"ANTHOCYANINS EXTRACTION FROM CAMOTE TOPS (*Ipomoea batatas*) LEAVES AS AN ALTERNATIVE pH INDICATOR AND ITS COLOR CHART"

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Abstract: The role of pH indicator was used in various ways including measuring the pH of farm soil, different household substances and bodies of water. This comparative experimental study was conducted to prove and present an alternative pH indicator that can measure accurate pH level of a substance with distinct color change and wavelength that can be observed with the color chart of alternative pH indicator as the output of this study. In addition, this study considered the role of anthocyanin content of camote tops leaves extract on the absorption of light and in spectrophotometeric analysis and compare its efficacy with Phenol red. Researchers applied two concentration in testing: 300mL of water: 5 grams of camote tops leaves: 180 mL of ethanol; and 400mL of water: 5 grams of camote tops leaves: 240 mL of ethanol in different volume of 3mL, 5mL, and 10mL of camote tops leaves extract. The results indicated that both concentrations compared to Phenol red in terms of pH level and wavelength the two pH indicators showed no significant difference but had a significant difference in terms of color change. The researchers concluded that anthocyanins from camote tops leaves extract can be an alternative pH indicator that shows a wide pH range from 2-11 levels (pink as acid, green as basic to yellow in highly basic). The researchers developed a pH color chart of camote tops leaves extract recommended for measuring pH level of household substances, farm soil, bodies of water, and are readily available science experiments that can benefit farmers, teachers, and students.

Keywords: *pH (Potential of Hydrogen), anthocyanins, alternative, color, chart.*

INTRODUCTION

A pH indicator or acid-base indicator is a compound that changes color in solution over a narrow range of pH values. It usually has weak acids or weak base. That indicates whether a solution is acidic (pH < 7), basic (pH > 7) or (pH = 7) neutral. A "pH" value was approximated number between 0 and 14 as the universal pH indicator. The anthocyanins found in flowers, fruits, and vegetables that could be used as an alternative pH indicator (Helmenstine, 2019).

Based on the study of Staff (2023), testing the pH of the solution was a fundamental skill in Chemistry. Students typically tested pH using a pH meter, litmus or pH paper strips, or one of a variety of commercial synthetic acid-base indicator solutions. Commercial pH indicator was hard to find and costly. However, effective pH indicators could also be made at home or in the classroom from items that we probably have in the kitchen or garden.

The "Talbos ng Kamote" or "Sweet Potato Leaves" is a kind of plant (scientifically called Ipomoea batatas) that is always seen growing in vacant lots and in the roadside anywhere in the Philippines. It grows all year round and does not need that much maintenance because it grows wild most of the time. The anthocyanins content in a camote plant is believed to be mostly found within the leaves. The plants that have anthocyanins are called natural pH indicators or plant pH indicators which are cheaper and easier to find than the commercial ones (Sweet Potato Leaves, 2018).

According to the Khodadadianzaghmari et al. (2024), pH measurements have been, and continue to be widely used as a rapid, accurate measurement of fluids of all sorts. This includes agricultural, wastewater, pharmaceutical and educational applications critical measurement in industries, testing a sample against a legal requirement and is also of outstanding importance in water and environmental analysis.

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Plants that have anthocyanins could also be produced as pH indicators. It could be used to identify pH level, color changes of different household and laboratory chemicals. According to the Păusescu et al. (2022), the majority of pH indicators used today are synthetic. A synthetic indicator is a man-made chemical substance in the laboratory which was used to determine pH of a substance, such as litmus paper, Phenol red and methyl violet. Synthetic indicators have certain disadvantages such as high cost, availability, chemical pollution and have hazardous effects to both human and environment. Hence, natural indicators obtained from various plants like flowers, fruits, and leaves would be more advantageous (Okoduwa et al., 2015). Moreover, there has been a growing needed to utilize alternative resources as a material in the laboratory.

Sold in the market are several types of expensive commercial pH indicator like paper strips and Phenolsulfonphthalein (Phenol red) that could read pH range with multiple color changes (Bhise et al., 2014). Internationally, the Phenol red price range for 325 mL is 24 dollars converted into peso, it would cost 1,324.90 pesos and for 250 mL is 40 dollars converted into peso, it would cost 2,214.76 pesos (G-Biosciences, 2023). For the local market the Phenol red with 240 mL size bottle cost 1000 pesos. With this cost, it was feasible and beneficial to create an alternative pH indicator as a substitute for expensive synthetic or commercial pH indicators.

In this experimental study, the researchers observed the reaction of anthocyanins extraction from camote tops (Ipomoea batatas) leaves in different substance, and identified the relevance of the pH indicator on an experimental basis and to make a color chart/pH scale for alternative pH indicator of camote tops leaves (Ipomoea batatas). This had been conducted at the Physical Laboratory of Holy Trinity College at General Santos City. Furthermore, the results of this study may become a basis for the use of plants that are locally available in the country as a cheaper alternative, and to test that camote tops leaves were a good pH indicator.

Research Questions

This study aimed to determine the pH level, color change, and color wavelength of selected 20mL household substances using different concentrations of camote tops (sweet potato leaves) extract as a pH indicator and comparing it with the commercial pH indicator, Phenol red. Specifically, it sought to analyze these properties under varying extract volumes and solvent compositions. First, the study investigated the pH levels, color changes, and corresponding color wavelengths when using 3mL, 5mL, and 10mL of camote tops extract, prepared with a mixture of 300mL of water, 5 grams of camote tops, and 180mL of ethanol. Similarly, it examined the same parameters using another formulation consisting of 400mL of water, 5 grams of camote tops, and 240mL of ethanol, applied in 3mL, 5mL, and 10mL volumes. Lastly, the research assessed the pH level, color transition, and wavelength of household substances when tested with Phenol red as an indicator, using 3mL, 5mL, and 10mL of the solution. By comparing the results, the study aimed to evaluate the effectiveness and sensitivity of camote tops extract as a natural pH indicator in relation to a commercially available alternative.

1.Is there a significant difference between the pH level, color change, and color wavelength of selected 20mL household substances using 3mL, 5mL, and 10mL with a concentration of 300 mL of water: 5 grams of camote tops leaves: 180 mL of ethanol of camote tops leaves extract and Phenol red pH indicators?

2.Is there a significant difference between the pH level, color change, and color wavelength of selected 20mL household substances using 3mL, 5mL, and 10mL with a concentration of 400 mL of water: 5 grams of camote tops leaves: 240 mL of Ethanol of camote tops leaves extract and Phenol red pH indicators?

3.What alternative indicator to determine pH level and color change can be made from camote tops leaves?

LITERATURE REVIEW

pH Indicator and its Uses

pH indicator is a compound that changes color in solution over a narrow range of pH values. Only a small amount of indicator compound is needed to produce a visible color change (Helmenstine, 2019). pH indicators are specific to the range of pH values one wishes to observe. For example, common indicators such as phenolphthalein, methyl red, and bromothymol blue are used to indicate pH ranges of about 8 to 10, 4.5 to 6, and 6 to 7.5 accordingly. On these ranges, phenolphthalein goes from colorless to pink, methyl red goes from red to yellow, and bromothymol blue goes from yellow to blue (Acid-Base Indicator, 2017).

Camote Tops (Ipomoea batatas) Leaves

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As defined by Specialty Produce (2023), sweet potato camote leaves are medium to large in size and are chordate, or heart-shaped with pointed tips. The leaves grow in an alternate patterns and may be palm-shaped or known as having multiple lobes depending on the variety. Sweet potato leaves range in color from dark to yellow-green or purple and tend to be darker on the surface and lighter on the underside. They grow on slender, green stems rising from long, creeping vines, and these vines could grow to four meters in length. The top ten centimeters of the leaves and stems are the tender and the most commonly consumed. Sweet potato leaves have a slight bitterness when raw, but when cooked, the leaves take on a mild, delicately sweet flavor with a taste similar to spinach and water spinach. Sweet potato leaves, botanically classified as Ipomoea batatas, grow on an herbaceous perennial vine and belong to the Convolvulaceae, or morning-glory family. Also known as 'Camote' or 'Kumara', sweet potato plants are grown mostly for their sweet, tuberous root vegetables, but the leaves, shoots, and flowers are also edible and used in culinary applications (Specialty Produce, 2023).

The earliest cultivation records of the sweet potato date to 750 BCE in Peru. By the time Christopher Columbus arrived in the 'New World' in the late 15th century, sweet potatoes were well-established as food plants in South and Central America. As claimed by Specialty Produce (2023), these plants are native to South America and were originally cultivated by the Incans. Today, sweet potato leaves can be found at local markets in Asia, Africa, Europe, South America, Central America, and the United States. It was introduced to the Philippines from Latin America during the Spanish colonial period. Camote tops extract is considered as an acid-base indicator because it has a presence of anthocyanins which produces specific colors in solutions of different acidity and basicity. The purple-colored variety of sweet potato leaves contains high anthocyanins content. To be specific, basic colors of anthocyanins including blue, purple, red and orange are directly associated with quantities of hydroxyl groups and are indirectly related to quantities of methoxyl groups that are present in a plant. Anthocyanins extract, on the other hand, was able to show multiple color changes due to more than one proton donation or acceptance group stability over a fairly wide pH range when they contain two or more acyl groups (Yamanaka et al., 2022).

Phenol red (Phenolsulfonphthalein)

As mentioned by Abbey Color (2022), Phenol red is a water-soluble dye used as a pH indicator, changing from yellow to red over pH 6.8 to 8.2, and then turning a bright pink color above pH 8.2. As an acid pH indicator, it has a transition point of 7.5 (acid side to yellow / alkaline side to red). As such, Phenol red can be used as a pH indicator dye in various medical and cell biology tests such as biologists utilized them in cell cultures. Phenol red has been used in the PSP (Phenolsulfonphthalein) test for kidney functions, most recently, medical researchers have discovered that Phenol red can serve as an estrogen mimic and is used in the process of in vitro fertilization, and Phenol red is a dye used in automotive coolants.

Comparison of Natural and Synthetic Indicators

The research undertaken by Kadam et al. (2021) investigated the comparison of natural and synthetic pH indicators, specifically focusing on the use of acidified methanolic extract derived from flowers and other plants as indicators in acid-base tests. The research found that natural indicators, easily extracted and abundant, yielded good results similar to synthetic indicators. During titration, distinct color changes occurred at the equivalence point where acid and base were balanced, which aligned with those observed using standard synthetic indicators. This proved that natural indicators could be as just good for these tests, cost-effective, accurate, cheaper, and accessible making it a valuable alternative for such analyses.

The Department of Chemistry of Ethiopia led by Baye and Analecto (2020), provides experimental evidence supporting that extracted plants, specifically the Acanthus pubescens (prickly Acanthus) flower extracts could be a natural and environmentally friendly alternatives to synthetic acid-base indicators. The study indicated that both ethanolic and acidified ethanol extracts from these flowers can effectively substitute phenolphthalein, bromothymol blue, and methyl red in acid-base indicators. The study also concluded that natural pH indicator derived from plants offers numerous benefits including cost-effectiveness, availability, ease of preparation, precision and accuracy of the results. To make the extract of the indicator, the researchers in this study mixed the 30 grams dried powder of Acanthus pubescens flower with 150 mL of 97% ethanol in 250 mL Erlenmeyer flask and stirred using magnetic stirrer for 2 hours to disperse the powder completely.

pH Levels of Household Chemicals

Investigating pH level of common household substances is designed to know safety measures when using it. The skills used and developed are pH testing methods, and observation of pH levels. pH methods is utilized to discover if household substances are labeled as acidic, neutral, and basic.

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Oxalic Acid. It is a chemical known as the first in the homologous series of aliphatic dicarboxylic acid that was being used in various industrial areas such as metal surface usage and the manufacturing and processing of textile (Sawada & Murakami, 2015). This activity is the key for an environmental parameter to measure the medium of pH values and the highest recorded pH value of oxalic acid if added to water is exhibited at pH 6. The pH level of oxalic acid is ranging to 2 to 7. This is called as an acidic because there is a presence of citric and gluconic acid that both can increase and decrease the medium of pH and can decrease the oxalic acid concentration.

Vinegar. It contains phenolic compounds and has physiochemical properties like density, total titratable acidity and pH values. In terms of pH value, it varies from between 2.58 and 3.67 for homemade vinegar and between 2.22 and 2.86 for commercial vinegar (Budak et al., 2022).

Lemon Juice. The juice yield from the lemon was investigated by many researchers and they measured the pH level of fresh juices using by digital pH meter after extraction and they find out that the degree of ripening would influence the level of ripe state of lemon, that would give a highest biochemical characteristics (Ogundele & Bolade, 2021) and they revealed that the pH values in the lemon juice would generally increasing due to its degree of ripening. The lowest pH values exhibited 2.87 to 3.27 pH levels (ripe lemon) and the acidity of the lemon juice exhibits an inverse relationship with their corresponding pH values. The acidity of the juices was determined by the titration method.

Orange Juice. It is one of the most popular marketed fruit juices and it contains phenolic compounds. Clinical trials study the stability of these compounds and its pH levels. They found out that the measured pH values ranged from 3.50 to 3.97 in both enriched samples of orange juices. The observed pH values are similar to the experimentation conducted by Rapisarda et al. (2015) proves that the increase pH value of the concentration is due to the citric acid during storage period and the pH level decrease, probably correlated to an increase weak acid concentration.

Soft Drink. It is one of the most important types of drinks in the beverage industry and in recent times this frequent consumption leads to investigation to provide information about its history, ingredients and its pH values to its consumers. The measured pH value determines the initial hydrogen ion concentration and the pH value found in soft drinks exhibited from 5.5 containing higher concentrations (Louie, 2023).

Distilled Water and Tap Water. Water from various sources was collected to measure its pH level using pH meter and pH indicator strips. Normal saline and distilled water exhibited a pH level between 5.4 and 5.7 while the tap water from the faucet is exhibited approximately 7.5 pH level (Kulthanan et al., 2014).

Baking Soda. It has been investigated that the effect of adding alkaline substances to the water would increase its pH level value. Recent evidence suggested that using baking soda and being mixed with water with a neutral pH level of 7, shows that this substance can exhibits about 8 or 9 pH level (Professional Business Consulting Services, 2023). This studies shows that adding baking soda to water increase its alkalinity that makes it neither base or acidic.

Ammonia. pH is a fundamental particles property that has a great effects in the formation of aerosol in the ammonia (NH3) that composes its toxicity, composition and nutrient level. High level of ammonia suggested to have a pH level from 4 to 10 and as the pH of water decreases the ammonia ions are favored (Wang et al., 2020).

Soapy Water. A synthetic detergent contains synthetic surfactant and typically has a high pH level ranging from 9 to 10. As a result, the soapy water pH is neutral or slightly acidic than true soaps (Alsalhi et al., 2024). This cross sectional study was carried out in Riyadh and pH level was measured using laboratory-validated techniques.

Bleach. Commercial bleach is widely available in the market with higher concentration and higher stability of sodium hypochlorite solution (Lantagne, 2019). To develop an accurate level of concentration, they analyze the commercial bleaches for sodium chlorite concentration and its pH level in 32 different bottles. They used Hanna Instrument multimeter to measure pH level and they calibrated a data of mean measured concentration. As a result, the pH level of the commercial bleached varied from 11 to 13, making it as strong base.

Relationship of Color Change and Wavelength

Anthocyanins extraction method can determine the pH values based on the color change due to the reversible changes at different pH values (Taghavi et al., 2022). Anthocyanins color is dependent on its significant variations of pH level if it is acid or base and the molecule is pigmented at pH of 1.0 and neutral or colorless at pH of 4.5 and higher. Therefore, at pH 1.0 the molecules strongly

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absorb the light between 460-550 nm; however, at a pH of 4.5 higher is colorless. Thus, this difference in absorbance of the color change at 520 nm is directly proportional to its concentration and accurately and rapidly estimates the anthocyanins. This reason makes the pH method vulnerable.

Spectrophotometry is a method for measuring the wavelength and intensity of ultraviolet and visible light absorbed from a concentration sample. The basic principle of this method is based on measurement of the final wavelength and intensity or the final absorbance by the samples (Skoog, 2017). Therefore, this is the guidelines used on how to interpret UV spectrum in terms of determining its structure of the concentration.

RESEARCH METHODOLOGY

The researchers utilized the comparative experimental design that describes and explains the differentiation and similarity of phenomena and provided them a strategy on how to gather and analyze data for their comparative research that involved laboratory test procedures. This study then compared two independent variables and determined the similarities and differences of the effect to the dependent variables. Therefore, the design is appropriate to be used by the researchers to compare Phenol red pH indicator to camote tops (Ipomoea batatas) leaves extract as an alternative pH indicator in terms of pH level, color change and color wavelength of the selected 20mL household substances.

Participants

A Bachelor of Secondary Education Major in Science is a four-year teacher education program that prepares students to teach Science education at the secondary level. The degree program includes a sufficient number of Biology, Chemistry and Physics courses to prepare graduates to teach Physical and Biological Sciences classes. It also includes Earth and Environmental Science courses, in addition to professional and general education courses that provide science teachers with the content and pedagogical knowledge they need to function as professionals who can contribute to the improvement of students' academic achievement and science education in general.

Instruments of the Study

In this study, the researchers utilized a validated quantitative test observation sheet as the research instrument to record observations upon conducting the experiment or testing process. It includes the columns for 11 household substances: oxalic acid, vinegar, lemon juice, orange juice, soft drink, distilled water, tap water, baking soda, ammonia, soapy water, and bleach. The variables needed to be observed and seek results: pH level, color change and wavelength. The researchers listed down the data gathered during experiments in a tabular presentation of data.

Procedure

The observations from the conducted experiment and the results obtained during the test are used to determine what hypotheses should be accepted or rejected. The test is comparative analysis, it involves comparing two indicators: the camote tops leaves extract as an alternative pH indicator and the Phenol red pH indicator in different mL: 3mL, 5mL, and 10mL. The researchers chose this type of analysis to compare the differences and similarities of a synthetic commercial pH indicator to an alternative pH indicator, specifically to conclude if there are significant differences in terms of pH level, color change and color wavelength of selected 20mL household substances when using 3mL, 5mL, and 10mL of camote tops leaves extract and Phenol red pH indicator.

Ethical Considerations

Observing ethical standards in research is essential. At the core, this helped shape the true aims The researchers made certain that all ethical considerations were followed to avoid any practice that may cause abuse and exploitation to those with whom they sought to conduct the research with.

Honesty and Objectivity. The researchers made certain that biases in the study procedure and data analysis and interpretation are avoided. Data is never fabricated, falsified, or misinterpreted. The researchers maintained these ethical principles in conducting the study.

Risk and Harm. Harms and risk to human lives especially to the researchers are avoided and minimized. The researchers ensured that safety guidelines are practiced before, during, and after the experimentation. Rest assured that any harm physical, financial, psychological, or legal harm were avoided or minimized to maintain safety to the researchers.

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Proper Disposal of Waste. The researchers ensured that research is conducted responsibly in a safe, transparent, and responsible manner and with minimal harm to the environment and public health. Experiments may generate waste that is considered special or hazardous, such as chemicals and when substances are mixed. In such cases, researchers ensured proper handling and disposal of these wastes according to strict guidelines and regulations of the laboratory. This may involve special handling procedures, designated storage areas, and proper draining of chemicals to minimize risks and maintain socially and environmentally friendly whenever possible.

Respect for Intellectual Property. The researchers ensured that proper acknowledgement and credit are given to the authors cited and sources used in this study. Any copyright included in the paper is recognized.

RESULTS

In this chapter, the results of the study are presented and discussed concerning the main objective of this study which are to determine the pH level, color change, and color wavelength of selected 20mL household substances using, Camote Tops Leaves.

The Results of Final Graphing of Color Wavelength of Camote Tops Leaves Extract in Two (2) Concentration: 300mL of Water: 5 grams of Camote Tops Leaves: 180mL of Ethanol and 400mL of Water: 5 grams of Camote Tops Leaves: 240mL of Ethanol

Figure 1 and Figure 2 show the final absorbance of the camote tops leaves and the final chart of graph for absorbance. The concentration of the household chemicals shows different absorbance and as the concentration increases, the wavelength increases as well. Therefore, the absorbance in the final graph is directly proportional to its concentration.

Household Substances	Wavelength	Final Absorbance
Oxalic Acid	470nm	15.3
Vinegar	470nm	3.429569768
Lemon Juice	470nm	2.573333333
Orange Juice	500nm	0.166666667
Soft Drink	480nm	20.44333333
Distilled Water	470nm	15.92
Tap Water	440nm	3.636666667
Baking Soda	440nm	0.116666667
Ammonia	780nm	42.76666667
Soapy Water	470 nm	10.22666667
Bleach	780nm	28.26333333

Figure 1. Camote Tops Leaves Final Absorbance

Figure 1 shows the final amount of the light absorption of a substance and their corresponding final wavelength. The absorption of substance, bleach and ammonia showed the highest absorption at around 780 nm. This absorption reaches its highest peak called as

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absorption maximum wavelength. Tap water and baking soda showed the lowest absorption at around 440 nm that showed the molar absorption (Cadondon et al., 2021).

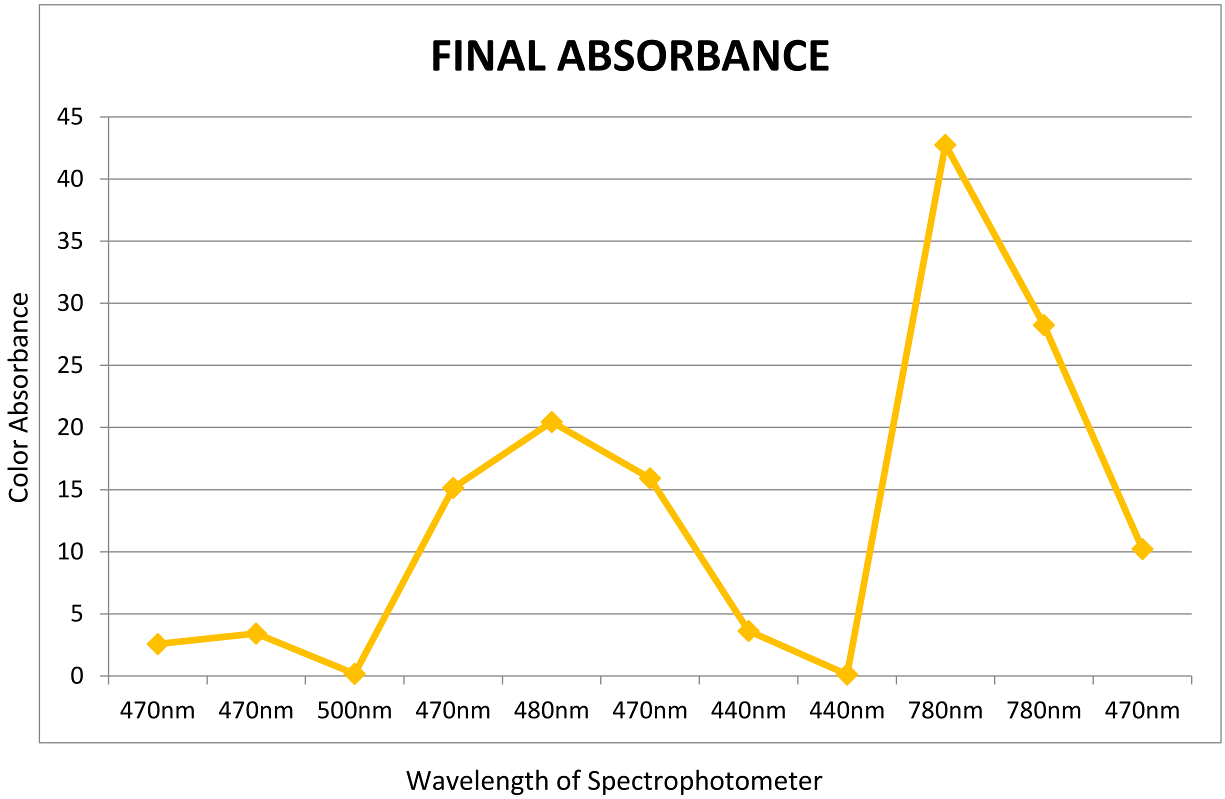

Figure 2. Chart and Graph of Color Wavelength and Final Absorbance

Figure 2 shows the final absorbance of camote tops leaves color wavelength that is done through the use of spectrophotometer and the formula of Beer Lambert Law Theory about the color absorbance.

Figure 2 shows the effect of final absorbance and the substituent of two concentrations on the reference structure in Figure 1 in camote tops was discussed. This analysis involved employing a spectrophotometer and applying the Beer-Lambert Law Theory to comprehend color absorption, considering factors like absorption shift and wavelength influence. Consequently, the correlation between the final absorbance (found in the third column) and the wavelength (in the second column) will determine the resultant color absorbed.

Oxalic acid= Red; Vinegar= Orange; Lemon Juice= Orange; Orange juice= Red; Soft Drinks= Red; Distilled water= Green; Tap water= Dark Green; Baking soda=Red; Ammonia= Violet; Soapy water= Violet; Bleach= Colorless (acidic). This includes the shift from absorption and the influence of the wavelength. There is a clear influence of the substituent that will cause the absorbance region to shift higher and there is influence on the color change. Therefore, the larger wavelength the higher absorbance can be observed, the color shift from the substance of ammonia and bleach exhibits is 780 nm in camote tops shows Bathochromic and Hyperchromic effects that affects the absorption wavelength. This exhibits very strong light absorption near 40, Hypochromic and Hypsochromic was observed from lemon juice, vinegar and orange juice, 470 and 500 nm in camote tops and this group shows a weaker absorption based on the characteristics from spectrophotometer (Al-Qahtani, 2021).

The Results of Final Graphing of Color Wavelength of Phenol red Commercial pH Indicator

Figure 3 and Figure 4 show the final absorbance of the Phenol red final absorbance and the final chart of graph for absorbance. The concentration of the household chemicals shows different absorbance and as the concentration increases, the wavelength increases as well. Therefore, the absorbance in the final graph is directly proportional to its concentration.

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Household Substances	Wavelength	Final Absorbance
Oxalic Acid	470nm	0.066666667
Vinegar	500nm	0.066666667
Lemon Juice	470nm	0.1
Orange Juice	470nm	0.066666667
Soft Drink	480nm	0.233333333
Distilled Water	470nm	0.33333333
Tap Water	440nm	0.133333333
Baking Soda	440nm	0.03333333
Ammonia	780nm	0.033333333
Soapy Water	470 nm	0
Bleach	780nm	0

Figure 3 . Phenol red Final Absorbance

The final absorbance of Phenolphthalein red wavelength is discussed in Figure 20. This was done through the use of spectrophotometer and the formula of Beer Lambert Law Theory about the color absorbance and it includes the shift from absorption and the influence of the wavelength. Therefore, the final absorbance in the third column and wavelength in the second column will determine its corresponding final color absorbed.

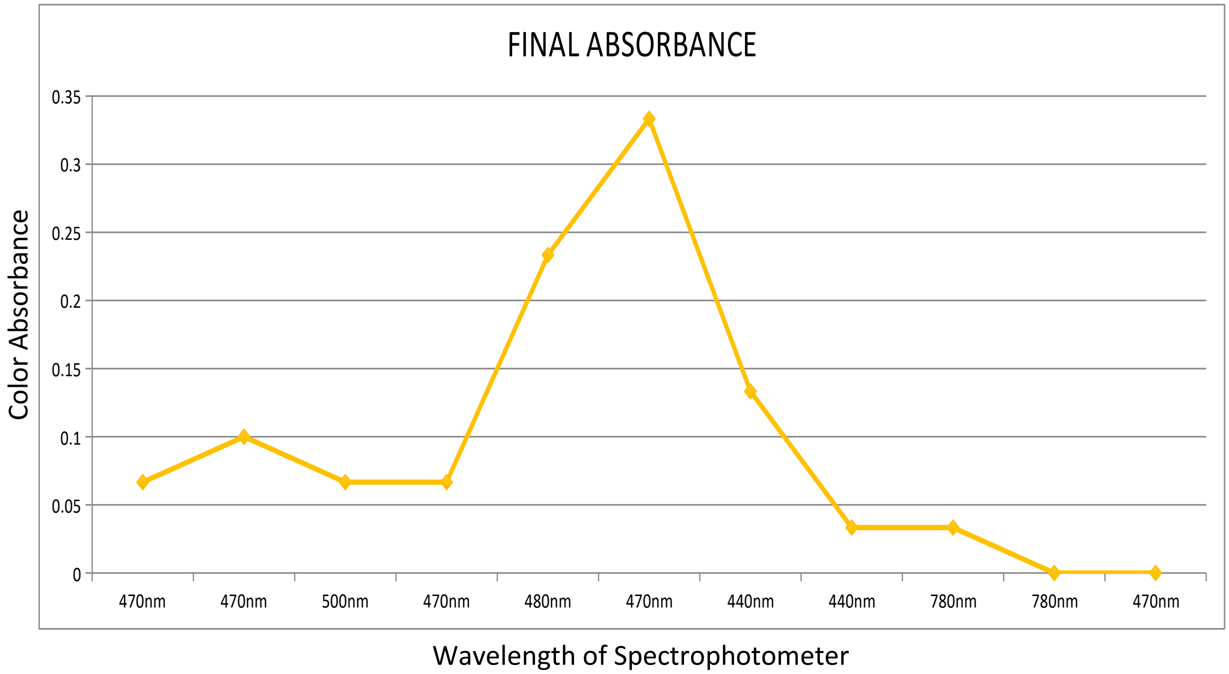

Figure 4. Chart and Graph of Color Wavelength and Final Absorbance

In Figure 4, the final absorbance of Phenolphthalein Red wavelength will now be discussed. This was done through the use of spectrophotometer and the formula of Beer Lambert Law Theory about the color absorbance and it includes the shift from absorption and the influence of the wavelength. Therefore, the final absorbance in the third column and wavelength in the second column will determine its corresponding final color absorbed.

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Oxalic acid= Red; Vinegar= Orange; Lemon Juice= Orange; Orange juice= Red; Soft Drinks= Orange; Distilled water= Red; Tap water= Red; Baking soda=Red; Ammonia= Red; Soapy water= Red; Bleach= Violet (unstable color). Thus the larger wavelength the higher absorbance can be observed, the color shift in the substance oxalic acid, lemon juice, orange juice, distilled water and soapy water exhibits 470 nm in Phenol red shows Bathochromic and Hyperchromic effects that affect the absorption wavelength. This exhibits very strong light absorption near 0.3, Hypochromic and Hypsochromic was observe from Tap water, Bleach and Ammonia that exhibits 440 nm and 780 nm in Phenol red and this group shows a weaker absorption based on the characteristics from spectrophotometer (Al-Qahtani., 2021).

The Significant Difference of Camote Tops Leaves Extract as an Alternative pH Indicator with a Concentration of 300mL of Water: 5 grams of Camote Tops Leaves: 180mL of Ethanol and Phenol red Commercial pH Indicator

Table 1 presents the results and discussion of the statistical analysis that has been done. This presented the significant difference of an alternative pH indicator camote tops leaves extract and Phenol red commercial pH indicator in terms of the pH level, color change and color wavelength. This would be presented by one (1) table following the sequence of the specific research problem.

Table 4 presents the results of an analysis comparing the pH level, color change, and color wavelength of selected household substances using both camote tops leaves alternative indicator and Phenol red pH indicators, with a solvent composition of 300mL water and 180 mL ethanol. The analysis shows that there is no significant difference in the pH level between the two indicators (F-value = 0.768, p-value = 0.167), indicating that both indicators yield comparable results in terms of pH measurement. However, there is a significant difference in the color change produced by the two indicators (F-value = 4.611, p-value = 0.000), suggesting that they may have distinct sensitivities or response mechanisms to the pH of the tested substances.

Table 1

VARIABLE	**Camote Tops Leaves Alternative Indicator** **300mL of water: 5 grams of Camote Tops Leaves: 180 mL of Ethanol**			
Phenol red pH indicators	**F -value**	**p- value**	**Remarks**	**Decision**
pH level	.768	.167	Not significant	Do not Reject Ho
Color change	4.611	.000	significant	Reject Ho
Wavelength	1.081	.097	Not significant	Do not Reject Ho

Legend: (<0.1)- Significant differences, and decision must reject the Ho_1
(>0.1)- Not Significant differences, and decided to do not reject the Ho_1

On the other hand, the analysis indicates that there is no significant difference in the color wavelength between the two indicators (F-value = 1.081, p-value = 0.097), implying that both indicators may exhibit similar color spectra despite differences in color change. Overall, these findings suggest that while both camote tops leaves and Phenol red indicators may provide similar pH measurements, they may differ in their ability to produce distinct color changes in response to pH variations.

Based on the study of Alsahi et al. (2024), mentioned that camote tops Leaves anthocyanins as pH indicator has a pH range of 2 to12, 2 to 6 as acid with a low pH color that appeared pink and 8 to 12 as basic with a high pH color that appeared green. Above pH range 12, camote tops extract turns to yellow. As stated by Porres and Stanyon (2017), Phenol red also known as Phenolsulfonphthalein or PSP is used as pH indicator: its color exhibits a gradual transition from yellow to red over the pH range of 6.8 to 8.2. Above pH 8.2, Phenol red turns to bright pink (fuchsia) color.

A local study conducted by Bicol (2024) proves that the properties of camote tops leaves extract can indicate pH level of various solutions. It aimed to evaluate the efficiency of camote tops (*Ipomoea batatas)* in distinguishing between acidic and basic levels.

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The central aspect of this study was the extract obtained from the camote tops leaves which is purple in color. When added to solutions, it resulted in a range of pink and green hues. The color intensity decreased as the acidity of a substance decreased, similar to the observation with bases.

As stated by Pham et al. (2019), the certain commercial indicators like phenolphthalein only exhibit a limited color change, typically from colorless to pink in acid-base titration. Unlike phenolphthalein, on the other hand, anthocyanin extract demonstrates the ability to display multiple color changes. In terms of appearance, the color shift from red to pink in acidic solutions, green in mildly basic solutions to yellow in a high basic solutions.

Therefore, in terms of pH level and color wavelength of camote tops leaves and Phenol red have no significant differences. This proves that natural indicators can be as just good for testing, pH, cost-effective, accurate, cheaper, and accessible making it a valuable alternative for such analyses.

The Significant Difference of Camote Tops Leaves Extract as an Alternative pH Indicator with a Concentration of 400mL of water: 5 grams of Camote Tops Leaves: 240mL of Ethanol and Phenol red Commercial pH Indicator

Table 2 presents results and discussion of the statistical analysis that has been done. This presented the significant difference of an alternative pH indicator camote tops leaves extract and Phenol red commercial pH indicator in terms of the pH level, color change and color wavelength. This would be presented by one (1) table following the sequence of the specific research problem.

Table 2

VARIABLE	**Camote Tops Leaves Alternative Indicator 400mL of Water: 5 grams of Camote Tops Leaves: 240 mL of Ethanol**			
Phenol red pH indicators	**F -value**	**p- value**	**Remarks**	**Decision**
pH level	.077	.128	Not significant	Do not Reject Ho
Color change	5.231	.032	significant	Reject Ho
Wavelength	.115	.137	Not significant	Do not Reject Ho

Legend: (<0.1)- Significant differences, and decision must reject the Ho_2
(>0.1)- Not Significant differences, and decided to do not reject the Ho_2.

Table 2 presents the results of a similar analysis, but with a solvent composition of 400mL water and 240mL ethanol. Similar to Table 1, the analysis shows that there is no significant difference in the pH level between camote tops leaves and Phenol red pH indicators (F-value = 0.077, p-value = 0.128). This indicates that both indicators yield consistent pH measurements regardless of the solvent composition. However, in terms of color change, the analysis reveals a significant difference between the two indicators (F-value = 5.231, p-value = 0.032), suggesting that their responses to pH variations may be influenced by the solvent composition. Interestingly, there is no significant difference in the color wavelength between the two indicators (F-value = 0.115, p-value = 0.137), implying that their spectral characteristics remain consistent despite changes in color change. Overall, these results suggest that while both camote tops leaves and Phenol red indicators may yield similar pH measurements, their responses to pH variations may be influenced by factors such as solvent composition, highlighting the importance of considering experimental conditions when choosing a pH indicator.

Both tables provide valuable insights into the performance of camote tops leaves and Phenol red indicators in qualitative pH testing, shedding light on their sensitivity to pH variations and potential differences in response mechanisms under different experimental conditions.

A local study conducted by Bicol (2024), it proves that the properties of camote tops leaves extract can indicate pH level of various solutions. It aimed to evaluate the efficiency of camote tops (*Ipomoea batatas)* in distinguishing between acidic and basic levels. The central aspect of this study was the extract obtained from the camote tops leaves which is purple in color. When added to solutions, it resulted in a range of pink and green hues. The color intensity decreased as the acidity of a substance decreased, similar to the observation with bases.

Based on the study of Pham et al. (2019), certain commercial indicators like phenolphthalein only exhibit a limited color change, typically from colorless to pink in acid-base titration. Unlike phenolphthalein, on the other hand, anthocyanin extract demonstrates the ability to display multiple color changes.

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Alternative Basis of Color Chart in Camote Tops Leaves Extract as an Alternative pH Indicator

Figure 5 and Figure 6 show the output of the study by developing a color chart for camote tops leaves extract as a basis of color change observation. This output was developed to help future studies and reader to know what pH level is indicated in the color change of low pH (acid), neutral, high pH level (base), and strong base substances. This present in a chart with pH 2 to 11 and a color that indicated the level of pH.

pH	2	3	4	5	6	7	8	9	10	11
Color	Red	Dark Pink	Pinkish Pink	Orange Pink	Faint Orange	Faint Green	Green	Blue Green	Dark Green	Yellow

Figure 5. Color Chart of Camote Tops Leaves as Alternative pH Indicator

Figure 5 serves as a basis of color change of the application of camote tops leaves alternative indicator when used in determining the pH level of the substance. The color change can range from 2 to 11 pH level. The color that will be observed in the substances will be their pH level. High acid substances would appeared red, low acid substances appear as dark pink to light pink hues. Basic substances appear as green hues and a substance that have high base pH would appeared yellow in color.

Indicator	Low pH Color	Neutral	High pH Color	Highest pH Color
Camote Tops *(Ipomoea batatas)* Leaves	Pink 2-6	Apple Green 7	Green 8-10	Yellow 11

Figure 6. pH Range and Color Change of Camote Tops Leaves pH Indicator

Figure 6 demonstrates the color changes of camote tops leaves extract in low pH substance, neutral, high pH substance and highest pH substances. Low pH level from 2 to 6 appear as pink hues, neutral pH level 7 appear as green, High pH level from 8 to10 appear as green hues. Above pH 11 appear color yellow because of strong base properties.

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DISCUSSION

This chapter presents the summary of the findings, conclusions and recommendations of the study.

INSIGHTS

The study demonstrated the effectiveness of camote tops (sweet potato leaves) as a natural pH indicator, showing distinct color changes across different pH levels. Acidic substances produced vibrant red hues, while alkaline substances resulted in varying shades of blue. These observations confirm that camote tops can serve as a reliable alternative to synthetic pH indicators. Furthermore, the results remained consistent when different concentrations (3mL, 5mL, and 10mL) of the extract were used, suggesting its robustness in pH determination. Increasing the volume of the extract enhanced its sensitivity, producing more pronounced and distinguishable color changes, which indicates that adjusting the concentration can improve accuracy in qualitative pH testing.

A comparison with Phenol red, a commonly used commercial indicator, revealed that while both indicators effectively detected pH changes, camote tops displayed more distinct color transitions, making it more visually accessible for qualitative analysis. The wavelengths recorded for both indicators showed no significant difference, but the stronger color variations in camote tops suggest its potential as a practical and cost-effective alternative. Additionally, the study explored the impact of different solvent compositions, demonstrating that while the pH sensitivity remained stable, variations in the ethanol and water mixture influenced the extract's color intensity. This implies that the solvent composition may affect the efficiency of anthocyanin extraction and its interaction with pH levels.

The findings suggest that camote tops can be a valuable natural alternative to synthetic indicators, particularly in educational and laboratory settings where accessibility and affordability are essential. The development of a color chart based on its pH responsiveness further enhances its practical application. Given its effectiveness and availability, camote tops can be utilized in various fields such as food science, agriculture, and environmental monitoring. However, further research could explore its long-term stability, reproducibility, and potential applications beyond laboratory use. Overall, the study highlights the potential of camote tops as an eco-friendly and sustainable option for pH determination, offering a viable solution to reduce reliance on synthetic chemicals. researchers and future studies may build upon the findings of the current research and explore additional factors that may influence the performance of pH indicators, such as temperature, light exposure, and sample composition. By conducting interdisciplinary research projects and collaborating with experts from different fields, researchers may gain a comprehensive understanding of pH testing principles and develop improved methods for qualitative testing. Additionally, future studies may investigate the potential applications of alternative pH indicators in emerging fields, such as point-of-care diagnostics and environmental monitoring, to address pressing societal needs and challenges.

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