural pH indicators and supported further studies on plant-based options.

Social Action. This study may serve as a valuable source of data for further study.

Scope and Limitations

The study focuses on the acceptability of Bignay (*Antidesma bunius*) fruit extract as an organic-based pH indicator. Fully matured red Bignay fruits were analyzed for their total phytochemical content, specifically flavonoids and free radical scavenging antioxidants, focusing on the extract's ability to exhibit.

The study examined the acceptability of the Bignay pH indicator as a good replacement to various synthetic indicators used at schools, considering factors such as its colorimetric response, odor, and accuracy to evaluate the extract's effectiveness and reliability. This study was conducted at Brgy. Bubukal, Sta Cruz, Laguna during the first semester September to December 2024.

Additionally, the product of this study underwent DOST Phytochemical testing to further support the study.

Definition of Terms

To provide a clearer understanding of the study, the following terms were conceptually and operationally defined.

Accuracy- The Bignay pH indicator's ability to provide consistent and accurate measurement of pH.

Bignay Fruit - It is used as active ingredient for a natural pH indicator

Color Change- The visible color change of the Bignay extract solution in response to different pH levels.

Concentration - The ratio of Bignay extract to alcohol in the solution.

Organic pH Indicator- Natural substance, such as Bignay extract, used to identify pH levels.

pH Indicator - Unit of measurement that was used to determine the concentration of hydrogen ions in a solution.

Shelf- life - Duration of the Bignay extract solution effective as a pH indicator.

RESEARCH METHODOLOGY

This chapter outlined research methods that are used in the study, including the research design, respondents, sampling technique, research instruments, research procedures, statistical treatment data and the experimental procedures such as extraction of bignay fruit and observe the acceptability of bignay fruit extract as active component for alternative pH indicator.

Research Design

The study utilized an Explanatory Sequential Research Design, which combines both Experimental and Descriptive approaches. The experimental phase specifically employed a pre-experimental design, as this phase primarily aimed to test the Bignay pH indicator with acidic and basic substances. Additionally, this phase involved the formulation and testing of the Bignay pH indicator based on parameters such as color, odor, and shelf life. Meanwhile, the descriptive phase used a survey questionnaire administered to professional chemistry teachers. This made it possible to evaluate the acceptability of the Bignay pH indicator as an alternative to synthetic indicators used at schools in terms of color, odor, and accuracy.

Population of the Study

The participants of this study consisted of professional chemistry teachers, who were chosen because they possess necessary knowledge and expertise to evaluate the acceptability of Bignay pH indicator as an alternative to synthetic pH indicators used at schools. Through purposive sampling, the researchers selected 15 teachers who have at least two years of experience in handling chemistry classes to make sure their feedback is grounded on their professional teaching experience.

Instrument

Primarily, the main instrument for this study is the Bignay pH Indicator, which was developed from the Bignay *(Antidesma bunius)* fruit extract. For the experimental phase, the materials used included 70% ethyl alcohol, a beaker, a graduated cylinder, a glass rod, filtering gauze, an amber bottle, a clean cheesecloth, a thermometer, a steamer, glass vials, a digital pH meter, phenolphthalein, acidic and basic solutions, droppers, vial rack, and a wash bottle. These were sterilized, laboratory-grade materials to ensure the reliability of the output.

In the descriptive phase, the researchers utilized structured survey questionnaires, with a four-point Likert scale, ranging from 1 (Strongly Disagree) to 4 (Strongly Agree). The questionnaire was divided into three sections:

Color Section:

In this section, the participants were asked to rate the color change of the Bignay pH indicator when it was added to acidic and basic solutions, as color is an essential factor for users to easily identify the pH of a solution.

Odor Section:

While odor is not usually a major concern for pH indicators, this section checked if Bignay pH indicator has any noticeable smell. Respondents rate whether the odor was strong, pleasant, or unpleasant and if it affects the odor of substances when added.

Accuracy Section:

In this section, respondents evaluated how accurately the Bignay pH Indicator detects pH changes. Participants were asked if the color change happens at the right pH levels and whether it matches the expected results based on the developed scale.

These sections focused on the key features that make Bignay pH indicator acceptable as a good replacement for synthetic pH indicator used at schools.

Procedures

The study followed the Explanatory Sequential Research Design consisting of experimental and descriptive phases.

Experimental Phase

Bignay fruit extraction

- Rinse the bignay fruit using tap water to remove dirt and impurities, they dry.
- Crush the bignay fruit using mortar and pestle to release its extract.
- Filter the extract using a fine strainer to remove any residues.

Making the solution

- Pour 200ml of 70% of ethyl alcohol into a clean beaker, then, place the beaker into a steamer heat the alcohol
- Once the alcohol has reached 50 degrees Celsius, remove the alcohol from the steamer.
- Prepare 100ml bignay fruit extract into another beaker.
- Pour the heated alcohol into the bignay fruit extract and stir continuously for five minutes using a stirring rod.

- Once cooled, transfer the solution into an amber glass container using a funnel. Then, seal the container tightly.

Testing the solution

Concentration Test

Different Bignay-to-alcohol ratios were prepared to determine the optimal mixture. The solutions were evaluated for color clarity and reaction efficiency, and the ratio producing the best results was selected.

Color Test

The indicator was added to solutions with varying pH levels, and the resulting color changes were observed and recorded to develop a pH color scale.

Odor Test

The indicator was added to acidic and basic solutions to identify any changes in scent caused by chemical reactions**.**

Shelf-life Test

The stability of the Bignay pH Indicator over time was assessed by storing the prepared indicator in clear glass bottles under controlled conditions.

Descriptive Phase

The researchers conducted a survey, alongside live demonstrations, utilizing the pH indicator to obtain evaluation from professional chemistry teachers.

Phytochemical Test

Lastly, the Bignay pH indicator underwent a DOST Phytochemical testing that aims to determine its chemical components that contributed to its color changing property.

Data Gathering

Proceeding to the second part of the study, the data gathering, the researchers collected essential information to address the research questions. The following methodologies were employed:

Serial Dilution

This method involved preparing a series of solutions with varying concentrations and systematically testing their effectiveness. It was used to determine which ratio of Bignay fruit extract to alcohol produced the most distinct and stable color changes when mixed with acidic and basic substances.

Color Test

The color test for a pH indicator involved observing the color change when the indicator was added to solutions with varying pH levels. Moreover, the researchers used this method to identify the color changes of substances when the Bignay pH Indicator was added and developed a color scale that helped indicate the pH level of substances.

Odor Test

This test was used to identify any changes in scent that occurred due to chemical reactions when the Bignay pH Indicator was added to acidic and basic substances. For instance, some indicators emitted a faint smell depending on the substances used in the formulation. Moreover, the researchers used this test to identify any changes to the odor of substances when the Bignay pH Indicator was added.

Shelf-Life Test

The shelf-life test assessed the stability of the pH indicator over time under controlled storage conditions. It examined possible changes in performance, such as the range and intensity of color transitions and the odor of the solution. Through this test, the researchers determined the duration for which the indicator remained effective before requiring replacement.

Bignay Ph Indicator Acceptability Survey

To evaluate the acceptability of the Bignay *(Antidesma bunius)* extract as a natural pH indicator, the researchers conducted a survey to the selected science teachers. The survey aimed to gather feedback on the effectiveness, practicality, and overall acceptability of the Bignay indicator compared to synthetic indicators used at schools. This approach enabled the researchers to understand participants' perceptions regarding the acceptability of the Bignay pH indicator.

After completing the necessary data, the researchers proceed with analyzing the gathered data and formulate the conclusion and recommendations.

Statistical Treatment of Data

In order to address the problem of this research the data underwent the following analysis and statistical treatment. The simple descriptive method was used, including mean, percentage, and weighted mean, to determine the acceptability of Bignay (Antidesma bunius) fruit extract as an Organic based pH indicator.

Formulas:

Mean

Where:

x̄ - Mean

Σx - Sum of all values

N - Total number of values

$$\overline{X} = \frac{\sum X}{N}$$

Standard Deviation

Where:

σ = population standard deviation

N = the size of the population

Xi = each value of the population

μ = the population mean

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}$$

Weighted Mean

Where:

W - Weighted Average

wi - Data applied to x values

n - Number of items to be averaged

Xi - Data values to be average

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

Presentation, Analysis, And Interpretation Of Data

This chapter presents the results obtained from the experiments conducted by the researchers and data gathered from participants.

The data collected from various testing methods conducted by the group are undertaken in consideration of the objectives of this study, including color change observations and comparative analysis with traditional and synthetic indicators; odor: odor of the Bignay pH indicator and odor of the substances mixed with the Bignay pH indicator; shelf life: assessing the appearance of in a span of two months and evaluating the color change when mixed with acidic and basic substances.

Furthermore, this chapter also includes the presentation of statistical data from the participants of this study, which will unveil any observed challenges, limitations, and the overall acceptability of Bignay fruit extract as an organic-based pH indicator.

Table 1: Color reaction of Bignay pH indicator to substances with two different ratios.

This table aimed to display the results of the concentration test of bignay-to-alcohol ratio to various acidic and basic substances. Different ratios were prepared and examined for color clarity and reaction effectiveness.

SUBSTANCES	1:2	2:1
Acidic:	Color	Color
Muriatic Acid	Light Pink	Red
Oxalic Acid	Hot Pink	Dark Pink
Basic:		
Sodium Bicarbonate	Olive green	Dark green
Antacid	Blue	Brown
Bleach	Light Yellow	Clear

The analysis of the data presented in Table 1 reveals that the 1:2 ratio (1 Bignay: 2 alcohol) exhibits a clear and consistent color spectrum, ranging from light pink (indicating a strong acid) to hot pink (indicating a weak acid) and transitioning through green, blue, and yellow (indicating weak to strong bases).

Furthermore, both ratios demonstrated almost identical colorimetric scale; however, according to the study of Kang et al. (2020), distinct color changes upon reacting to acid-base solutions must be considered to acknowledge that the solution is potent.

Based on these findings, the 1:2 ratio was selected for its superior and more reliable results compared to the other ratio.

Color

Table 2: Comparison of Bignay pH Indicator to Litmus pH paper and Phenolphthalein

This table compared the Bignay pH indicator, litmus paper, and phenolphthalein in terms of color reaction, pH detection, and reaction speed across various substances.

		BIGNAY PH INDICATOR		LITMUS PAPER		PHENOLPHTHALEIN	
SUBSTANCES	**pH level**	**Color**	**Speed of Reaction**	**Color**	**Speed of Reaction**	**Color**	**Speed of Reaction**
Hydrochloric acid *(l)*	0-1	Light Pink	Fast	Red	Fast	Colorless	Fast
Oxalic acid *(l)*	1.3-2	Pale Pink	Fast	Red	Fast	Colorless	Fast
Citric acid *(l)*	2-3	Pink	Fast	Red	Fast	Colorless	Fast
Acetic acid *(l)*	2.4 -3	Pink	Fast	Red	Fast	Colorless	Fast
Lead Nitrate *(l)*	5-6	Hot Pink	Fast	Red	Fast	Colorless	Fast
Sodium Bicarbonate *(l)*	7-9	Olive Green	Slow	Blue	Fast	Pink	Fast
Antacid *(l)*	8-9	Blue	Slow	Blue	Fast	Pink	Fast
Bleach *(l)*	11-13	Light Yellow	Fast	Blue	Fast	Pink	Fast
Sodium Hydroxide *(l)*	13-14	Yellow	Fast	Blue	Fast	Pink	Fast

With this data, based on the study of Roy, S., & Rhim, J. W, (2021), shows that Bignay pH indicator showed a distinct array of colors representing different pH levels, as compared to conventional pH measuring instruments used in schools like Litmus paper and Phenolphthalein.

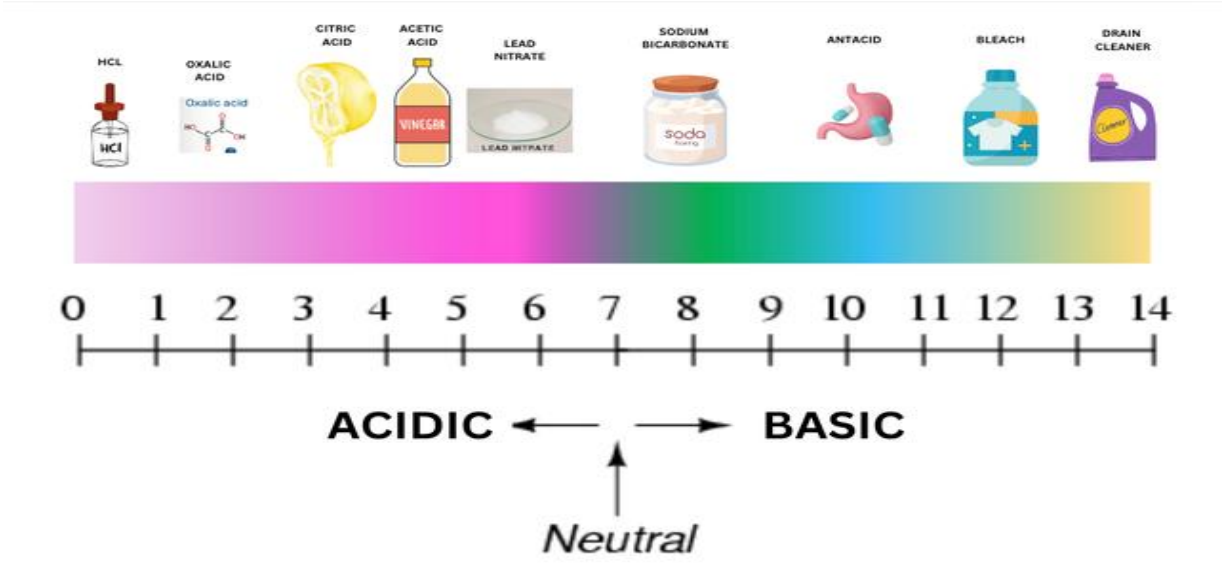


Figure 2: Developed Color scale of Bignay pH Indicator

Which showed a completely different color scale than of phenolphthalein: colorless to magenta (Ka et al., 2020), and blue and red for pH paper (Table 2).

Table 3: Comparison of color of the substances when mixed with Bignay pH Indicator

This table showed the colorimetric response of Bignay pH Indicator to various substances. Acids turned the indicator pink, lead nitrate turned it hot pink, bases turn it green/blue/yellow, and bleached turns it light yellow.

SUBSTANCES	COLOR	COLOR WHEN MIXED WITH BIGNAY PH INDICATOR
Hydrochloric acid (*l*)	Yellow	Light Pink
Oxalic acid (*l*)	Colorless	Pale Pink
Pale Pink	Colorless	Pink
Acetic acid (*l*)	Colorless	Pink
Lead Nitrate (s*)*	White	Hot Pink
Sodium Bicarbonate (*l*)	White	Olive Green
Antacid (s*)*	White/Pink	Blue
Bleach (*l*)	Colorless	Light Yellow
Sodium Hydroxide (*l*)	Colorless	Yellow

Overall, as anchored to study of Roy, S., & Rhim, J. W. (2021) the Bignay pH indicator displays a clear transition and distinct color range compared to litmus paper and phenolphthalein, as tested to the aforementioned substances.

Odor

Table 4: Comparison of Odor of the substances when mixed with Bignay pH Indicator

This table showed the changed in odor of various substances before and after being mixed with the Bignay pH indicator. The indicator added to both acidic and basic solutions to observed any scent variations resulting from chemical reactions.

SUBSTANCES	ODOR	ODOR WHEN MIXED WITH BIGNAY PH INDICATOR	ODOR WHEN MIXED WITH PHENOLPHTALEIN
Hydrochloric acid *(l)*	Unpleasant	Slightly Unpleasant	Unpleasant
Oxalic acid *(l)*	Odorless	Pleasant	Odorless
Citric acid *(l)*	Odorless	Pleasant	Odorless
Acetic acid *(l)*	Unpleasant	Slightly Unpleasant	Unpleasant
Lead Nitrate *(s)*	Unpleasant	Pleasant	Unpleasant
Sodium Bicarbonate *(s)*	Odorless	Pleasant	Odorless
Antacid *(s)*	Odorless	Pleasant	Odorless

Substances, especially acidic and basic substances, have their own distinct odor, varying from their intensity: odorless, mild, and strong, and scent: pleasant, slightly unpleasant, and unpleasant. This analysis aims to evaluate the odor of certain substances mixed with a Bignay pH indicator and phenolphthalein.

As per the researchers' odor analysis of acidic and basic substances mixed with the Bignay pH indicator and phenolphthalein, odorless substances turn slightly pleasant, and unpleasant substances turn slightly unpleasant.

Overall, the Bignay pH indicator is an altering factor to the odor of acid and basic substances.

Table 5: Color and Odor of Bignay pH Indicator over 60 days

This table presented the results of the shelf-life tested conducted on the Bignay pH indicator. Over a 60-days observation period, the indicator's color and odor are monitored to determine its stability under controlled storage conditions.

AGE	COLOR OF BIGNAY PH INDICATOR	ODOR OF BIGNAY PH INDICATOR
Day 1	Red	Pleasant
Day 10	Red	Pleasant
Day 20	Red	Pleasant
Day 30	Red	Pleasant
Day 40	Red	Pleasant
Day 50	Red	Pleasant
Day 60	Red	Pleasant

With this data, the researchers aim to analyze the physical properties of the Bignay pH Indicator over time. Physical properties like color and odor of the solution may influence its effectiveness over time. Additionally, the level of anthocyanin could be inferred based on the intensity of solution's, which is directly proportional to its shelf life (Xue, H., Zhao, J., et. al 2024).

Furthermore, this data shows that the Bignay pH Indicator remains the same from day 1 to day 60 *(Table 5).*

Table 6: Actual color of Bignay pH Indicator in Day 1, Day 30, and Day 60.

This table showed presented the observed color of the Bignay pH indicator over a seven-day period, specifically on days 1,30, and 60. This data provided insights into the indicator's stability and color retention over timed.

Day 1	Day 30	Day 60
		

Table 7: Color change of substances when mixed with Bignay pH Indicator over time

This table showed the color changed of various acidic and basic substances when mixed with the Bignay pH indicator over a 60-day period. The observations are recorded daily to assess the indicator's consistency and the stability of its reactions over timed.

AGE	**SUBSTANCES**								
	Hydro chloric acid *(l)*	**Oxalic acid *(l)***	**Citric acid *(l)***	**Acetic acid *(l)***	**Lead Nitrate *(s)***	**Sodium Bicarbonate *(s)***	**Antacid *(s)***	**Bleach *(l)***	**Sodium Hydroxide *(l)***
Day 1	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 10	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 20	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 30	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 40	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 50	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow
Day 60	Light Pink	Pale Pink	Pink	Pink	Hot Pink	Green	Blue	Light Yellow	Golden Yellow

In determining the Bignay pH Indicator effectiveness after several days of its creation, the table displays the color change of the solution over a week (Table 7). The consistent colorimetric result of the Bignay pH indicator upon mixing it with a variety of acidic and basic substances implies that the indicator is still usable (Xue, H., Zhao, J., et. al 2024).

Overall, this shows that after day 60, the Bignay pH Indicator is still as effective as it was in day 1.

Table 8: Actual photo of substances mixed with Bignay pH Indicator

These images presented the actual appearance of the substances after being mixed with the Bignay pH indicator on Day 1, Day 30, and Day 60. The photos document any visual changed over timed to supported the stability and consistency findings of the indicator.

Day 1	

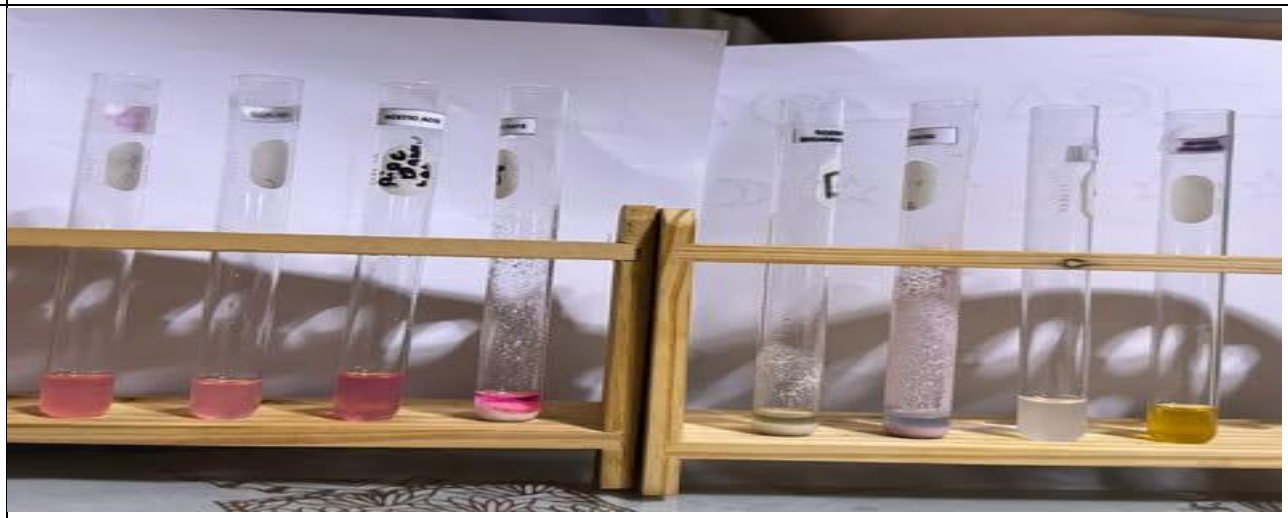
Day 30	
Day 60	

Table 9: Level of acceptability of Bignay pH Indicator as an alternative to Synthetic pH Indicator such as Phenolphthalein in terms of Color

This table presented the results of the Bignay pH indicator acceptability surveyed, which aimed to assess its effectiveness and practicality compared to synthetic indicators liked phenolphthalein. Respondents' ratings on color clarity.

QUESTIONS	MEAN	SD	VERBAL INTERPRETATION
The Bignay pH indicator produces a distinct color when mixed with acidic/basic solutions.	3.80	0.41	Strongly Agree
The color change of the Bignay pH indicator accurately reflects the pH of acidic/basic solutions.	3.80	0.41	Strongly Agree
The color transformation of Bignay pH Indicator, when exposed to acidic and basic substances, endures for a significant amount of time.	3.87	0.35	Strongly Agree
The Bignay pH indicator's color change is immediate when mixed with acidic/basic solutions.	3.53	0.52	Strongly Agree
The color intensity of the Bignay pH indicator matches that of phenolphthalein in acidic/basic solutions.	3.33	0.72	Strongly Agree

Legend: 0.00 – 0.99 = Strongly Disagree; 1.00 – 1.99 = Disagree; 2.00 – 2.99 = Agree; 3.00 – 4.00 = Strongly Agree

Table 9 shows the Level of acceptability of Bignay pH Indicator as an alternative to synthetic indicators such as phenolphthalein in terms of Color. Among the statements above "The Bignay pH indicator produces a distinct color when mixed with acidic/basic solutions" received a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. Next is "The color change of the Bignay pH indicator accurately reflects the pH of acidic/basic solutions" with a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. Then the color transformation of the Bignay pH Indicator, when exposed to acidic and basic substances, endures for a significant amount of time." with a mean score of 3.87 and SD of 0.35, interpreted as strongly agree. Furthermore, the Bignay pH indicator's color change is immediate when mixed with acidic/basic solutions" with a mean score of 3.53 and SD of 0.52, interpreted as strongly agree. Lastly, "The color intensity of the Bignay pH indicator matches that of phenolphthalein in acidic/basic solutions." with a mean score of 3.33 and SD of 0.72, interpreted as strongly agree. Overall, the general weighted mean of 3.67 with a standard deviation of 0.48 indicates that respondents strongly agree on the acceptability of the Bignay pH indicator in terms of color. Table 9 shows the Level of acceptability of Bignay pH Indicator as an alternative to Phenolphthalein in terms of Color. Among the statements above "The Bignay pH indicator produces a distinct color when mixed with acidic/basic solutions" received a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. Next is " The color change of the Bignay pH indicator accurately reflects the pH of acidic/basic solutions" with a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. The color transformation of Bignay pH Indicator, when exposed to acidic and basic substances, endures for a significant amount of time." with a mean score of 3.87 and SD of 0.35, interpreted as strongly agree. Furthermore, The Bignay pH indicator's color change is immediate when mixed with acidic/basic solutions" with a mean score of 3.53 and SD of 0.52, interpreted as strongly agree. Lastly, "The color intensity of the Bignay pH indicator matches that of phenolphthalein in acidic/basic solutions." with a mean score of 3.33 and SD of 0.72, interpreted as strongly agree. Overall, the general weighted mean of 3.67 with a standard deviation of 0.48 indicates that respondents strongly agree on the acceptability of the Bignay pH indicator in terms of color. The visibility of color change refers to how easily users can detect a transition in color, which is crucial in applications like pH indicators (Lee et al., 2021).

Table 10: Level of acceptability of Bignay pH Indicator as an alternative to Synthetic pH Indicator such as Phenolphthalein in terms of Odor.

This table showed the acceptability of Bignay pH Indicator as an alternative to *synthetic pH indicator* phenolphthalein, specifically focusing on odor. The data gathered through mean scores and standard deviation revealed that generally "Strongly Agree" that the Bignay pH indicator had a tolerable, stable, and pleasant odor compared to phenolphthalein.

QUESTIONS	MEAN	SD	VERBAL INTERPRETATION
The odor of the Bignay pH indicator is tolerable during experiments.	3.80	0.41	Strongly Agree
The smell of the Bignay pH indicator lingers for a long time after mixing with acidic/basic solution.	3.60	0.51	Strongly Agree
Mixing the Bignay pH indicator with acidic/basic solutions does not produce an unpleasant odor.	3.80	0.41	Strongly Agree
The odor of the Bignay pH indicator remains stable in different concentrations of acidic/basic solutions.	3.73	0.46	Strongly Agree
The odor of the Bignay pH indicator is more pleasant than phenolphthalein.	3.73	0.46	Strongly Agree

Legend: 0.00 – 0.99 = Strongly Disagree; 1.00 – 1.99 = Disagree; 2.00 – 2.99 = Agree; 3.00 – 4.00 = Strongly Agree

Table 10 shows the Level of acceptability of Bignay pH Indicator as an alternative to synthetic indicators such as phenolphthalein in terms of Odor. Among the statements above "The odor of the Bignay pH indicator is tolerable during experiments." received a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. Next is " The smell of the Bignay pH indicator lingers for a long time after mixing with acidic/basic solution" with a mean score of 3.60 and SD of 0.51, interpreted as strongly agree. Then "Mixing the Bignay pH indicator with

acidic/basic solutions does not produce an unpleasant odor" with a mean score of 3.80 and SD of 0.41, interpreted as strongly agree. Furthermore, "The odor of the Bignay pH indicator remains stable in different concentrations of acidic/basic solutions" with a mean score of 3.73 and SD of 0.46, interpreted as strongly agree. Lastly, "The odor of the Bignay pH indicator is more pleasant than phenolphthalein" with a mean score of 3.73 and SD of 0.46, interpreted as strongly agree. Overall, the general weighted mean of 3.73 with an SD of 0.45 indicates that respondents strongly agree that the Bignay pH indicator is acceptable in terms of odor. The data shows consistency across all questions, supporting the conclusion that Bignay extract is a tolerable and more pleasant alternative to phenolphthalein in odor-related aspects.

Table 11: Level of acceptability of Bignay pH Indicator as an alternative to Synthetic Indicator such as Phenolphthalein in terms of Accuracy.

This table showed the acceptability of Bignay pH indicator as an alternative to synthetic indicators such as phenolphthalein, focusing on accuracy. The data, gathered through mean scores and standard deviations, revealed that respondents generally "Strongly Agree" with positive statements regarding the Bignay pH indicator's accuracy.

QUESTIONS	MEAN	SD	VERBAL INTERPRETATION
The Bignay pH indicator provides reliable pH readings in acidic/ basic solutions.	3.67	0.49	Strongly Agree
The Bignay pH Indicators provides reliable results in both diluted and concentrated solutions.	3.60	0.51	Strongly Agree
The Bignay pH indicator's color change is precise and easy to interpret in laboratory conditions.	3.67	0.62	Strongly Agree
The color transition of the Bignay pH indicator clearly reflects pH changes.	3.87	0.35	Strongly Agree
The accuracy of Bignay pH indicator is comparable to synthetic indicators like phenolphthalein.	3.80	0.41	Strongly Agree

Legend: 0.00 – 0.99 = Strongly Disagree; 1.00 – 1.99 = Disagree; 2.00 – 2.99 = Agree; 3.00 – 4.00 = Strongly Agree

Table 11 shows the level of acceptability of Bignay pH indicator as an alternative to synthetic pH indicators such as phenolphthalein in terms of accuracy. The response of the participants is computed using in statistical treatment to get the mean and standard deviation of each question thus, in question number (1) The Bignay pH indicator provides reliable pH readings in acidic/ basic solution resulted with the mean of 3.67 and with standard deviation of 0.49 with that the verbal interpretation for this question result in Strongly Agree, while in computing the question (2) The Bignay pH Indicators provides reliable results in both diluted and concentrated solutions resulted with the mean of 3.60 and standard deviation of 0.51 thus, the verbal interpretation for this is strongly agree. Furthermore, in the third question (3) The Bignay pH indicator's color change is precise and easy to interpret in laboratory conditions with the mean of 3.67 and standard deviation of 0.62 it shows that the verbal interpretation is also strongly agree, in the fourth question (4) The color transition of the Bignay pH indicator clearly reflects pH changes resulted with the mean of 3.87 and standard deviation of 0.35 thus, the verbal interpretation for this is still strongly agree. Lastly, for the final question (5) The accuracy of Bignay pH indicator is comparable to synthetic indicators like phenolphthalein is computed and result with the mean of 3.80 and standard deviation of 0.41 resulting in verbal interpretation of strongly agree. Overall, the general weighted mean for the accuracy with the mean of 3.72 and standard deviation of 0.48 results the overall table with the verbal interpretation of strongly agree.

Small changes can be easily detected and accurately connected to the solution's pH, making the measurements sensitive and reliable. This accuracy helps in identifying even small pH changes, leading to a more detailed and trustworthy analysis Kim et al. (2024).

Table 12: Summary table of the Acceptability of Bignay pH Indicators as an Alternative to Synthetic pH Indicators such as Phenolphthalein.

This table summarizes the overall acceptability of Bignay pH indicators as an alternative to phenolphthalein, considered color, odor, and accuracy.

Indicators	Mean	SD	Interpretation
Color	3.67	0.48	Strongly Agree
Odor	3.73	0.45	Strongly Agree
Accuracy	3.72	0.48	Strongly Agree

Based on the quantitative evidence and observational analysis, the following findings were noted when comparing Bignay pH Indicator to synthetic pH indicators such as phenolphthalein as a pH indicator:

1. Color: The Bignay pH indicator consistently displayed distinct and clear color changes at varying pH levels, comparable to the sharp transitions seen with phenolphthalein. This indicates that the Bignay extract is capable of effectively signaling changes in pH through observable color variations.

2. Odor: The odor of the Bignay pH indicator was mild and not disruptive to the experiment, unlike some chemical indicators that may produce strong or unpleasant odors. This makes it a more user-friendly option in School laboratory settings.

3. Accuracy: The Bignay pH indicator reliably indicated the correct pH ranges in multiple trials, demonstrating accuracy comparable to phenolphthalein. The endpoints were clear and consistent, supporting its validity as an alternative pH indicator.

Given these observations, Bignay pH Indicator is considered effective, accurate, and efficient as a pH indicator. Therefore, the null hypothesis is rejected based on the consistency of color changes, mild odor, and reliable accuracy demonstrated during the tests

SUMMARY, FINDINGS, AND RECOMMENDATIONS

This chapter enumerates the summary of findings, conclusions made from the findings, and the recommendations which are based on the result of the experiment and gathered data from the survey questionnaire.

Summary Of Findings

This study determines the acceptability of Bignay *(Antidesma bunius)* fruit extract as an Organic-Based pH indicator.

This study (1) indicate the capability of Bignay fruit extract as an alternative pH indicator, (2) Assess the acceptability of Bignay fruit extract as active component in indicating the acidity and basicity of solution in terms of: Concentration of Bignay extract to alcohol, color changes and shelf life, (3) Evaluate Bignay extract pH indicator as compared to phenolphthalein, and (4) Seek professional advice to assess the acceptability of Bignay pH indicator in terms of: color, odor, and accuracy.

Furthermore, the study employed an *Explanatory Sequential Research Design*, with both experimental and descriptive phases. The experimental Phase was composed of stages, from the creation of the indicator to the necessary testing *(Concentration test, Color test, Odor test, Shelf-life test)* conducted by the researcher.

Moving on, the descriptive phase utilized a structured survey questionnaire consisting of sections such as, *Color, Odor, Accuracy,* which are important aspects that makes an indicator a good indicator as anchored to studies. The questionnaire was employed to professional chemistry teachers, in a face-to-face setup, to get hands-on observation and analysis of the product, to determine if it's an acceptable alternative to synthetic indicators used

at schools. To further support the study, the product underwent DOST Phytochemical testing to analyze its chemical components that contributed to its color-changing properties.

Moreover, the findings of the study, based on the data gathered from each phase, confirmed that the Bignay pH indicator showed excellent performance as an alternative to synthetic indicators used at schools. Firstly, based on the concentration test done at the initial stage of the experimental phase revealed that 1:2, Bignay-to-alcohol ratio, showed superior results, considering color clarity and reaction efficiency. Next, the colorimetric response of Bignay pH indicator when tested to acidic and basic solutions, unveiled that the color transition for acidic substances ranges from *hot pink to pale pink (strong to weak acids)*, and basic substances ranges from *green, blue, and yellow (weak to strong basic).* The odor of the Bignay pH Indicator is considered pleasant as is, and when mixed with acidic and basic substances. Lastly, the Bignay pH indicator lasts until 7 days of storage.

The acceptability phase revealed that the indicator is truly acceptable as an alternative to synthetic indicators used at schools such as phenolphthalein. The data from the participants underwent the following analysis and statistical treatment, whereas a simple descriptive method was used to quantify the results of the survey, considering factors such as color, odor, accuracy. The level of acceptability of Bignay pH indicator in terms of color resulted with the general weighted mean of *3.67* and standard deviation of *0.48*, thus, the verbal interpretation based on its color is *Strongly Agree.* Its level of acceptability in terms of Odor garnered a general weighted mean of *3.73* and Standard deviation of *0.45* the verbal interpretation is also *Strongly Agree. Lastly, the level of acceptability in terms of accuracy* obtained *a* general weighted mean of *3.72* and standard deviation of *0.48* thus, the verbal interpretation for the accuracy is *Strongly Agree.*

To further support the findings, the DOST phytochemical test report revealed that Bignay pH indicator contained significant constituents such as *Sterols, Triterpenes, Flavonoids, Alkaloids, Glycosides, and Tannins,* which were known to have color-changing properties in response to varying pH levels.

Conclusion

The following are the researchers' conclusion based on the findings of the research:

The Bignay pH Indicator showed clear results in the color change test. It changed colors from light pink, pale pink, pink, and hot pink in acidic solutions, while green, blue, and yellow appeared in basic solutions. These clear color changes show that the Bignay extract works well as a natural acid-base indicator. Compared to phenolphthalein, which changes from colorless to pink in basic solutions, the Bignay extract shows a wider range of colors, making it a good alternative for testing pH. One limitation of this study is that Bignay is seasonal, which may affect the availability of the extract for consistent use in future applications. This could limit the practicality of using Bignay as a regular pH indicator unless methods for preserving or storing the extract are developed.

Recommendations

Based on the results and conclusions that were mentioned above the following are recommended.

1. Since the fruit is used due to its anthocyanin and other phytochemical content it should be well ripe (violet in color) before using it to create an organic based pH indicator.

2. The researchers suggest to powderized the Bignay fruit to expand the shelf life of the said solution.

3. Future researchers should use a freshly picked bignay fruit if it will be used eventually for the study, since Bignay *(Antidesma bunius)* fruit can rot quickly after picking from the tree.

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