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NATURAL INDICATOR: AN UNIQUE REPLACEMENT FOR STANDARD INDICATORS

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ABSTRACT

Present study investigated a natural indicator for acid - base solution which is collected from Ripe fruit of puisak, light yellow Dahlia flower, Orange Mari Gold flower and Red Salvia flower. Colour change of the indicator and pH range were determined for each type of acid-base solution. These values were comparable to those obtained from the standard indicators. Colour pigments were extracted from the flowers via cold extraction using soxhlet extractor. The pH value of the extracts with wavelengths of absorption was determined using UV/Visible spectrophotometer. From the result obtained, all the extracts exhibited sharp contrast between their colours in acid and base. The maximum wavelengths of absorption obtained from all extract fall within the visible region of electromagnetic spectrum. These values are almost similar to that obtained from synthetic indicators. It is on these bases that we concluded that natural indicators could be an excellent replacement for synthetic indicators since they are cheap, readily available, simple to extract, non toxic and also environment friendly.

KEYWORDS: Absorption, Acid-Base, Dahlia, Mari Gold, Natural Indicator, Ph, Ripe Fruit of Puisak, Salvia, Wavelength

INTRODUCTION

In continuation of our earlier study [1], here we observed that some commonly flower petals act as a natural indicator which responses acidic and basic solutions.

The changes in hydrogen ion concentration accompanying the addition of a base to an acid are important for analytical purposes. Here we shall discuss how the pH of a solution changes during the course of acid-base titrations in aqueous medium. We shall see how the acidity of substances is measured. We shall produce natural indicating substances and we will determine the colour scale of them. In most cases we will use household and natural substances.

Indicators are pigments or dyes that can be isolated from a variety of sources, including plants, fungi and algae [2, 3]. Virtually any flower that red, blue or purple in colour contains a class of organic pigments known as anthocyanin that can change colour with pH [4]. Some naturally coloured substances change colours when the acidity or alkalinity of their environment changes, for example, grape juice, brown tea, and some flower pigments. These substances are called acid-base indicators [5]. Indicators change colour at a particular stage of chemical reaction [6]. A number of commonly used indicators in the laboratories are methyl red, methyl orange, phenolphthalein, phenol red, methyl yellow, pentamethoxy red, bromophenol blue, thymol blue,

And so forth [7]. Most type indicators are available for different types of titrimetric analyses. For acid-base titrations, organic dyes, which are either weak acids or bases, serve excellently as indicators [8, 9].

On the bases of these rationales of the hazardous effects of synthetic indicators, there has been a increasing

interest in the search for alternative sources of indicators from natural sources of plant origin. The alternatives from plant origin are probably cheaper, readily available, easy to extract, less toxic to users and environmentally friendly [10-13].

The quality of a good indicator is that its colour change should be sharp, there would be contrasting colour change in acid-alkaline medium and the colour change occurs strictly at the neutralization point.

Indicators are dyes or pigments that are isolated from a variety of sources, including plants, flower petals, fungi and algae. Almost any flower that is, red, blue, pink, yellow, purple etc. in colour contains a class of organic pigments called anthocyanins that changes colour with pH. The use of natural dyes as acid-base indicators was first reported in 1964 by Sir Robert Boylein his collection of essays Experimental History of Colours [14].

METHODOLOGY

Materials

The materials are Ripe fruit of puisak, light yellow Dahlia flowers, Orange Mari Gold flowers and Red Salvia flowers, distilled water, sodium hydroxide and H_2SO_4, CH_3COOH, KOH.

Apparatus

The apparatus consists of Mortar and pestle, weighing balance, beakers, conical flask, burette, pipette, retort stand with clamp, white tile, wash bottle, spatula, stirrer, soxhlet extractor and filter paper (Whatman 40).

Sample Preparation

The four different samples were collected from unwanted materials (pistil, stamen and stalk). They were dried at room temperature. The weights of the samples were constantly taken to ensure that the samples are completely dried. The samples were grounded with mortar and pestle. Each of the samples was filtered and 20 grams was weighed for each and extracted with distilled water.

Sample Extraction

The three flowers and one ripe fruit were extracted by one method, namely, cold method of extraction [15].

Cold Extraction

Exactly 20 grams of each sample of light yellow Dahlia flowers, Orange Mari Gold flowers and Red Salvia flowers and ripe fruit of puisak was weighed and transferred into four separate beakers. 250 ml of distilled water was added into each sample and left overnight. On the following day, they were decanted into clean beakers and rinsed with 20 ml of water to clear the colouring matter. It was then concentrated on a water bath [16].

Characterization of Extract

The extracts were characterized with the use of UV/Visible (Elico, 171, Mini spectro) spectroscopy to determine the wave length of maximum absorption and with the use of pH meter (Elico L1 614 pH analyser) to determine the pH of the cold extracts.

Reaction of Extracts with Acids and Bases

Samples of extract obtained were added to different acids and bases to test if there will be any colour change. The acids used for these were H_2SO_4, CH_3COOH while the bases for these were NaOH and KOH.

UV/Visible Spectroscopy

The Elico 171 Mini Spectrophotometer was used to carry out the whole experiment. The cell to be used for the UV/Visible spectroscopy was washed thoroughly with distilled water. Distilled water was used to calibrate the instrument at the wave length of 400 nm. Therefore 0.001 ml of each extract was diluted with 10 ml of distilled water and 5 ml of the extract was measured and placed in the cell. The absorbance of the extract was determined within the visible region (i.e., 400-750nm) and the wavelength of maximum absorption (λ_{max}) of each extract was extrapolated from the graph.

pH Study

pH study of the above solutions were measured with a pH meter(Elico L1 614 pH analyser).

RESULTS & DISCUSSIONS

The results obtained for the evaluation of the extracts are as presented in Tables 1, 2, 3 and 4. Table 1 to Table 4 shows the initial colour and colour change with acid and base of the four experimental naturally occurring colour pigments. Fig.1 to fig.4 shows the Absorbance vs. Wavelength of these colour pigments. From the graph it was noticed that ripe fruit of puisak shows better colour absorption peak than the other three.

Table 5 shows the colour change of some standard indicators in acidic and basic solutions.

Figure 1 shows the variation of absorbance with wave length of ripe fruit of puisak(cold extract). Here maximum absorbance is near about 1.5. But same plot of different flowers (Figure 2 for For light yellow dahlia flower distilled water extract, Figure 3 for orange Mari Gold flower distilled water extract, Figure 4 for red salvia flower distilled water extract) have shown that the maximum absorbance is near about 1. So, from the figures maximum absorbance of ripe fruit of puisak (violet) is high than the other three flowers extract.

From the UV visible spectrophotometric data it has been found that Absorption Vs. wavelength plot, the intercept value of ripe fruit of puisak is high than the other three. Here absorption is high. So, colour density is high than the other three. We search that naturally occurring colour which is cheap and easily available. Therefore, ripe fruit of puisak is highly dense colour which is easily available in nature. The decreasing order of intercept from the above spectroscropic plots that Ripe fruit of puisak> Orange mari gold> Light Yellow dahlia> Red salvia.

Table 1: Ripe Fruit of Puisak (Cold Extract) (Initial Colour of Extract, Deep Violet)

Solvent	+	Extract	=	Colour Change
ACID				
H_2SO_4	+	Extract	=	Light violet
CH_3COOH	+	Extract	=	Light violet
BASE				
NaOH	+	Extract	=	Deep sap green
KOH	+	Extract	=	Deep sap green

pH=8.5

Table 2: Light Yellow Dahlia (Cold Extract) (Initial Colour of Extract, Pale Yellow)

Solvent	+	Extract	=	Colour Change
ACID				
H_2SO_4	+	Extract	=	Pale red
CH_3COOH	+	Extract	=	Pale red
BASE				

NaOH	+	Extract	=	Deep straw yellow
KOH	+	Extract	=	Deep straw yellow

pH=4.3

Table 3: Orange Mari Gold (Cold Extract) (Initial Colour of Extract, Light Orange)

Solvent	+	Extract	=	Colour Change
ACID				
H_2SO_4	+	Extract	=	No change
CH_3COOH	+	Extract	=	No change
BASE				
NaOH	+	Extract	=	Deep orange
KOH	+	Extract	=	Deep Orange

pH=8.4

Table 4: Red Salvia (Cold Extract) (Initial Colour of Extract, Light Red)

Solvent	+	Extract	=	Colour Change
ACID				
H_2SO_4	+	Extract	=	Light pink
CH_3COOH	+	Extract	=	Very light pink
BASE				
NaOH	+	Extract	=	Light yellow
KOH	+	Extract	=	Light yellow

pH=8.4

Table 5: Acid-Base Indicators

Indicator	Colour Change Interval(Ph)	Acid	Base
Thymol blue	1.2-2.8	Red	Yellow
Methyl orange	3.1-4.4	Red	Yellow
Methyl red	4.4-6.2	Red	Yellow
Chlorophenol red	5.4-6.8	Yellow	Red
Bromothymol blue	6.2-7.6	Yellow	Blue
Phenol red	6.4-8.0	Yellow	Red
Thymol blue	8.0-9.6	Yellow	Blue
Phenolpthalein	8.0-10.0	Colourless	Red
Alizarin yellow	10.0-12.0	yellow	Green

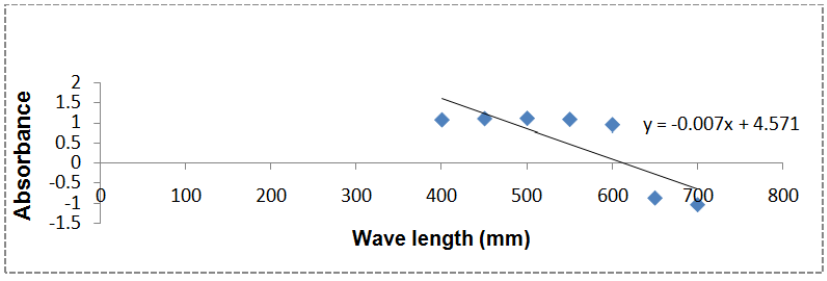

Figure 1: For Ripe Fruit of Puisak Distilled Water Extract

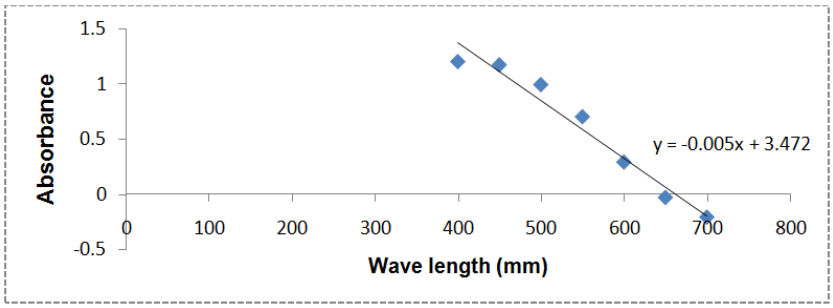

Figure 2: For Light Yellow Dahlia Flower Distilled Water Extract

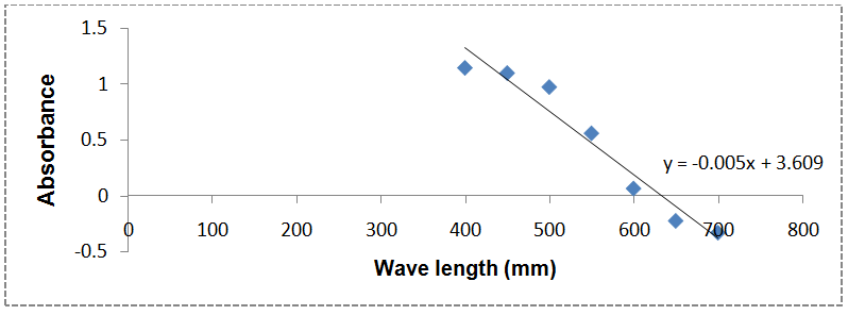

Figure 3: For Orange Mari Gold Flower Distilled Water Extract

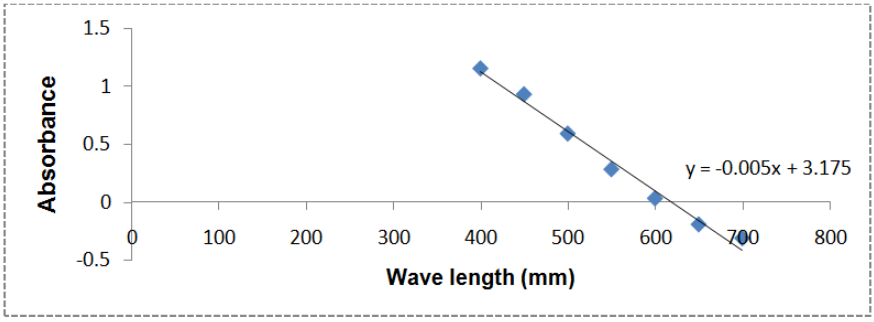

Figure 4: For Red Salvia Flower Distilled Water Extract

From Table 1 it was observed that at acidic solution, deep violet colour changed to light violet and at basic solution, it was changed to sap green. The pH of ripe fruit of puisak (cold extract) was 8.5. So, it was supported the nature of Alizarin Yellow indicator in basic region (Vide Table 5).

From Table 2 it was observed that light yellow dahlia responded light yellow to pale red at the acidic region and deep straw yellow at the basic region. The pH of the light yellow dahlia (Cold extract) was 4.3. So, it was supported the nature of nearly methyl orange in both acidic and basic regions (Vide Table 5).

From Table 3, it was observed that orange mari gold (cold extract) did not show any significant change in acidic and basic solutions, yet its pH was 8.4.

Lastly from Table 4, it was found that red salvia respond light red to light pink at the acidic region and light red to light yellow at basic region. Its colour change was prominent. At basic region, its colour was similar with Alizarin S(well-known indicator of us) and at acidic region colour change did not match any standard indicators.

Indicators are dyes or pigments that are generated by the electronic structure of the dyes interacting with sunlight

in plant tissues. The primary pigments occurring in plants are chlophylls and carotenoids, accumulated in plastids, and anthocyanins and betalanins which are dissolved in vascuoler sap. Different pigments display an ability to absorb varied wave lengths of visible light. Flavonoids together with anthocyanins confer a wide spectrum of colour to flowers and fruits, including yellow.

From the above study it has been found that naturally occurring flower petals are much more important to determine acid-base colour change. Here we found that ripe fruit of puisak colour responses in visible region than the other three flower petals.

CONCLUSIONS

From the result obtained, all the extracts exhibited sharp contrast between their colours in acid and base. The maximum wavelengths of absorption obtained from all extract fall within the visible region of electromagnetic spectrum. These values are almost similar to that obtained from synthetic indicators. We search that naturally occurring colour which is cheap and easily available. Therefore, ripe fruit of puisak is highly dense colour which is easily available in nature. The decreasing order of intercept from the above spectroscopic plots that Ripe fruit of puisak> Orange mari gold>Light Yellow dahlia> Red salvia.

It is on these bases that we concluded that natural indicators could be an excellent replacement for synthetic indicators since they are cheap, readily available, simple to extract, non toxic and also environment friendly.

In a tannery industries, research laboratories, schools, colleges, chemical companies and consultants that make use of indicators for the determination of acidity, alkalinity, humidity and extent of reactions. Therefore, from this study valuable in producing efficient indicator from flowers as substituent or possible replacement for standard indicators.

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