Investigation of Water Hyacinth and Red Cabbage to be used as pH Indicators

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Abstract

Most of the pH indicators are natural indicators consisting of flowers, fruits and vegetables, they can be used directly without toxicity and they can be obtained readily everywhere in the world. At present, the control of pH is important in biochemical processes, analytical procedures, agriculture and industrial processes. Hence, the role of pH indicators will become significant. Therefore, this work is an attempt to investigate the naturally occurring species, flowers, fruits and vegetables, which can be used as nontoxic, less expensive and readily available pH indicators. In this research work, water hyacinth and red cabbage were investigated to be used as pH indicators. Flowers of water hyacinth and vegetable of red cabbage were selected as samples and tested to be used as pH indicators by using buffer solutions with pH values of 2, 4, 6, 7, 8, 10 and 12. The two samples red cabbage and water hyacinth were observed to be suitable for the best pH indicators.

Introduction

Indicator is a substance used to show visually, as by change of colour, the condition of a solution with respect to the presence of a particular material, as an acid or an alkali.

There are many kinds of indicators such as acid-base indicators, adsorption indicators (also called absorption indicators), oxidation-reduction indicators, pH indicators and universal indicators.

Acid-base indicators are weak acids and bases. A typical indicator will ionize in solution according to the equation.

$$HIn \rightleftharpoons H^+ + In^-$$

The chemical species, HIn and In^-, are different in colours. When the solution is acidic, the HIn species dominates and solution will indicate the colour of HIn. When the solution is more basic where In^- dominates, the solution will indicate the colour of In^-. If the acidity is between these two extremes, the colour is mixed because both HIn and In^- are present.

Adsorption indicator is the indicator used in the reactions that involve precipitation. Oxidation-reduction indicators are substances that show a reversible colour change between oxidized and reduced forms.

Universal indicator is a mixture of acid-base indicators that changes colour over a range of pH.

The pH indicators are substances that are added in small amounts to a solution so that the pH (acidity or basicity) of the solution can be determined visually. Hence, a pH indicator is a chemical detector for hydronium ions, H_3O^+. Normally, the indicator causes the colour of the solution to change depending on the pH values.pH indicators are essentially weak acids which exist as a natural dyes and indicate the concentration of hydronium ions, H_3O^+ or hydrogen ions, H^+.pH indicators are especially polyprotic and at least two or more than two pK_a, and, thus, three or more than three different species with different pH values and can exhibit three or more than three different colours.

For example, Thymol blue can give five different colours, red (pH <<0.7), orange (pH 0.7-2), yellow (pH 2.7-8), green (8-9.9), blue (pH>10).

pH indicators are employed in analytical chemistry and biology. Because of the subjective choice of colour, pH indicators are susceptible to imprecise readings. For

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applications requiring precise measurement of pH, a pH meter is frequently used. Acid-base indicators and universal indicator are also the pH indicators.

Aim and Objectives

The aim of this research is to investigate*Eichornia crassipes Solms* (Beda)and*Brassica oleracea Var*(Red cabbage) which can be used as pH indicators and objectives of this study are described below.

- To prepare buffer solutions having pH values of 2, 4, 6, 7, 8, 10 and 12 respectively
- To prepare sample solutions from flower and fruit by extracting with water
- To investigate the sample and to be used as pH indicator by observing the colours in buffer solutions of different pH

Botanical Description

Myanmar name - Beda
English name - Water Hyacinth
Botanical name - *Eichorniacrassipes*Solms.
Part used - Flower (petals)

Figure 1. Plant of Water Hyacinth

Myanmar name - Go-bi-dope
English name - Red cabbage
Botanical name - *Brassica oleracea* Var.
Part used - Leaves

Figure 2. Vegetable of Red cabbage

Materials and Methods

The flower of water hyacinth was collected from Taung Ta Man Lake and the vegetable of red cabbage was collected from the Ocean Super Centre in Mandalay. In order to obtain solutions with pH values of 2, 4, 6, 7, 8, 10 and 12, required volumes of acetic acid and sodium acetate, or ammonia and ammonium chloride solutions were calculated firstly. Then calculated volumes of required solutions were added into a volumetric flask and then diluted with distilled water up to the mark for respective buffer solution. The pH of prepared buffer solutions was confirmed by using the universal indicator papers. Then the petals of water hyacinth and the leaves of red cabbage were cut into small pieces and blended with a blender and filtered. 10 ml of a sample solution was placed in a test tube. Then, 10 ml of each buffer solutions (pH 2, 4, 6, 7, 8, 10 and 12) was placed in a test tube. All these 8 test tubes were placed in two test tube racks. Finally, 0.5 ml of a sample solution was added into the test tubes containing buffer solutions, compared the colours of buffer solutions and noted the colours obtained.

Results and Discussion

For acidic buffer solutions, the pH values required were 2, 4, 6 and 7. The solutions used to prepare buffer were 0.2 M acetic acid (with$K_a = 1.8 \times 10^{-5}$) and 0.2 M sodium acetate solution.The amount of acetic acid and sodium acetate solutions used to prepare the buffer solution were calculated on the basis of Henderson- Hasselbalch equation,

$$pH = pK_a + \log \frac{[Salt]}{[Acid]}$$

Table (1) Results for the Calculation of Volume of Solutions

No.	volume of acid solution used	volume of salt solution used	volume adjusted	pH
1.	49.9 ml	0.1 ml	100 ml	2
2.	41.7 ml	8.3 ml	100 ml	4
3.	2.4 ml	47.6 ml	100 ml	6
4.	0.25 ml	49.75 ml	100 ml	7

For basic buffer solutions, the pH values required were 8, 10, and 12. The solutions used to prepare buffer were 0.2 M ammonia aqueous solution($K_b = 1.8 \times 10^{-5}$) and 0.2 M ammonium chloride solution.The amount of ammonia solution and ammonium chloride solution used to prepare the buffer solution were calculated on the basis of Henderson-Hasselbalch equation,

$$pOH = pK_b + \log \frac{[Salt]}{[Acid]}$$

Table (2) Results for the Calculation of Volume of Solutions

No.	volume of acid solution used	volume of salt solution used	volume adjusted	pOH	pH
1.	2.4 ml	47.6 ml	100 ml	6	8
2.	41.7 ml	8.3 ml	100 ml	4	10
3.	49.9 ml	0.1 ml	100 ml	2	12

Results for the Confirmation of pH Prepared Buffer Solutions

Each of the buffer solutions of pH 2, 4, 6, 7, 8, 10, and 12 was examined by the colour which can be given with an indicator paper and identified and confirmed by comparing the colour given with standard colour.

Figure (3) Results for the Confirmation of pH of Prepared Buffer Solutions

(i) Water hyacinth

Table (3) Results for the Experiment of Sample Solution Extracted from Water Hyacinth

pH	2	4	6	7	8	10	12
Colours	purple	pink	blue	Blue	colourless	greenish brown	brown

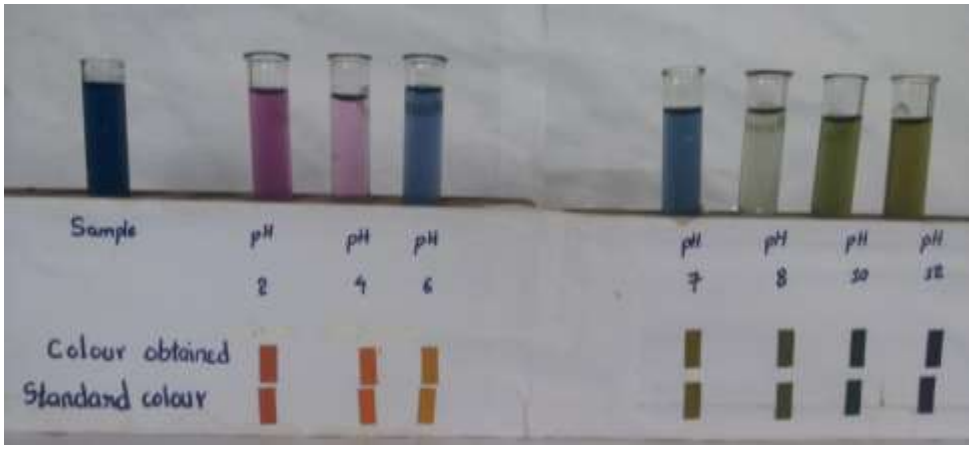

Figure (4) Colours Extracted from Water Hyacinth at Various pH Values

(ii) Red Cabbage

Table (4) Results for the Experiment of Sample Solution Extracted from Red Cabbage

pH	2	4	6	7	8	10	12
Colour	red	deep purple	purple	violet	blue	green	green

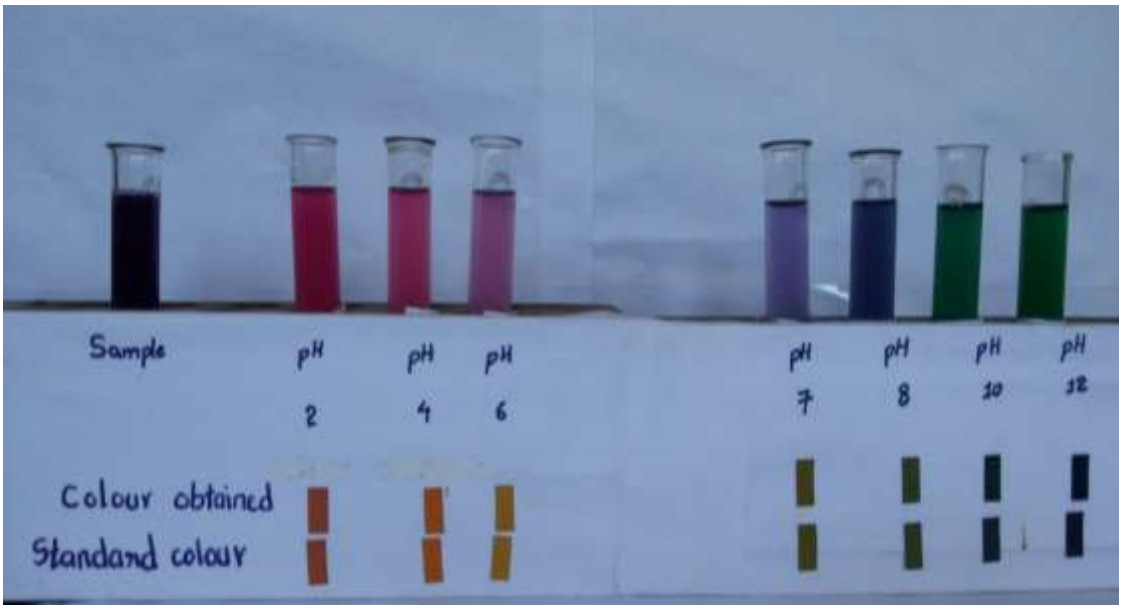

Figure (5) Colours Extracted from Red Cabbage at Various pH Values

Conclusion

In this research work, flower of water hyacinth and vegetable of red cabbage were investigated to be used as pH indicators. These samples were selected on the basis of anthocyanin contents and availability in the environment. Especially, the flowers, fruits and vegetables having colours were taken priority over others.

Since the pH range for the colour change of an indicator is 2 unit of pH, the pH of buffer solutions to be tested the colour of sample solutions were selected as 2, 4, 6, 8, 10 and 12. Buffer solution of pH 7 was also used to investigate the colour of neutral condition. Hence, seven different pH values were used.

The extracts of water hyacinthand red cabbage gave five and six different colours for the seven pH varieties and they were observed to be suitable for pH indicators. These samples are nontoxic and have health benefits, the extracts of all these samples can also be used as the colorant for foods of suitable pH values safely.

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