Efficiency and Effectiveness of Universal Indicator from Native Plants in South of Thailand

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Abstract. A chemical universal indicator is generally the device of acid base indicator. But there are some limitations like environmental pollution, availability, and higher cost which lead to search for natural compounds as an acid base indicator was started. To solve these limitations based on STEM theory, the universal indicator from native plants in South of Thailand such as Melastoma, Phae, Mulberry, Sweet potato, Kuaam, Blue pea, Pandanus palm, Turmeric, and Roselle was developed to a useful pH indicator device. The objectives of this research are to compare the native plants colour extraction of the solution between distilled water and 95% of ethanol solution, to identify the stable and clear colour drying paper, and to analyse efficiency and effectiveness of the universal indicator from native plants. The results showed that all of native plant can be extracted by ethanol solution 95 percent. There are six stable and clear colour paper including Melastoma, Phae, Mulberry, Blue pea, Turmeric, and Roselle that can be made to the universal indicator from native plants. The resolution efficiency can be divided the pH measurement into 7 ranges: 1-2, 3-4, 5-6, 7, 8-11, 12, 13-14. The 30 randomly effectiveness tests of the universal indicator from native plants has 100 percent of accuracy.

1. Introduction

The science standard 3, indicator 3.1 of grade 7 in The Thailand Basic Education Core Curriculum [7] specifies learners to experiment and explain acid-base properties. In generally, the simple method to test an acid-base property is to using a litmus paper. It is handy as a general acid-base indicator but cannot be used to determine the pH value. One way to indicate the pH value range from 1 to 14 is to use an universal indicator which composed of a solution of several chemical compounds such as water, propan-1-ol, phenolphthalein sodium salt, sodium hydroxide, methyl red, bromothymol blue monosodium salt, and thymol blue monosodium salt.

The world has become aware of environmental issue in recent year. Synthetic compounds are highly polluting, hazardous and much more costly [3]. For these reasons there has been an increasing interest in searching for alternative sources of indicators from natural origin [1]. Several authors have reported on the effectiveness of natural indicators in acid-base titrations [2] e.g. Nerium odorum, Thespesia populnea extract used as indicators [6]; Morus alba linn fruit extract indicator [5] and Ixora coccinea, Datura stramonium, Sun flower (Helianthus annus), pride of Barbados (Caesalpinia pulcherrima) and rail creeper (Ipomoea palmate) flower petal extracts [4]. However, no evidence is available with regards to the pH ranges of the indicator, its optimum function and its possibilities of replacing some expensive commercial indicators [1].
On the other hand, as concern about the challenges of globalization and a knowledge-based economy, scientific and technological innovations have increased in theirs important [8]. One way to provide all citizens with the competences necessary to succeed in this new information-based and highly technological society, education in the fields of science, technology, engineering and mathematics (STEM) is becoming increasingly more important [8]. Therefore, this research further investigated the potentials of using native plant with extract and drying into paper as a source of natural indicator for simple pH indicator based on STEM education. The outcome of the study not only could promote the use of the native plant as a raw material to produce the natural pH indicator but also make learners to have the ability of problem solving, process thinking, project management, and STEM applying.

2. Materials Methods

2.1. Native Plants in South of Thailand

Different parts of native plant such as Melastoma, Phae, Mulberry, Sweet potato, Kuuam, Blue pea, Pandanus palm, Turmeric, and Roselle were collected from Moo 3, Sam Tambon sub district, Chulabhorn district, Nakhon Si Thammarat province, Thailand.

2.2. Chemical Reagents

The analytical grade of buffer solutions pH range 1 to 14 were prepared from The Center for Scientific and Technological Equipments of the Walailak University, Thailand.

2.3. Experimental Methods

2.3.1. Colour Extraction. 15 g f native plants were grinded by mortar and pestle. The grinded native plant were extract with two cases of 30 ml solvents (distilled water and 95 percent of ethanol). They were extracted and sieved though filter paper. The extracted solutions were observed the solubility and colour as shown in Table 1. The colour results of the solution was recorded by compare with standard 216 colour chart.

| Native plants   | Solubility and Colour | Distilled water | Ethanol |
|-----------------|-----------------------|-----------------|---------|
| 1. Melastoma    | Dissoluble            | #9900FF         | Soluble | #CC00FF |
| 2. Phae         | Dissoluble            | #CC00FF         | Soluble | #6600FF |
| 3. Mulberry     | Soluble               | #9900FF         | Soluble | #663366 |
| 4. Sweet potato | Dissoluble            | #9900CC         | Soluble | #CC00CC |
| 5. Kuuam        | Soluble               | #FF0000         | Soluble | #FF3399 |
| 6. Blue pea     | Dissoluble            | #0033FF         | Soluble | #3300FF |
| 7. Pandanus palm| Dissoluble            | #666633         | Soluble | #336633 |
| 8. Turmeric     | Dissoluble            | #FFCC33         | Soluble | #FF9933 |
| 9. Roselle      | Dissoluble            | #CC00FF         | Soluble | #CC00FF |
2.3.1. Colour dyeing. The filter papers were dyed by extracted colour solutions and dried in the air. The only dyed papers which is stable and clear colour were collected to make the universal indicator from native plants as shown in Table 2.

**Table 2.** The dyed colour papers from the native plant solutions.

| Stable and clear colour papers | Unstable and unclear colour papers |
|--------------------------------|-----------------------------------|
| 1. Melastoma                   | 4. Blue pea                       |
| 2. Phae                        | 5. Turmeric                       |
| 3. Mulberry                    | 6. Roselle                        |
| 1. Sweet potato                | 2. Kuuam                          |
| 3. Pandanus palm               |                                  |

2.3.2. Efficiency of Universal Indication from Native Plants. The universal indicator from native plants was tested the colour change with buffer solutions pH range 1 to 14. The colour change patterns were analysed to make the table colour of the universal indicator from native plants which was used as measuring tool to indicate the pH value as presented in Table 3.

**Table 3.** Colour change and pH resolution efficiency of universal indicator with buffer solution pH range 1 to 14

| Colour change | Buffer solution pH range 1 to 14 |
|---------------|---------------------------------|
|               | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| pH resolution efficiency | 1-2 | 3-4 | 5-6 | 7 | 8-11 | 12 | 13-14 |
|               |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
2.3.3. Effectiveness of Universal Indication from Native Plants. The universal indicators were thirty sampling tests to analysed pH value with closed pH value. The pH test results were examined the accuracy and calculated the effectiveness as presented in Table 4.

Table 4. Thirty sampling tests of the universal indicator from native plants

| Sampling No. | pH value test | pH value answer | Result | Sampling No. | pH value test | pH value answer | Result |
|--------------|--------------|----------------|--------|--------------|--------------|----------------|--------|
| 1.           | 7            | 7              | Correct| 16.          | 8-11         | 8              | Correct |
| 2.           | 13-14        | 14             | Correct| 17.          | 5-6          | 6              | Correct |
| 3.           | 1-2          | 2              | Correct| 18.          | 13-14        | 14             | Correct |
| 4.           | 5-6          | 6              | Correct| 19.          | 1-2          | 2              | Correct |
| 5.           | 3-4          | 3              | Correct| 20.          | 13-14        | 13             | Correct |
| 6.           | 12           | 12             | Correct| 21.          | 3-4          | 3              | Correct |
| 7.           | 8-11         | 8              | Correct| 22.          | 5-6          | 6              | Correct |
| 8.           | 5-6          | 6              | Correct| 23.          | 1-2          | 2              | Correct |
| 9.           | 8-11         | 10             | Correct| 24.          | 13-14        | 14             | Correct |
| 10.          | 8-11         | 11             | Correct| 25.          | 8-11         | 9              | Correct |
| 11.          | 7            | 7              | Correct| 26.          | 5-6          | 5              | Correct |
| 12.          | 1-2          | 2              | Correct| 27.          | 3-4          | 4              | Correct |
| 13.          | 12           | 12             | Correct| 28.          | 7            | 7              | Correct |
| 14.          | 3-4          | 3              | Correct| 29.          | 12           | 12             | Correct |
| 15.          | 8-11         | 10             | Correct| 30.          | 5-6          | 6              | Correct |

100 % of pH measurement effectiveness

3. Results and Discussion
From Experimental data, it is obtained that all native plants can be extracted to colour solutions by 95% of ethanol. However, in dyeing method, there are only six stable and clear colour dyed papers to make the universal indicator including Melastoma, Phae, Mulberry, Blue pea, Turmeric, and Roselle. The pH resolution efficiency of universal indicator from native plants can be divided into seven ranges: 1-2, 3-4, 5-6, 7, 8-11, 12, and 13-14. Additionally, its effectiveness to correctly indicate pH value is 100 %.

4. Conclusion
From the results obtained, it is confirmed that the universal indicator from native plants can be an alternative device to measure pH value based on STEM theory. It is also confirmed that the universal indicator is not only high resolution efficiency and pH measurement effectiveness but also green, available, and economical product.

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