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Improvisation of Indicator Using *Hibiscus sabdariffa* (zobo) Fruit for Acid-Base Titration and Testing for the Presence of Acids and Bases in Substances

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ABSTRACT: one of the main practical's conducted in senior secondary schools chemistry is acid-base titrations. In these titrations, synthetic indicators are used to determine the equivalent points. In most secondary schools, some of these indicators are not readily available; some are toxic and therefore not safe to handle while some require special procedure to prepare. Consequently, there is need to consider the suitability of natural indicators which are cheap, harmless and easy to prepare. This study therefore is aimed at investigating the suitability of *Hibiscus sabdariffa* extract as indicator in acid-base titration and to test for the presence of acids and bases in substances. The expected result shows that in strong acid-strong base titration the plant extract under study is suitable. It is also suitable in testing for the presence of acids and bases in substances. It was recommended that the use of *Hibiscus sabdariffa* extract as indicator in acid-base titration should be incorporated in the teaching of acid-base titrations in secondary schools.

Keywords: improvisation, acid-base titration plant indicator

INTRODUCTION

The major factors militating against science education in Nigeria are lack of practical materials and high cost of conventional science teaching materials (Along, 1998, Garba, 2011). This brings serious problems in experimental activities in the schools which threatens the potential for increase in students' scientific knowledge.

In senior secondary school chemistry practical syllabus acid-base titration is one of the experimental activities required. Acid-base titration involves the determination of the concentration of an acid or base by exactly neutralizing the acid or base with an acid or base of known concentration. In such titrations, indicators are used to determine the equivalent points or end point by reacting reagents (Nwosu et al., 2004). In acid-base titrations, an indicator is used to determine the end point of the titration at which the acid and base are in exact proportions necessary to form salt and water only.

Majority of indicators in use today are synthetic which include methyl red, methyl orange, phenolphthalein, phenol red, et c. synthetic indicators are expensive, some have toxic effects on users and can cause environmental pollution (Pathade et al., 2009). Natural indicators from plant pigments have been found to be readily available in the surroundings or in the market. They are also easy to prepare by simple extraction and eco-friendly (Pathan and Farooqui, 2011; Vinayak et al., 2013; Eze and Ogbuefi, 2014).

Natural indicators are dyes or pigments that are isolated from plants part like flowers, fruits and leaves, fungi and algae (Vinayak et al., 2013). The coloured pigments obtained from these sources exhibit colour change with variation of P^H (Abbas, 2012). Researchers have worked on some plant extract as indicators and have found them to be accurate and precise at equivalent points in acid-base titrations (Ayodele, 2019; Vinayak et al., 2013; Sharma et al., 2013; Jain, 2013; Izonfor et al., 2006; Pathade et al., 2009; Pathan and Farooqui, 2011).

Problem Statement/Justification

There is little or no experimental activities in senior secondary school chemistry laboratories due to lack of chemicals and materials required. This is because, these chemicals and materials are expensive and there is no enough money to purchase them. Consequently, there is need to explore and integrate local materials as reagents in secondary school experimental chemistry (Ayodele, 2019). Acid base titration is a major practical in secondary school chemistry curriculum. It requires the use of indicators to show a colour change at the end point during titration. Synthetic indicators not always available, slightly expensive and some have toxic effects. The use of plant extract as indicators is cheaper and sustainable alternative which would also promote green chemistry. It is on this basis that this study investigates the suitability of the aqueous extract of *Hibiscus sabdariffa* as indicators in acid-base titrations.

Objectives of the Study

- To improvise indicator from crude extracts of Roselle fruit (*Hibiscus sabdariffa*)
- To use the extract as an indicator in acid base titrations; and
- To minimize the cost associated with use of synthetic indicators.

LITERATURE REVIEW

Roselle (*Hibiscus sabdariffa*) is an annual, erect, bushy herbaceous sub-shrub that grows up to 10 feet tall, with smooth, cylindrical typically red stems. The leaves are alternate 3 to 5 inches long, green with reddish veins and long or short petioles. The capsule turns brown and splits open when mature and dry to release the seeds in it by explosive mechanism. The calyx, stems and leaves tastes sour (acidic) and closely resemble cranberry (*Vaccinium* spp) in flavour. It is extensively cultivated in tropical Africa, Asia, Australia and Central America (Schippers, 2000). *Hibiscus subdariffa* is native to west and East Africa and South-East Asia. *Hibiscus sabdariffa* plant is used for making wine, juice, jam, tea, syrup, soup, porridge, flavour and medicine. *Hibiscus sadariffa* has also been found to possess antiseptic, diuretic, antioxidant properties (Al-Hashimi, 2012; Oivera-Garcia et al., 2008).

MATERIALS AND METHOD

This study is conducted in Jakusko Local Government Area in Yobe State, North-Eastern Nigeria. The study area covers more than 3,941km2 of different land units and a population of 229,083 (NPC, 2006). It is located between the longitude 10.7746 22N and 12.380634 longitudes E. the average daily temperature ranges from 26 to 44C° the area is dominated by Bade people which are the major ethnic group. The inhabitants of the area are predominantly peasant farmers cultivating such crops as millet, guiniea corn, rice, beans, beniseed etc.

The raw materials used were Hibiscus sadariffa fruits. The materials/equipment used include, P^H meter, retort stand, burette, pipette, beakers, funnel, conical flask, dropper, blender, analytical balance, white muslin cloth Uv-via spectrometer. All equipment were prepared according to the official method of preparation in AOAC (2019) with modification.

Sample Collection

The fresh fruits of *Hibiscus sabdariffa* were collected from the biological garden of Umar Suleiman College of Education Gashua, Yobe State. The samples were identified in the herbarium of the institution.

Extraction

The Hibiscus sabdariffa fruit were rinsed to remove dirt and stains and dried under the shade. The dried specimen was blended into powder using mortar and pestle and sieved. 1kg of powdered specimen was dissolved in 2 liters of distilled water for 24 hours. After the extraction the Juice was filtered using muslin cloth the juice extracted was analyzed using UV absorption spectrometer.

Method of Data Collection

This is an experimental research. Hence, laboratory experiment was used as the method of data collection. Titration of strong acid and strong based (0.5M H_2SO_4 and Sodium hydroxide NaOH) was carried out using methyl orange as indicator and then the same titration was carried out again using the improvised indicator and the titre values compared to determine the suitability of the improvised indicator.

Titration

Table 1. P^H of indicator

Indicator	P^H	Colour Change in Acid	Colour Change in Base
Methyl orange	6.1	Reddish	Yellow
Hibiscus sabdariffa	2.8	Brown	Pale blue

25ml of sodium hydroxide was pipetted out into a clean conical flask and 3 drops of methyl orange indicator was added and titrated against 0.5M H_2SO_4 acid in the burette. The titration was repeated for consisted values. Same titration procedure was followed using the *Hibiscus sabdariffa* indicator and the readings were recorded. The improvised indicator was also used to test for the presence of acids and bases in some edible fruit juices and household products.

RESULTS AND DISCUSSION

The analyzed results are presented in tables 2 and 3. The results in table 2 (Titration of Strong acid and strong base) shows that the end points obtained using synthetic indicator and *Hibiscus sabdariffa* indicator are close to each other. This shows that the plant extract used is suitable for strong acid strong base titration. The result in table 3 also shows that the *Hibiscus sabdariffa* indicator is suitable for testing for the presence of acids and bases in substances.

Table 2: strong acid strong base titration

Indicator	Experiment 1	Experiment 2	Experiment 3	Average titre value
Methyl orange	46.80ml	46.70ml	46.80ml	46.77ml
Hibiscus sabdariffa	47.90ml	47.70ml	48.00ml	47.87ml

Table 3: test for the presence of acid and bases

Substance + few drops of indicator	Colour change	Inference
Wood ash solution	Blue	Basic
Lemon juice	Red	Acidic
Potash solution	Blue	Basic
Unripe orange	Red	Acidic
Unripe mango	Red	Acidic
Soap solution	Blue	Basic
Garden egg juice	Blue	basic

CONCLUSION

This study investigated the suitability of *Hibiscus sabdariffa* extract as indicator for acid-base titration and to test for the presence of acids and bases in substances. Based on the result obtained therefore, it can be concluded that the improvised indicator is suitable for testing the presence of acids and bases in substances.

RECOMMENDATIONS

1. It is recommended that the extract of *Hibiscus sabdariffa* as indicator can be used in teaching acid-base titrations in secondary school.
2. This study should encourage use of locally available materials in teaching experiments.

3. The improvised indicator can be used to teach the topic acids and bases in primary synthetic acids and bases can be dangerous.
4. Workshops and seminars can be organized for science teachers on how to improvise materials from locally available materials

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