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APPLICATION OF PRINCIPLES AND TOOLS IN GREEN CHEMISTRY TO EDUCATION USING ROSE FLOWER EXTRACT AS ACID-BASE INDICATOR.

A. O. OLANREWAJU and N. O ADEOSUN .

Chemistry Education Department, Federal College of Education (Technical) Asaba, Delta State. Nigeria.
americanagold44@gmail.com 07067788977., geekaynas4@gmail.com 08130673938

ABSTRACT

Currently, there is increasing awareness in global sustainability. To make sure that prospective generations of chemists are fortified with appropriate knowledge on how to safeguard the earth for future generations, substantial efforts and variations in educational programs/curriculum at our various institutions will be needed. Green Chemistry is considered as significant tool to control the rise of hazardous chemicals, encourages revolution of product that are eco-friendly and economically stable. Synthetic chemical used in the laboratory as indicator for acid- base titrations can be switched to using the natural indicators from various flower extract and as well gives accurate results. This study therefore applied the concept of green chemistry principles and tools into chemistry learning to produce acid-base indicator from Rose flower (Rosa sp.) extract by extraction method, then macerated and extracted again in ethanol, n-hexane and chloroform respectively, It was tested in solution of pH 1-12 and found out that Rosa sp is a good replacement for phenolphthalein, methyl red, etc. indicators for different acid and bases. It is then concluded that natural indicators are substitute to synthetic indicator. This therefore reflects green chemistry principles 1, 4, 5, 7, and 12, respectively. The flower is eco-friendly, simple to prepare, pollution free, harmless to health and inert. It was then recommended that institutions should (1) Create awareness of green chemistry principles and tools to their Chemistry students (2) Enforce their Chemistry lecturers to imbibe the use of natural indicators for their various titrations carried out in the institution laboratory to promote sustainable development.

Keywords: Chemistry, green Chemistry, principles, sustainable development, Laboratory, Rosa sp indicator, natural, synthetic.

INTRODUCTION

Education is one of the important features that is involved in green chemistry for sustainable development. Chemicals are often regarded harmful, especially to the environment. Green Chemistry principles was introduced in an academic environment in the 1980s as guidelines for sustainable development focused on chemistry. Implementation of green chemistry has been done in many fields [7, 8], but few in the field of education. In recent years, experts in science education and policymakers have emphasized the need to advance science education and technology to face the challenges of the globalization era [1, 2]. Natural acid-base

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indicators are greener alternatives to synthetic ones to solve the problems of environmental pollution, cost and human health, thereby leading to the increasing demand for the development of green indicators as effective alternatives for synthetic acid-base indicators used in the school chemistry laboratory. Experiment to identify the nature of acid-base solution using this indicator. Indicators that are usually used are commercial indicators derived from the synthesis of chemical industries such as phenolphthalein, methyl orange, bromo thymol blue and many others [10, 11]. Commercial indicators are expensive and have toxic effects, also cause environmental pollution [12]. For this reason, more interest in finding alternative sources of indicators comes from natural resource [13, 16]. These alternative indicators are cheaper, more available, simple to extract, less toxic to users and environmentally friendly (2). Some highly coloured pigments obtained from plants are found to exhibit colour changes at various pH values (13, 15).

Roses flower is a flowers that can be used to produce natural acid-base indicator. Rose, (genus Rosa), genus of some 100 species of perennial shrubs in the rose family (Rosaceae), are native primarily to the temperate regions of the Northern Hemisphere. Many roses are cultivated for their beautiful flowers, which range in colour from white through various tones of yellow and pink to dark crimson and maroon, and most have a delightful fragrance, which varies according to the variety and to climatic conditions. Promising results were obtained when a natural indicator prepared from methanolic extracts of the species were tested against standard synthetic indicators. The indicator was useful in all types of acid – base titrations except weak acid and weak base titration. (13, 16) used Hibiscus Sabdariffa petals extract for acid – base titrations. The results were compared with those of standard end point indicators as phenolphthalein and methyl red. Prominent absorption peaks in the 500 – 550 nm wavelength region of the UV/Visible spectrum of methanolic extract established the presence of anthocyanidins. In other studies, methanolic extracts of Antirrhinummajus belonging to the family of Scrophulariaceae as well as Dianthus plumaris which belong to the family of Caryophyllaceae used also gave sharp and concentrated colour change as compared to phenolphthalein and methyl orange indicators (9, 10). In all these titrations the extract was found to be accurate and useful for indicating the end point of a neutralization reaction. Colour changes of natural indicators at different pH values is due to the presence of anthocyanins and flavonoids, which are pH sensitive. Anthocyanins are organic compounds that are typically found in the aqueous sap of the vacuole of the epidermal plant cells. Almost any plants that have blue, violet, purple or red flowered colours contain organic pigments ‘anthocyanins’ that changes colour with change in pH. The colour stability of anthocyanins depends on structure of the anthocyanins, oxygen pH, water activity, temperature, and light. They tend to be red in a

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more acidic solution and blue in basic solution (15, 17). Anthocyanins have several physiological activities which include antioxidant, anti-hepatic-carcinogenic, anti-inflammatory, anti-tumour, cardioprotective and cancer chemo preventive, hence they are safe to use in acid-base titration. This study therefore applied the concept of Green Chemistry principle and tools into chemistry learning by producing natural acid-base indicators from the extract of rose flowers (Rosa sp)

MATERIALS AND METHODS

The primary raw material used for the study was the roses (Rosa sp.) flower. The making of this natural indicator was done by extraction method. Extraction begun with the maceration process followed by solvent extraction using separating funnel. 20 grams of powdered rose flower was weighed, levelled to increase the surface area of the particles so that the anthocyanin dyestuff contained in it can increasingly dissolved in the solvent. The maceration process was repeated in 50 mL of 96% ethanol. The use of ethanol as a solvent in the softening process is because of the polarity of the anthocyanin compound is similar to Rosa sp, so, it will be more efficient to get the extract. The softened extract then vaporized until the volume reached 40-50% of the initial volume. The macerated extract got extracted again using n-hexane and chloroform three times by separating funnel. The roses extract was obtained as a natural indicator in the form of solution, tested using a solution of pH 1-12 in order to see the colour changes that could arise. The results of the colour changes was then used as a colour change guide in acids and bases solution. The researchers set out a questionnaire to be acquainted if students were aware of green chemistry tools and principles. Furthermore, to apply the indicators in chemistry learning, a simple chemical experiment was performed to determine the acid and base properties of a solution using HCl, NaOH, CH_3COOH, and NH_4OH solutions at concentration of 0.1 M. This solution was chosen because it is easy to find in the school laboratory and students can do these experiments easily.

RESULTS AND DISCUSSION

The result of solvent extraction showed that Rosa sp extract in the ethanol fraction showed a pink colour. The test results of a solution with pH 1 of the rosa sp indicator showed purplish pink and gradually faded as the pH rises to 7, as well initiated a very faded colors at pH 8 to become blue and gradually faded with a pH range of 9-12. These results prove that in red roses, there is anthocyanin dyes that are acidic and red. In alkaline conditions, it will fade blue to blue colour the anthocyanin stability is strongly influenced by pH so that roses can be used as an alternative raw material as a substitute for commercial acid base indicators. The difference

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in colours seen in a solution with a pH range of 1-12 after adding the rose indicator can be seen in the **Table 1** below.

Table 1: Change of the color indicators of rose extract to pH solution 1-12

pH	COLOURS
1	purpishpink
2	pink
3	pink
4	faded pink
5	white
6	white
7	white
8	white
9	faded blue
10	sky blue
11	Blue
12	Deep Blue

The sensitivity of the extracts to different pH were attributed to the presence of anthocyanins and flavonoids. The results of the questionnaire revealed that 45 out of 52 students had no knowledge of green chemistry and had never applied green chemistry principles in learning. The researcher then introduced green chemistry and its principles especially, principle 12. Different colour were obtained in four solutions tested using rose extract indicator by the students' experimentation. Tests on HCl solutions show a faded pink colour, indicating that the HCl solution is acidic because the anthocyanin pigment in roses will show redness when at low pH. The colour stability of anthocyanins in roses is strongly affected by the change in pH so that in CH_3COOH solution the colour is getting faded but still in the acidic atmosphere. In the solution, NH_4OH obtained a colour that faded and showed a blue colour but very faded. This indicates that the pH is increasing, and the solution is base. The results of the experiments obtained can be seen in table 2 below;

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Table 2: Results of identification of acid base solution with Rose sp indicator.

SOLUTION	COLOUR CHANGES
HCl	**Purplish pink**
NaOH	**Blue**
CH_3COOH	**Faded Pink**
NH_4OH	**Faded blue**

CONCLUSION

The acid –base indicators used in the chemistry laboratory are synthetic as well as expensive for the schools to afford for their large number of laboratory sessions, toxic to students and teachers especially when vapours evolves in the laboratory classes which become a pollutants to the school surrounding affecting both animals and human health. This study focused on a natural indicator for acid-base titrations which was extracted from Rose flower. Based on this result, it can be concluded that the Rosa sp can be used as an alternative raw material for acid-base indicator. The use of Rosa sp as an indicator portrays an application of the concept of green chemistry and its principle to chemistry learning which includes the prevention of the formation of hazardous wastes, the design of safe chemical products, the use of safer solvents, and the design of materials that are easily degraded. Students were eager to inquire on other alternative materials that can be used as an acid-base indicator. Henceforth, the concept of green chemistry and its principles should be taught to chemistry students in learning so that they can be more active and engaged in science issues that is related to sustainable development.

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