Evaluation of Potentials of *Dissotis Rotundifolia, Centrosema Pubescens* and *Allium Cepa* Extracts as Indicator for Acid-Base Titration

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Abstract: **This work investigates the potentials of methanol and acetone extracts of leaves *Dissotis rotundifolia, Centrosema pubescens*and *Allium cepa* bulb as indicators for acid-base titration. Each extract was used in the titration of H_2SO_4 vs NaOH, H_2SO_4 vs NH_4OH, CH_3COOH vs NaOH, and CH_3COOH vs NH_4OH. Standard indicator (phenolphthalein) was also used separately for each titration. Each titration was carried out in triplicate. The results obtained revealed that the extracts of these plants have sharp colour changes in acidic and basic medium. Both the methanol and acetone extracts of some of these plants have titre values close to the one obtained when using standard indicator, though some discrepancies were observed with some of the titre values for weak acid /strong base and weak acid/weak base. The titre values of the methanol extracts of *Allium cepa* (20.93ml) and acetone extracts of *Allium cepa* (22.67ml) and *centrosema pubescens* (26.20ml) deviated remarkable from that of the standard commercial indicator for weak acid /strong base titration and for the titration of weak acid/weak base; only the methanol and acetone extracts of *Dissotis rotundifolia* compared favourably with that of the standard indicator. However methanol and acetone extracts of Dissotis *rotundifolia, Centrosema pubescens* and *Allium cepa* bulb can be used as indicators for acid-base titration and hence can serve as suitable replacement for the commercial indicators.**

Keywords: **Dissotis rotundifolia, Centrosema pubescens and Allium cepa bulb, acid-base indicator.**

INTRODUCTION

Today, as a result of environmental pollution as well as the global economic changes, there have been growing needs in the utilization of natural resources as alternative materials for both chemical laboratories and industries. This is because natural resources are environmentally friendly, easily available and of low cost compared to the synthetic standard ones.

Synthetic indicators are expensive and some of them have toxic effects on the users and can also cause environmental pollution [1], [2]. For these reasons there have been increasing interests in searching for alternatives sources of indicators from natural origin [3].

An acid-base indicator is usually a weak organic acid denoted as (Hln) that has a different colour from its conjugate base (ln) [4]. Indicator causes the colour of the solution to change depending on the pH of the solution [5].

Volumetric analysis is one of the quantitative analytical techniques used to analytically determine chemical interaction of strong or weak acids and bases in raw materials, intermediate and finished products for quality assurance purposes [3].

This quantitative determination can be accomplished by the use of appropriate weak organic dye (indicator) either from natural source or synthetic ones. Although there is automated titration apparatus that determine the equivalent point between reacting species, indicators are still needed for teaching and research laboratories for simple titration [1].

Synthetic indicators include phenolphthalein, methyl orange and methyl red etc. The potentials of natural indicator from plant origin have been reported by many authors. Nwosu, [1] reported the potentials of natural indicator from Hibiscus (red species), Bougainvillea and rose flowers. Industrial and analytical potentials of the plant extracts from the fruit of *Telfrair occidentalis* have also been reported [6].

Utilization of Hibiscus flower extract, mango seed extracts, Ginger stem extract and kola nut seed extract as natural indicators for acid – base titration have also been reported [7].

Eze, and Ogbuefi [3] investigated the analytical potentials of dye extracts from *Aspilia Africana* flowers. Sudarshan *et al*., [8] and Izonfuo, *et al*., [9] reported their findings on the use of some natural dye extracts as indicators in acid-base titrimetry.

Report on the utilization of phenolic and acetone extracts of *Allium cepa, Centrosema pubescens* and *Dissotis rotandifolia* as acid base indicator is scanty. Hence this work aims at determining the potentials of these plants extracts as indicators for acid-base titration in order to ascertain their suitability or otherwise in replacing the synthetic indicators which are sold at the high cost and which also pose some environmental problems.

2.0 Materials and methods

2.1 Samples Collection

Fresh samples of *Dissotis rotundifolia* and *Centrosema pubescens* were collected from a botanical garden in Akwa Ibom State University, Ikot Akpaden. The samples were authenticated by a botanist in the department of Botany, Akwa Ibom State University. Onion bulbs (*Allium Cepa*) were

bought from Ikot Akpaden local market in Mkpat Enin Local Government area, Akwa Ibom State. The samples were washed and dried. Ten (10) grams of air dried sample was weighed and each sample was macerated separately with methanol and acetone. After 24 hours, the extracts were filtered using Whatman filter paper and the filtrates obtained were used for titration to screen their indicator properties.

2.2 Experimental Procedure

The experimental work was done using the extract of each sample separately. Another experiment was also done using the standard indicator (phenolphthalein). 25ml of the base was measured into a conical flask and 1.0ml of the indicator was added using a 1.0ml dropper. A 50ml burette was filled with the acid and titrated against the base until a sharp colour change was observed signifying the end of the titration reaction. The first titration was carried out using the standard indicator (phenolphthalein). Each titration sequence was done using either the standard indicator or the plant extract and the titration was carried out in triplicate and the values for the end points recorded. The mean value was calculated for each set of values. This step was carried out for the strong acid vs strong base, strong acid vs weak base, weak acid vs strong base and weak acid vs weak base. 1M of volumetric solutions were used in all the titrations and the end point values obtained are recorded in Table 3 and 4, and illustrated in figure 1 and 2.

Table 1: End point colours changes of titration with methanol extract and standard indicator

Titrants	**Titrand**	**phenolphthalein**	***Allium cepa***	***Centrosemapubescens***	***Dissotis rotundifolia***
H_2SO_4	NaOH	Purple to Colourless	Green to colourless	Yellow to colourless	Green to colourless
H_2SO_4	NH_4OH	Purple to Colourless	Green to pink	Yellow to colourless	Green to colourless
CH_3COOH	NaOH	Purple to Colourless	Green to Yellow	Yellow to colourless	Green to colourless
CH_3COOH	NH_4OH	Purple to Colourless	Green to colourless	Yellow to colourless	Green to colourless

Table 2: End point colours changes of titration with Acetone extracts

Titrants	**Titrand**	***Allium cepa***	***Centrosema pubescens***	***Dissotis rotundifolia***
H_2SO_4	NaOH	Yellow to colourless	Yellow to colourless	Green to colourless
H_2SO_4	NH_4OH	Yellow to colourless	Yellow to colourless	Green to colourless
CH_3COOH	NaOH	Yellow to colourless	Yellow to colourless	Green to colourless
CH_3COOH	NH_4OH	Yellow to colourless	Yellow to colourless	Green to colourless

2.1 Colour changes

The results of the screening for strong acid vs strong base (H_2SO_4 vs NaOH), strong acid vs weak base (H_2SO_4 vs NH_4OH), weak acid vs strong base (CH_3COOH vs NaOH) and weak acid vs weak base (CH_3COOH vs NH_4OH) and their colour changes at the beginning of the titration and at the end point are recorded in table 1 and 2.

All the extracts showed sharp colour change and exhibited some colour changes across the range of titrations. Both the methanol and acetone extracts of *Dissotis rotundifolia* before titration exhibited a characteristic green colour but became colourless when the end point of the titration was reached for all the different range of titrations carried out. The methanol and acetone extracts of *Centrosema pubescens* before titration exhibited a characteristic yellow colour which changed to colourless at the end point of the titration and it exhibited same colour changes when applied to the full range of titration carried out. The acetone extract of *Allium cepa* was also uniform with its colour changes across the range of titrations carried out as it changed from yellow at the beginning of the titration to colourless at the end point. The methanol extracts of *Allium cepa* show different colour changes at the end of the titration. In the titration of strong acid vs strong base and weak acid vs weak base it exhibited a characteristic green colour at the beginning of the titration and changed to colourless at the end point of the titrations. There was observed diversity during the titration of strong acid vs weak base as the characteristic colour was green at the beginning of the titration and changed to pink at the end point of the titration. The titration of weak acid vs strong base gave a yellow colour at the end of the titration from the green that was observed at the beginning of the titration.

The reason for the observed colour changes are due to the presence of plant pigments primarily anthocyanin [7]. Anthocyanin is responsible for the attractive colours of plants [10]. Anthocyanins are generally degraded at higher pH and due to this; they are more stable in acidic media. In acid solutions, anthocyanins exist as four equilibrium species

which are quinoindal base, flavylium cation, the carbinol or the pseudo-base and chalcone. This transformation leads to the change in colour when a base is introduced during titration. The colours obtained differ depending on which anthocyanin compound is present in the plant and also depending on how the base attacks the bonds in the compound [1].

Table 3: Titration with methanol extracts of *Allium cepa, Centrosema pubescens* and *Dissotis rotundifolia* as indicator

Titrant vs titrand	Phenolphthalein (ml) ± S.D	*Allium cepa* (ml) ± S.D	*Centrosema pubescens* (ml) ± S.D	*Dissotis rotundifolia* (ml) ± S.D
H_2SO_4 vs NaOH	11.70 ± 0.07	11.17 ± 0.67	11.67 ± 0.29	11.27 ± 0.31
H_2SO_4 vs NH_4OH	12.17 ± 0.05	11.87 ± 0.39	12.43 ± 0.53	11.50 ± 0.10
CH_3COOH vs NaOH	24.40 ± 0.05	20.93 ± 0.53	24.23 ± 0.45	23.70 ± 0.28
CH_3COOH vs NH_4OH	18.47 ± 0.14	19.73 ± 0.42	22.50 ± 0.36	19.17 ± 0.19

Table 4: Titration with acetone extracts of *Allium cepa (AEA), Centrosema pubescens(AEC)* and *Dissotis rotundifolia (AED)* as indicator

Titrant vs titrand	Phenolphthalein (ml) ± S.D	*Allium cepa* (ml) ± S.D	*Centrosema pubescens* (ml) ± S.D	*Dissotis rotundifolia* (ml) ± S.D
H_2SO_4 vs NaOH	11.70 ± 0.07	12.10 ± 0.70	11.37 ± 0.31	11.50 ± 0.35
H_2SO_4 Vs NH_4OH	12.17 ± 0.05	13.30 ± 0.40	12.53 ± 0.50	12.37 ± 0.55
CH_3COOH vs NaOH	24.40 ± 0.05	22.67 ± 0.49	26.20 ± 0.30	23.57 ± 0.57
CH_3COOH vs NH_4OH	18.47 ± 0.14	20.30 ± 0.37	24.33 ± 1.96	19.90 ± 0.20

2.2 End point detection

Results of the titration using methanol and acetone extracts of *Allium cepa, Centrosema pubescens, Dissotis rotundifolia* and the standard commercial indicator phenolphthalein are presented in table 3 and 4, and illustrated in a bar chart in fig 1 and 2.

In strong acid/strong base titration, the average titre values methanol extracts of *Allium cepa, Centrosema pubescens, Dissotis rotundifolia* were 11.17, 11.67 and 11.27ml and that of the acetone extract were 12.10, 11.37 and 11.50ml respectively, whereas that of the commercial indicator was 11.70ml. These results compared favourably with that of the commercial indicator.

For the titration of strong acid/weak base, the average titre value obtained for *Allium cepa, Centrosema pubescens, Dissotis rotundifolia* were respectively 11.87, 12.43, and 11.50ml for methanolic extracts while acetone extract gives the average titre values of 13.30, 12.53 and 12.37ml respectively. Both methanol and acetone extracts compared favourably with the average titre value of 12.17ml. Ochonogor [11] reported that the extract of hibiscus flowers compare favourably with phenolphthalein as indicator for strong acid/week base titration.

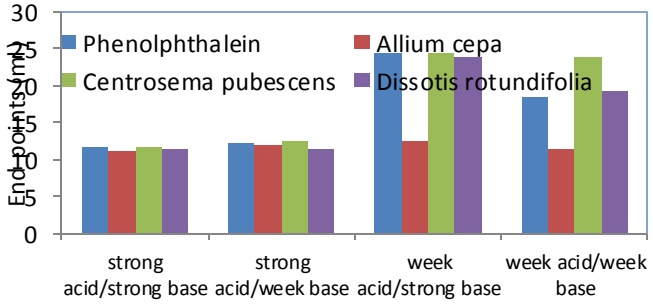

Fig1: Titre values of phenolphthalein and methanol extracts of the plants samples as indicators in different titration medium

For the titration of weak acid and strong base, the average titre values of 24.23and 23.70ml were obtained using methanol extracts of *centrosema pubescens* and*dissotis rotundifolia* respectively and the acetone extracts of *Dissotis rotundifolia* gives the titre value of 23.70ml. these value compared favourably with the titre value 24.40ml of the standard indicator.

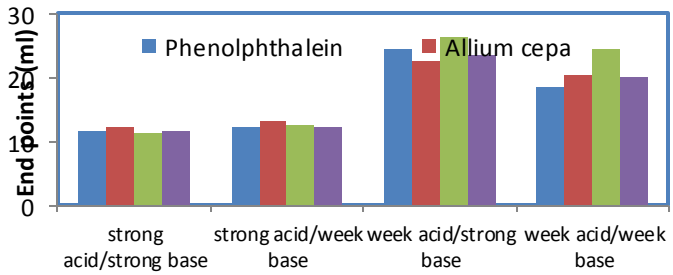

Fig 2: Titre values of phenolphthalein and acetone extracts of the plants samples as indicators in different titration medium

Whereas the titre values of the methanol extracts of *Allium cepa* 20.93 and acetone extracts of *Allium cepa* 22.67 and *Centrosema pubescens* 26.20ml deviate remarkable from that of the standard commercial indicator. Therefore they are not suitable indicators for this medium.

For the titration of weak acid/weak base, only the methanol and acetone extracts of *Dissotis rotundifolia* compared favourably with that of the standard indicator. Generally all the titre values were higher than the titre value obtained when using standard indicator.

Conclusion

It was observed that the methanol and acetone extracts of the samples used exhibited good acid-base indicator properties because they showed sharp colour changes at the end point of the titration. They showed values close to those obtained from the titrations with the standard indicator. Some discrepancies were observed with some of the titre values for weak acid /strong base and weak acid/weak base as some of the values were either slightly higher or lower than those of the standard indicators and can thus be concluded that they are not suitable for the weak acid/ strong base and weak acid/weak base titrations. Among all the extracts, methanol and acetone extracts of *Dissotis rotundifolia* compared favourably for all the titrations, while the extracts of *Allium cepa* and *Centrosema pubesens* can only be used for the titration of strong acid/strong base and strong acid/weak base.

However It can be concluded that the plant extracts of *Allium cepa*, *Centrosema pubesens* and *Dissotis rotundifolia* are suitable replacements for standard indicators for acid-base titrations since they are environmentally benign, eco friendly, easily available and some of their titre values compare favourably with that of the standard indicator.

References

[1] Nwosu, F. O., Adekola, F.A., and Ihedioha, K. C. (2004). Simple Titrimetric Colour Indicators from some Natural Flower Petals. Centrepoint (science edition). 12 (2):74-89.

[2] Pathade, K. S., Patil, S. B. and Konda-war, M. S., Naikwade N. S. and Magdum, C. S.(2009). "Morus Alba Fruit-Herbal Alternative to Synthetic Acid Base Indicators," *International Journal of Chem.Tech. Research*. 1 (3)549-551.

[3] Eze, S. O. and Ogbuefi, R. A. (2014). Analytical Potentials of Dye Extracts from *Aspiliaafricana* (Oramejula) Flowers. *Asia Journal of Natural & Applied Sciences*. 3(1):54-60

[4] Siberberg, M. S. (2006). "Acid-base indicators" Chemistry: The molecular Nature of Matter and Change. New York: Mc Graw Hill Higher Education. 824-825.

[5] Ikoku, C. Ahmed, M. and Joju, E. (1984). Laboratory to Organic Chemistry London: MacDonald & CO publisher Ltd. 145-147.

[6] Azundo, M. U., Chukwuneke, C.and Agbo, G. (2006). The dyeing of textile fabrics with natural dyes from some local tress. *J. Chem. Soc. Nig.* 23: 47-52.

[7] Uche, I. Onwuachu, Uju A. Aboh and Godson Iwuoha (2014). Extraction, Characterization and Workability of Some Local Plant Dyes as Acid-Base Indicators.*International Journal of Research in Applied, Natural and social Sciences*. 2(7):1-6

[8] Sudarshan, S., Bothara, S. B., and Sangeeta S. (2011): Acid-Base indicator properties of Dyes from Local flowers Cassia auncostifolia Linn, Thevetia peruviana (pers) K. Schum amd Thevetia Thvetiodes(Kunth) K. schum. *Pharmacognosy Journal* 3(19): 35-40.

[9] Izonfuo, W. A. L., Fekaruhobo, G. K., Obomanu. F. G. and Daworiye. L. J.(2006): Acid-base indicator properties of dye from local plants 1: dyes from Basella alba (Indian spinach) and Hibiscus. Sabdariffa (zobo). Journal of Applied Environmental Management 10(1); 5-8

[10] Arif Khan, P. M. and Farooqui, M. (2012). Analytical Applications of Plant Extracts as Natural pH Indicator: A Review. *Journal of Advanced Scientific Research*.2(4):20-27.

[11] Ochonogor, O.D. (2000). Improvised Indicator for Chemical Analysis in Mag Akala (Ed). 41st Annual Conference of Science Teachers Association of Nigeria (STAN). Held in Kano.

