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ACID-BASE INDICATOR PROPERTIES OF GUMAMELA PETAL VARIETIES

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Abstract — Exhaustive survey on the utilization of Philippine resources revealed urgent need for continued effort on the chemical study of the country's flora for commercial, industrial and educational purposes. Gumamela is one of the plants that have to be developed for its many uses. Isolation of acid-base indicator from plant is not new in chemistry. Several hundreds of indicators have been investigated and the list continues to grow. This study investigated on the acid-base indicator properties of gumamela petal varieties.

Three gumamela petal varieties namely: *Hibiscus rosa-sinensis* var. 'Gelia Castillo', *Hibiscus rosa-sinensis* var. 'Petite Peach' and *Malvaviscus arboreus* var. 'Penduliflorus' were used. Testing includes determination of the phytochemical components of the extract and determining indicator properties in acidic and basic solutions.

Results showed different color changes in acid and base solution for all the samples. Supported by phytochemical analysis, the study concluded that the gumamela varieties tested possessed natural acid-base indicator properties with *H. rosa-sinensis* var. 'Gelia Castillo' having the highest potential. A standard color matrix for each gumamela variety was developed to serve as guide in interpreting its response to acid and base solutions. The color matrix will serve as standard in determining pH of solutions.

***Keywords* — Acid-base, natural indicator, *H. rosa sinensis* L., acid-base color matrix, Malvaceae.**

INTRODUCTION

Gumamela or *H. rosa-sinensis L*. is a member of the Malvaceae family under the division Magnoliophyta. The plant is erect, highly branched, glabrous tree (Magdalita et al, 2019) with a height ranging from 90 cm to 6 m. The leaves are green, deltoid to ovate, measuring 7-12 cm and are continuously produced all year round.

Gumamela flowers are complete and perfect having the stalks holding the stamen and the pistil fused in one column emerging in the middle of flower (Ellis, 2017). It is commonly used for adorning home facades and gardens because of its beautiful color hues and color combinations, thus referred to as “Queen of Filipino Garden”.

More than its ornamental value, gumamela is also used as a herbal medicine to treat different ailments such as epilepsy, leprosy and diabetes (Kumar and Singh, 2012). It has also found its place as an important flower in education especially in the field of Science because of its viability as natural dyes, food flavor and coloring pigments. It has also find its way in the classroom as teachers are using it as a local indicator in the lesson for acid and bases.

About 300 species of *Hibiscus* plants are found worldwide. *Hibiscus* is regarded to be one of the most widely cultivated flowering plants in the tropics with short-lived but continuing blooms in brilliant hues of red, orange, purple, white and yellow since the original red-flower plant has undergone tremendous development. It is easily propagated and not particularly exacting in its growing requirements. It is connoisseur flower that gained countless fans like other flowers such as dahlias and rose (Magdalita, 2012). Some species of this plant are grown with double or semi-double petals for improving its aesthetic values. Most of its species represent some nations worldwide.

These flowering plants do not just range from its aesthetic value. It also serves a good source for medications to cure sickness, inflammation, and infections. The flowers are considered as astringent and yield polyphenols, flavonoids, anthocyanins and hisbiscetin. Studies also show that these flowers contain polysaccharides which promote wound healing and are immune modulating. The roots on the other hand, contain mucilage that is soothing on pethe mucous membranes as digestive and respiratory tracts (Stuart, 2016). Natural dyes is also an eco-friendly acid-base indicator (Pathan and Faroogui, 2011). *Hibiscus* plants are abundantly grown and cultivated in the native old world of many countries. Since it is most suitable for humid and tropical climates, great supplies can be found to tropical and subtropical countries.

Belonging to the family Malvaceae, gumamela (*H. rosa-sinensis*) is a common garden plant in the Philippines that produces large flowers, which measure about 4 inches in diameter. The flowers come in white, yellow, pink, red and thousands of color combinations, except true blue or black. Some smaller gumamela varieties have blossoms that are 2 inches in diameter and the flowers of other bigger varieties are 10 to 12 inches in diameter. The flowers come in single or double layers, depending on the variety.

Chemists perceived gumamela flowers as a complete chemical entity which is composed of different chemical compounds. Years of research in this plant species, great minds discovered that the fragrance in flowers is due to terpenes and terpenoids. The color is due to flavones, flavanols, anthocyanins and other phytochemicals and its nectar is a mixture of sweet carbohydrates. It has many applications where flowers can be used. One such application is the use of flower extract in acidimetry and alkalimetry as an indicator (Okoduwa et al., 2015).

The isolation of acid-base indicator from plant is not new in the field of chemistry. Several hundreds of these indicators have been investigated and the list continues to grow. Gumamela petal, as a possible source of acid-base indicator offers the advantage because it is generally considered a waste material and indigenous in the Philippines. Natural indicators must be developed for healthy environment and to find alternative materials that are available in the locality especially to far – flung barangays, thus this study.

The study investigated on the acid-base indicator potential of *H. rosa-sinensis* var. 'Gelia Castillo' var, *H. rosa-sinensis* var. 'Petite Peach' and *Malvaviscus arboreus* var. 'Penduliflorus'. It included the conduct of phytochemical analysis to determine the chemical nature of the materials. The responses of the extracts to acid and base samples were likewise noted from where a color matrix was developed as bases of the acid-base indicator properties. It however, does not consider other gumamela varieties which are not commonly available in the locale.

MATERIALS AND METHODS

The study involved three major phases such as: a) establishing phytochemical components of the samples, b) testing for the natural acid-base indicator properties, c) analysis of data and developing a color matrix for gumamela varieties. It was however preceeded by selecting a potential plant material that showed the characteristics of a potential natural acid-base indicator.

Collection and Description of the Raw Materials

Three varieties of gumamela flower were used in this research. These varieties are those that are common, dominant and can easily be found in the community. *H. rosa-sinensis var. 'Gelia Castillo'* (Fig. 1), *H. rosa-sinensis var. 'Petite Peach'* (Fig. 2) and *Malvaviscus arboreus var. 'Penduliflorus'* (Fig. 3) obtained from the Camarines Sur, Bicol Region, Philippines were used in the study.
H. rosa-sinensis '*Gelia Castillo*' has

Fig. 1. *H. rosa-sinensis* var. '*Gelia Castillo*'.

Fig. 2. *H. rosa-sinensis var. 'Petite Peach*'.

Fig. 3. *Malvaviscus arboreus var.*

has gold petals with deep maroon eye zone and orange halo. Flowers are large to extra-large, single, and with overlapped blooms. Plants have very prolific blooming habit, tall, upright bushy, and are well-branched. It is part of the UPLB Millenium H. Hybrids Series.

H. rosa-sinensis '*Petite Peach*' has peach flowers with a red eye and white halo. It has lanceolate and serrate leaf margins. It is a shrubby variety that is floriferous and vigorous. The variety produces small to medium sized flowers that are one day-old with 5 single type petals.

Malvaviscus arboreus var. *'Penduliflorus*' is a perennial, tall evergreen shrub that produces tubular, pendulous. Solitary flowers that are 6.4 cm long. It has multiple anthers. The flowers are drooping that never open. Leaves are dark green with alternate phyllotaxy, lancearate to ovate with a pointed tip.

Reasonable quantity of *H. rosa-sinensis* var. '*Gelia Castillo*', *H. rosa-sinensis* var. '*Petite Peach*' and *Malvaviscus arboreus* var. '*Penduliflorus*' were collected and the petals were thoroughly air-dried for three days. The 20g dried samples for each gumamela variety was used for the phytochemical analysis.

Establishing Phytochemical Components of the Samples

The highly colored pigments obtained from plants are found to exhibit color changes with variation of pH. The chemical substances which possess an apparent change in color of analyte and titrant reacting mixture very close to the point in the ongoing titration is known as indicator. Typically, the presence of flavonoids and alkaloids may result to sharp color changes (Hossain et al., 2013) which had occurred at end point of titrations. Thus, phytochemical analysis, a test to know the presence of flavonoid and alkaloid in the samples was employed.

***Collection and preparation of materials*.** The samples of *H. rosa-sinensis* var. 'Gelia Castillo', *H. rosa-sinen*sis var. 'Petite Peach' and *Malvaviscus arboreus* var. 'Penduliflorus' were collected in the province of Camarines Sur Philippines.

***Sample preparation*.** Appropriate quantity of *H. rosa-sinensis* var. 'Gelia Castillo' (sample 1), *H. rosa-sinensis* var. '*Petite Peach*' (sample 2) and *Malvaviscus arboreus* var. '*Penduliflorus*' (sample 3) were prepared and the petals were thoroughly air-dried for three days. The 20g dried samples was used for the phytochemical analysis.

***Phytochemical Analysis*.** The air-dried 20 g each of *H. rosa-sinensis* var. '*Gelia Castillo*', *H. rosa-sinensis* var. '*Petite Peach*' and *Malvaviscus arboreus* var. 'Penduliflorus samples were subjected to preliminary phytochemical screening to identify the chemical constituents at the Department of Science and Technology (DOST) Laboratory, Taguig, Philippines. Test for the presence of anthocyanins, specifically alkaloids, flavonoids, phenols and tannin using appropriate and standard method of phytochemical analysis.

Testing for the Natural Acid- Base Indicator Property

Laboratory testing to determine the potentials of extracts from the gumamela test varieties was employed. It was done through the following processes:

Plant Collection. Fresh samples of *H. rosa-sinensis* var. 'Gelia Castillo', *H. rosa-sinensis* var. 'Petite Peach' and *Malvaviscus arboreus* var. 'Penduliflorus' were collected in the province of Camarines Sur,Philippines.

Sample Preparation. Fifteen pieces of petals each of fresh *H. rosa-sinensis var. 'Gelia Castillo', H. rosa-sinensis var. 'Petite Peach'* and *Malvaviscus arboreus var. 'Penduliflorus'* were pounded using mortar and pestle and its juice was extracted using 15 ml of distilled water as the solvent. Extracts were labeled as Sample A for variety no. 1 (*H. rosa-sinensis var. 'Gelia Castillo'*), Sample B for variety no. 2 (*H. rosa-sinensis var. 'Petite Peach'*) and Sample C for variety no. 3 (*Malvaviscus arboreus var. 'Penduliflorus'*). The extracts were filtered and reserved for the actual laboratory test.

Experimental Design and Treatments. To determine the response of gumamela extracts to the acid-base solutions, a complete block design was employed. Standard acid and base solutions was prepared and used in the testing according to the experimental lay-out in table 1.

Table 1. The Experimental Lay-out.

Treatment 1 H. rosa-sinensis var. 'Gelia Castillo'			**Treatment 2** H. rosa-sinensis var. 'Petite Peach'			**Treatment 3** Malvaviscus arboreus var. 'Penduliflorus'		
pH 2	pH 7	pH 10	pH 2	pH 7	pH 10	pH 2	pH 7	pH 10
R1	R1	R1	R1	R1	R1	R1	R1	R1
R2	R2	R2	R2	R2	R2	R2	R2	R2
R3	R3	R3	R3	R3	R3	R3	R3	R3

Legend: R1-replicate 1; R2- replicate 23 R3- replicate

Three replicates each for every experimental treatment were tested Treatment 1 was *H. rosa-sinensis var. 'Gelia Castillo'reagents*; treatment 2 was *H.* rosa-sinensis var. 'Petite Peach' and treatment 3 was *Malvaviscus arboreus* var. 'Penduliflorus'. Each sample was tested with standard acid and base solutions of pH 2, 7 and 10. The main intent was to test the extracts with all the pH from pH 1 to pH 14 but the constraint of not having buffer for all the pH in the laboratory limited the conduct of the testing. Hydrochloric acid was the acid solution used and Sodium Hydroxide was the basic solution. The chemicals were particularly chosen because aside from being the common acid and base, it is also the strongest acid and base respectively.

Testing the indicator properties of the extracts. The filtrate (extract) of each flower was tested with acid and base solutions and the results were recorded. Three drops of the extract were added into each of the sample solution and the response was determined by observing any color change that will take place.

Analysis of Data and Development of Color Matrix

Observation about the color response of the various treatments tested to the standard acid and base solutions was used as basis of developing the standard color matrix for each of the gumamela species that can be used as a guide in using the natural indicator from gumamela plant species tested. UV Spectrophotometer was used to determine the wavelength of the color range to get the accurate color for each of the sample response.

RESULTS AND DISCUSSION

Acid-base indicator property of gumamela varieties were discussed on the following results. It was focused on a) phytochemical components of the extract; b) response of the gumamela extracts to standard acid and base solutions; c) color matrix that was developed from the color responses of the experimental extracts.

Phytochemical Components of the Samples

Phytochemicals are naturally occurring plant chemicals. They provide plants with color, odor, and flavor. Brightly colored plants are often sources of phytochemicals. Thousands of phytochemicals have been identified and scientists begun to investigate their promise. Some of the phytochemicals are carotenoids, flavonoids such as anthocyanins, indoles and glucosinolates, inositol, isoflavones, polyphenols and terpenes.

Table 2 presents the results of phytochemical analysis to the samples. Data reflected positive results about the phytochemical contents of the sample extracts tested. It can be gleaned from table 2 that sample extract 1 contains seven phytochemicals such as sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides and tanins. Triterpenes, flavonoids and tannins are the most abundant phytochemicals.

Table 2. Results of Phytochemical Test for Gumamela Varieties Tested.

Phytochemical	Samples		
	S1	S2	S3
Sterols	++	+	++
Triterpenes	+++	+++	+++
Flavonoids	+++	++	++
Alkaloids	+	+	(-)
Saponins	++	++	+
Glycosides	++	++	++
Tannins	+++	+++	+

Legend: S1- *rosa-sinensis var Gelia Castillo*
S2-rosa-sinensis var Petite Peach
S3-
Note: (+) traces; (++) moderate
(+++) abundant (-) absence of constituent

Sample extract 2 (*H. rosa-sinensis* var.'Petite Peach') likewise contains all the phytochemicals found in sample 1 but differ in the relative quantity. It was noted from the results that tripertenes and tannins are the phytochemical present in abundant quantity in the sample.

It can be noted further in table 2, that sample extract 3 (Malvaviscus arboreus var. 'Penduliflorus') contains phytochemicals such as sterols, triterpenes, flavonoids, saponins, glycosides and tannins. It was found not to contain alkaloids. It was further indicated in the results that triterpenes is the most abundant phytochemical in the sample.

Findings revealed that the three species tested contain the same phytochemical component except *Malvaviscus arboreus* var. 'Penduliflorus' which was found not to contain alkaloids.

Looking closely in the results, it can be gleaned that in terms of sterols, sample1 has a moderate content compared to trace content for both samples 2 and 3. All of the three varieties have abundant amounts of triterpenes.

In terms of flavonoids, sample 1 has an abundant content compared to moderate content for both samples 2 and 3. Samples 1 and 2 contain trace amounts of alkaloids while sample 3 does not contain it. Saponin is moderately observed in sample 1 and sample 2 but only trace amounts is observed in sample 3.

Glycosides were likewise found to be moderately present in all the three varieties. Tannin is abundant in samples 1 and 2 but only trace amount in sample 3.

It can be inferred from the results that gumamela varieties are of different chemical makeup. There may be similarities in the phytochemical components but generally it differ in the detectable amounts. It logically mean that there is a variation in the chemical constituents of petal extracts even if they were in the same family thus imply variations in the response to acids and bases. It may further imply that variations in the color matrix for responses to different pH of the varieties is possible.

Results of the study supported the findings of Magalong and Lopez (2007) on the determination of phytochemical content and antimicrobial properties of floral extracts from 14 cultivars of gumamela (*H. rosa sinensis*). The study revealed that all the floral extracts from the different gumamela cultivars were found to contain alkaloids, cardenolides and bufadienolides, tannins, protein and carbohydrates.

Results likewise conformed with the preliminary result of the phytochemical analyses, nutrient value and economic importance of *H. sabdariffa*, a gumamela species in Nigeria as reported by Okereke et. al. (2015). It showed that there are some plant chemicals present in the extract such as alkaloids, tannins, saponnins, glycosides, phenols and flavonoids.

Potentials as Acid-Base Indicator

Relating results of phytochemical analysis of the samples to its potential as natural acid and base indicator, it can be inferred that all the three samples can be a natural acid and base indicator because all of them contains flavonoids.

Flavonoids are a ubiquitous group of naturally occurring polyphenolic compounds characterized by flavan nucleus and represent one of the most prevalent classes of compounds in fruits, vegetables and plant-derived beverages. Anthocyanins are group of flavonoid compounds. The results obtained in all the types of acid-base titrations lead us to conclude that the presence of flavonoids made possible the sharp color changes that occurred at end point of titrations (Burungale and Mali, 2014).

Foregoing results of phytochemical analysis for all the 3 samples revealed presence of flavonoids thereby indicating potential of samples as acid-base indicator. The result conformed with the study of Magalong and Lopez (2007) and Okereke et. al.(2015); that flavonoids were present in H*ibiscus* varieties.

Responses of Gumamela Extracts to Acid and Base Solutions

Indicators are chemical substances added in small quantity to a solution to determine the acidity or alkalinity of the solutions (Garba and Abubakar, 2012). Indicators are weak organic acids or bases that exist in more than one structural form (tautomers) of which at least one form is coloured. Natural acid - base indicator helps determine the pH value of a given substance. Common natural indicators are pigment, known as anthocyanin, which reacts very visibly to changes in pH.

Table 3 presented the color responses of the sample extracts to the changes in pH with its corresponding changes in color. Three varieties of gumamela were investigated at pH 2, 7 and 10 and the color change was observed along with the changing pH.

Results of titration indicated that the three extracts tested have varying response to pH changes as indicated by the changes in color observed. Findings imply that color matrix vary among three varieties and thus have different responses and potentials as natural indicator.

Data reflected positive results about the phytochemical contents of the sample extracts tested. It can be gleaned from Table 2 that sample extract 1 contains seven phytochemicals such as sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides and tanins. Triterpenes, flavonoids and tannins are the most abundant phytochemicals.

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Table 3. Color Change of gumamela.

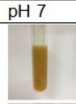
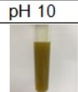
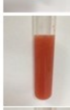
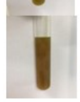
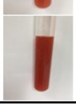
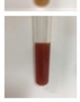
T	pH 2	color	pH 7	color	pH 10	color
1		pink		Dark yellow		green
2		red		Light pink		Dark green
3		Dark red		Red violet		violet

Table 3 presented the color responses of the sample extracts to the changes in pH with its corresponding changes in color. Three varieties of gumamela were investigated at pH 2, 7 and 10 and the color change was observed along with the changing pH.

Results of titration indicated that the three extracts tested have varying response to pH changes as indicated by the changes in color observed. Findings imply that color matrix vary among three varieties and thus have different responses and potentials as natural indicator.

Results of this study revealed that *H. rosa-sinensis* var. '*Gelia Castillo*', *H. rosa-sinensis* var. 'Petite Peach' usually turns to red or pinkish red in acidic (pH 2) titration while green to dark green in basic (pH 10) titration respectively. The extract of *Malvaviscus arboreus* var. '*Penduliflorus*' was observed to have a somewhat different color response among the varieties tested because the color changes from dark red to purple as it was titrated with acidic and basic solutions (pH 2 to pH 10). This study found out that the color changes of the extracts change as the pH changes for all samples tested thereby indicating its potentials as a natural acid base indicator.

Verification with UV Spectro-photometer

These results were supported by the data from UV Spectrophotometer that was used to determine the wavelength of the color range to get the accurate color for each titration. The figures below presented the absorbance and transmittance value of the extracts.

The Maximum absorption (Λ_{max}) of the initial color of the petal extract of *H. rosa-sinensis* var. '*Gelia Castillo*'. is 400 nm and a transmittance of 450 which corresponds to the color yellow (Figure 4).

The Maximum absorption (Λ_{max}) of the color of the petal extract of H.

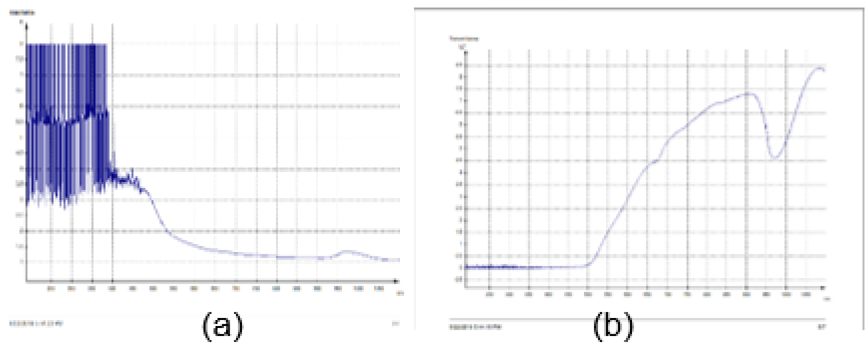


Fig. 4. Absorbance (a) and transmittance (b) of sample 1 before titration

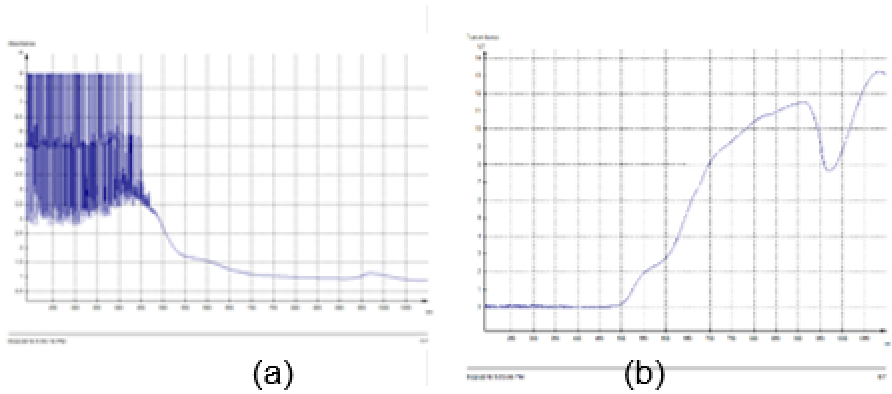


Fig. 5. Absorbance (a) and transmittance (b) of Sample 1 in basic solution.

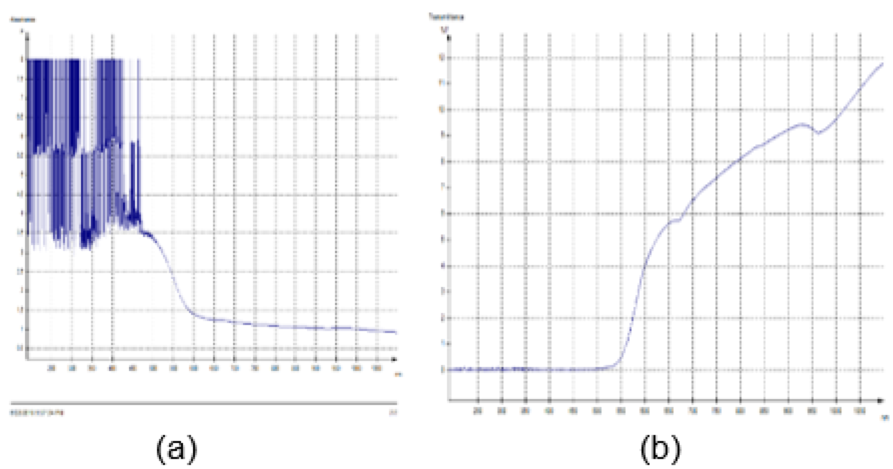
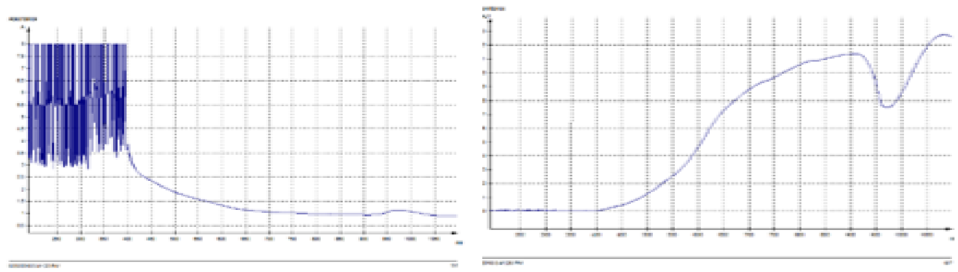


Fig. 6. Absorbance (a) and transmittance (b) of sample 1 in acidic solution.

rosa-sinensis var. '*Gelia Castillo*' in basic titration (Figure 5). It has an absorbance of 500 nm and a transmittance of 450 nm which corresponds to the color green.

The Maximum absorption (Λ_{max}) of the color of petal extract of H. rosa-sinensis var. 'Gelia Castillo' in acidic titration (Fig. 6a). It has an absorbance



(a) (b)

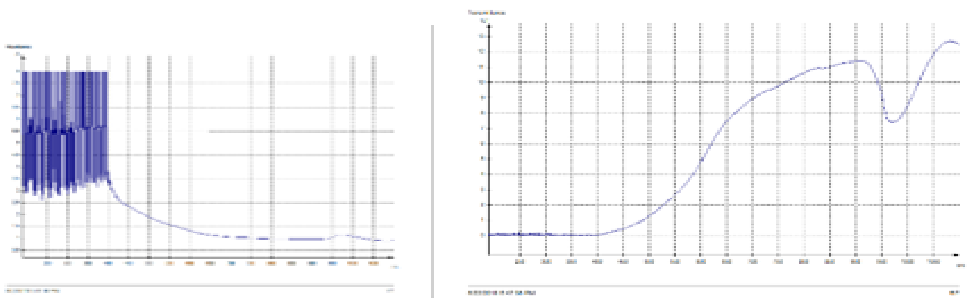
Fig. 7. Absorbance (a) and transmittance (b) of sample 2 before titration.

of 500 nm and a transmittance (Fig. 6b) of 490 nm which corresponds to the color red.

The Maximum absorption (λ_{max}) of the initial color of the petal extract of *H. rosa-sinensis* var. '*Petite Peach*' (Fig. 7). It has an absorbance of 400 nm and a transmittance of 430 nm which corresponds to the color pink.

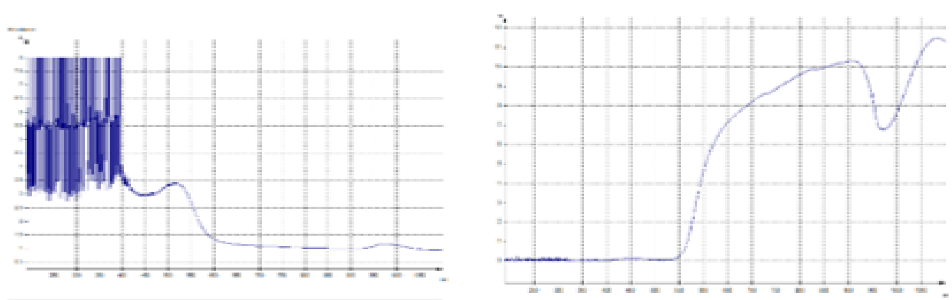
The maximum absorption (λ_{max}) of the color of the petal extract of *H. rosa-sinensis* var. '*Petite Peach*' in basic titration. Its absorbance is 400 nm and a transmittance of 400 nm which corresponds to the color green.

The maximum absorption (λ_{max}) of the color of the petal extract of *H. rosa-sinensis* var. '*Petite Peach*' in



(a) (b)

Fig. 8. Absorbance (a) and transmittance (b) of sample 2 in basic solution.



(a) (b)

Fig. 9. Absorbance (a) and transmittance (b) of sample 2 in acidic solution.

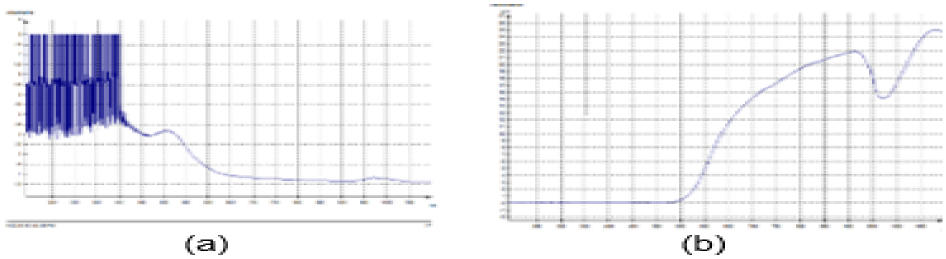


Fig. 10. Absorbance (a) and transmittance (b) of sample 3 before titration.

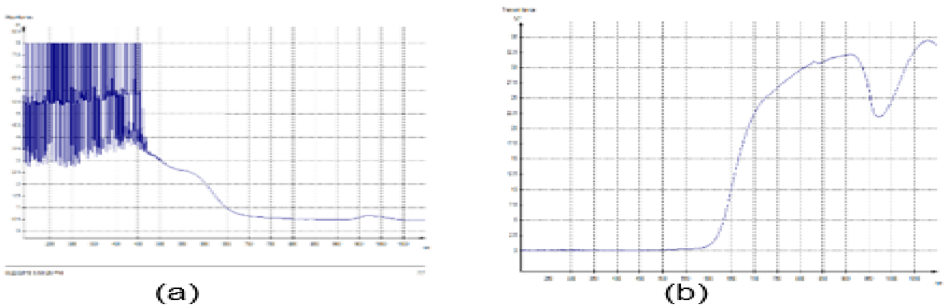


Fig. 11. Absorbance (a) and transmittance (b) of sample 3 in basic solution.

acidic titration 520 nm (Fig. 9) and a transmittance (Fig. 9b) of 500 nm which corresponds to the color red.

The Maximum absorption (λ_{max}) of the initial color of the petal extract of *Malvaviscus arboreus* var. '*Penduliflorus*' is 500 nm (Fig. 10) and a transmittance at approximately 500 nm which corresponds to the color red.

The maximum absorption (λ_{max}) of the color of the petal extract of *Malvaviscus arboreus* var. '*Penduliflorus*' in basic titration. It has an absorbance of 500 nm and a transmittance of 530 which corresponds to the color dark red to violet.

Noted in Fig. 12, that the maximum absorption (λ_{max}) of the color of the petal extract of *Malvaviscus arboreus* var. '*Penduliflorus*' in acidic titration is 550 nm and the transmittance is approximately 490 nm which corresponds to the color red.

Results of the study revealed that the color changes were in the visible region of the spectrum which is commonly from 200nm – 720nm. It was also observed that there was a shifting of color in each pH. In

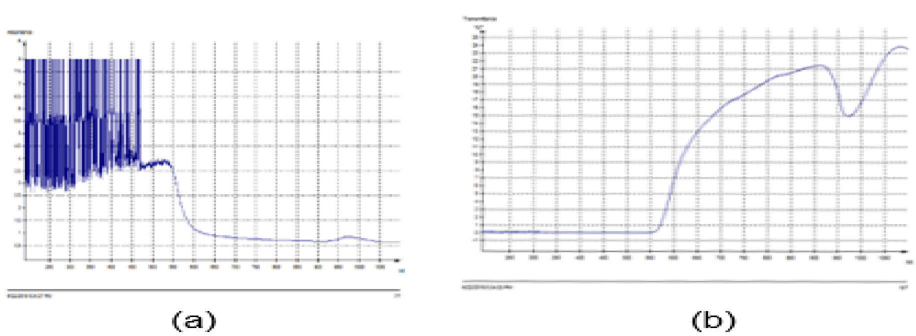


Fig. 12. Absorbance (a) and transmittance (b) of sample 3 in acidic solution.

addition, the color changes observed with the gumamela extract has a good agreement with the prescribed colours of anthocyanin in the itemized reagents. These results indicate the presence of anthocyanin in the petals of the three gumamela varieties, and their color changes with different pH thus a potential natural acid-base indicator.

The absorbance vs. wavelength peak results of this study is similar to the work of Senathirajah (2017). In the acidic pH, such as pH<4, the absorbance maxima were observed at 520 nm, whereas a red-shift was attained with the pH>4. The peak maximum was recorded at 529.5 nm, 537.5 nm and with the pH 4, 5, and 6, respectively. The solutions at pH 8, 9, and 10 showed further red shift and the absorbance maxima was recorded at 560.0 nm, 549.5 nm and 568 nm. The solution at pH 11 and 12 show the peak maxima at around 580 nm, however, the intensity seems to decrease with the solution of pH 12. In particular, no peak maxima were observed in the visible region for the extract at pH 13 and 14, indicate that there was a lost in the conjugation of the anthocyanin chromophore. These results indicate that the H. extract act as a potential indicator over a range of pH.

Results of this study further implied that aqueous extraction does not alter the pH level of the extracts. Thus, when doing or using the natural extract indicator, distilled water must be used. The result also revealed that natural acid-base indicator shifted its color as it shifted its pH.

Color Matrix of the Plant Samples

Acid-base indicators are important because they help chemists get an estimate of the pH value of a given substance. These indicators can be used to classify substances as acids or bases, which are two important classifications in the world of chemistry. Natural indicators relate information by demonstrating shifts in color to inform observers of whether materials are acidic or basic. The indicators, which are plants containing useful chemicals relative to pH levels however, do not provide a numeric value for acidity or basicity. Common natural indicators are litmus, red cabbage and *Hydrangea*. Anthocyanin in natural indicators reacts very visibly to changes in pH. There is a definite color matrix for a plant extract's response to acid and base solutions.

Responses of the various extracts tested to the acid and base solutions were used as basis in developing a standard color matrix for every gumamela species. Table 4 gives the color matrix developed from the responses of the gumamela extracts to standard acid and base solutions used in the laboratory procedures such as pH 2, 7 and 10 representing acid, neutral and base solutions. Observed color for the samples used in testing served as basis in coming up with a standard color matrix for all pH ranges.

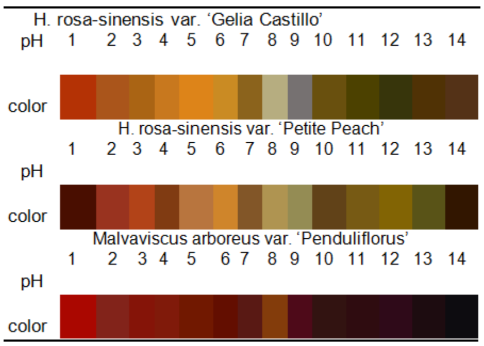
Table 4. Color matrix developed from the responses of the 3 treatments tested to standard acid and base solutions.

H. rosa-sinensis var. 'Gelia Castillo'			
pH	2	7	10
Color			
H. rosa-sinensis var. 'Petite Peach'			
pH	2	7	10
Color			
Malvaviscus arboreus var. 'Penduliflorus'			
pH	2	7	10
Color			

The matrix will define the natural indicator's response to acid and base solutions at various pH, thus will serve as a guide in coming up with an approximate pH of a test solution. Interpolation on the observed color range for each of the test extract resulted to the Standard Color Matrix for each gumamela variety given in table 5.

The results supported the findings of Jain et al. (2012) that aqueous petal extract of flowers shows yellow for weak base and greenish in strong base while pink to red in weak acid and strong acid at end point (Jain et al. (2012). It also conformed with the result of the study of Gupta et al., (2012) where the color changed from pink to greenish yellow in th case of aqueous floral extract of H. rosa

Table 5. Color Matrix for *Hibiscus.*



sinensis as natural indicator and the color changed from pink to green in the case of methanolic floral extract of *H. rosa sinensis* as natural indicator. Statistically also the use of natural indicator in acid base titration is proved, hence aqueous extract can be used with cent percent reliability and accuracy for acid base titration. Thus, the use of natural indicators in acid base titration is more beneficial because of their economy, easy to prepare, simplicity, easy availability, pollution free, inert and accurate results.

Potential Natural Acid-Base Indicator

The use of local materials has been the subject of cost oriented study by scientists over the years. Flower is one of such local (non-conventional) material that could be used in place of standard indicator in science teaching (Garba et al , 2012).

In this study, the results of extracts color changes in acid and base solutions, showed a wide array of shifting. Since, the extracts produced color changes; it implied that they can be used to detect acidity or alkalinity of solutions. It also revealed the potentials of flower extracts as indicator and confirmed the assertion that; nearly all brightly colored flowers can be used as indicators. Thus, all of the three varieties were potential natural acid-base indicator however; the best variety that showed sharp color changes at end points due to the relatively wide shift in absorption and transmittance value which falls on visible region of spectrum that can be associated to its abundant content of flavonoids was the *H. rosa-sinensis* var. 'Gelia Castillo'.

The findings therefore, indicate an alternative way of equipping laboratory with practical instructional material (indicator) using plants that are around or within the environment.

CONCLUSION

The phytochemical components of the three gumamela varieties tested were sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides and tannins. The findings also revealed that the three varieties contained the said constituents except for the alkaloids that is not found in *Malvaviscus arboreus* var. 'Penduliflorus'. Responses of the gumamela extracts were as follows: *H. rosa-sinensis* var. 'Gelia Castillo' extract exhibited a color change of red at pH 2 (acid), dark yellow at pH 7 (neutral), and green at pH 10 (base). *H. rosa-sinensis* var. 'Petite Peach' presented a color change of red at pH 2, pink at pH 7 and dark green at pH 10. *Malvaviscus arboreus* var. 'Penduliflorus' on the other hand showed a color change of dark red at pH 2, red violet at pH 7 and violet at pH 10.

Analysis of the noted response of the test extracts to acid base solution and interpolating the results yielded the standard color matrix for each gumamela variety. All of the three varieties were potential natural acid-base indicator however the best variety that showed sharp color changes at end points due to the relatively wide shift in absorption and transmittance value which falls on visible region of spectrum that can be associated to its abundant content of flavonoids was the *H. rosa-sinensis* var. 'Gelia Castillo'.

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