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Full Length Research

Comparism of *Cola acuminata* (Kola nut) fruit extract as natural indicator with standard indicators: Improvisation imperative in Nigeria school chemistry

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Chemistry education takes a center position in science and technology. Acid-base titration is an important aspect of practical that requires chemicals and compulsory for senior secondary certificate examinations in Nigeria. In acid – base titrations, indicators are employed to show a sharp color change at interval of pH. Natural pigments in plants known as anthocyanins are highly colored substances and may show color changes with variation of pH. An attempt has been made to compare the indicator activity of ethanolic fruit extract of *Cola acuminata* with methyl orange and phenolphthalein indicators in strong acid – strong base titrations at 0.1M and 0.5M concentrations respectively. The research is to see if ethanolic fruit extract of *C. acuminata* can replace the synthetic indicators as they contain certain disadvantages like chemical pollution, availability problem and high cost. Ethanolic fruit extract of cola acuminate gives sharp and intense color changes as compared to phenolphthalein and methyl orange at different concentrations. The equivalent points obtained by the *C. acuminata* fruit extract coincided with that of methyl orange. Ethanolic fruit extract of *C. acuminata* was found to be very useful, economical, simple, inert and accurate for acid – base titrations.

Key words: *Cola acuminata*, standard acid – base indicator; natural indicator, ethanolic extract.

INTRODUCTION

The demand for locally prepared indicators for acid – base titration in teaching and learning of chemistry in secondary schools and colleges is on the increase. There is a great emphasis on improvisation of science teaching and learning materials in the face of scarcity and cost of chemicals in science curriculum.

Eshiet (1996) stated that teaching materials could be readily required, modified or developed by an ingenious teacher to suit various needs and purposes in the teaching/ learning process. Improvisation in the context of this study means the sourcing for local material within the environment that can be useful in the teaching and learning of science. Enukoha (1998) saw improvisation as the act of providing relevant local materials for instruction by the teachers when commercially made instructional materials are not readily available.

Eze and Ogbuefi (2014) said that although there are automated titrations apparatus that determines the equivalent points between reacting species, indicators are needed for teaching and research laboratories for simple titrations. Natural indicators have been extracted from *Punica granatum* (Shubham et al., 2011). Ramling et al. (2010), also investigated flower extract of *Bombax malabaricum* as a natural indicator in acid – base titration.

Several other studies on the effectiveness of natural indicators in acid – base titration have been reported, Morus Alba in fruit extract indicator (Pathade et al., 2009), comparism of locally prepared indicators and standard indicators in volumetric analysis (Ezekiel, 2012). Untwal (2006) also studied the use of *Terminalia cattapa* fruit (tropical almond) extract as an indicator in acid –

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Table 1. 0.1M HCl – 0.1M NaOH titration results using 2 drops of EFECA indicator

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	24.00	48.10	24.10
Initial reading	0.00	24.00	0.00
Volume of acid used	24.00	24.10	24.10

Mean titre value: $\sum \frac{24.00 + 24.10 + 24.10}{3} = \frac{72.20}{3}$ X = $24.07cm^3$

Table 2. 0.5M HCl – 0.5M NaOH titration results using 2 drops of EFECA indicator.

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	16.90	33.80	16.80
Initial reading	0.00	16.90	0.00
Volume of acid used	16.90	16.90	16.80

$\bar{\bar{X}}$ titre value: $\sum \frac{16.90 + 16.90 + 16.80}{3} = \frac{50.60}{3}$ $= 16.87cm^3$

base titration.

The natural indicator source investigated in this study is ethanolic fruit extract of *C. acuminata* (kola nut). On the use of Kola as indicator for acid-base titrations, Osabohien (2002), reported that Kola contain dyes that can be extracted for acid-base indicator titrations.

Kola tree is a tropical tree which belongs to the family sterihaceace. It is mostly common in the rainforest region of West Africa. This crop is of socio – economic importance. There are over 40 kola species, out of which cola acuminata and cola nitida are of major social importance in Nigeria, Taiwo et al. (2008). They are use industrially for the manufacturing of different types of soft drink flavor (Beatle, 1970).

Caffeine contained in Kola nuts is useful as a fat burner Blades, (2000). Kola nut is chewed in Nigeria to reduce hunger and fatigue and to fight intoxication and hang over. It is cultivated mainly in the South Western Nigeria States and Mambilla Plateau of Taraba State. *C. acuminata* is a relative of Malvaceace plant family. It is an evergreen tree of about 20 meters high and has long and oval leaves. The pods are oval and contain five to six fruits in it. The nuts aroma is sweet and rose – like. (http://En.m.wikipedia.org/wiki/kolanut)

Kola nut is used as dyes because it contains anthocyanin which is very sensitive pigment toward PH change (Sachin et al., 2011). The objective of this research is to explore the indicator activity of ethanolic fruit extract of *C acuminata* and compare it with standard indicator in strong acid – strong base titration.

MATERIALS AND METHODS

Analytical grade reagents that is, hydrochloric acid (HCl), Sodium Hydroxide (NaOH) Phenolphthalein and Methyl Orange were obtained from Chemistry laboratory in College of Education, Zing in Taraba State. Reagents and volumetric solutions were prepared as per standard books (Jaffrey et al., 1996).

The *C. acuminate* nuts were purchased from Zing main market and were authenticated by a botanist in Biology Department of College of Education in Zing. One nut weighing 15g was cut into pieces and grounded into a mesh with a pestle in a mortar. The grounded mesh was macerated with 10ml of ethanol and water. The solid parts was filtered off and the filtrate (ethanolic extract of C. *acuminata* fruit was preserved in a tightly closed container and stored away from direct sunlight.

The experimental work was carried out by using the same set of glass wares for all types of titrations. The reagents were not calibrated; as the same aliquots were used for both titration of standard indicators and ethanolic fruit extract of *C. acuminata.*

10ml of titrand and 2 drops of indicator was titrated. A set of three experiments was carried out and results were recorded in Tables 1 to 6. The mean and standard deviations were calculated from the results. The result is shown in Table 7. The ethanolic extract of fresh fruit of *C. acuminate* was screened for it use as indicator for acid – base titration and the results of this screening were compared with the results obtained by using phenolphthalein and methyl orange for a strong acid and strong base (HCl and NaOH) titrations. The screening was carried out using two different molar strengths of acid and alkali, viz, 0.1M and 0.5M.

RESULTS AND DISCUSSIONS

For all the titrations with the strong acid and strong base, the mean equivalent points were obtained by the

Table 3. 0.1M HCl – 0.1M NaOH titration using 2 drops of Methyl orange indicator.

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	24.10	48.30	24.20
Initial reading	0.00	24.10	0.00
Volume of acid used	24.10	24.20	24.20

$\overline{X}$ titre value: $\sum \frac{24.10+24.20+24.20}{3} = \frac{68.50}{3} = 24.17cm^3$

Table 4. 0.5M HCl – 0.5M NaOH titration result using 2 drops of Methyl orange indicator.

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	16.70	33.30	49.80
Initial reading	0.20	16.70	33.30
Volume of acid used	16.50	16.60	16.50

$\overline{X}$ titre value: $\sum \frac{16.50+16.50+16.60}{3} = \frac{49.10}{3} = 16.53cm^3$

Table 5. 0.1M HCl – 0.1M NaOH titration result using 2 drops of Phenolphthalein indicator.

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	23.20	46.10	23.20
Initial reading	0.00	23.20	0.00
Volume of acid used	23.20	23.10	23.20

$\overline{X}$ titre value: $\sum \frac{23.20+23.10+23.20}{3} = \frac{69.50}{3} = 23.17cm^3$

Table 6. 0.5M HCl – 0.5M NaOH titration results using 2 drops of phenolphthalein indicator.

Burette reading	First reading (cm^3)	Second reading (cm^3)	Third reading (cm^3)
Final reading	16.20	32.20	16.30
Initial reading	0.00	16.20	0.00
Volume of acid used	16.20	16.20	16.30

$\overline{X}$ titre value: $\sum \frac{16.20+16.20+16.30}{3} = \frac{48.70}{3} = 16.23cm^3$

ethanolic fruit extract of *C. acuminate* matched with methyl orange for concentrations of 0.1M HCl and 0.1M NaOH and for concentrations of 0.5M HCL and 0.5M NaOH.

This result agrees with Uche et al. (2014), who also observed that the same concentrations of HCl and NaOH showed a very negligible slight variation in the mean equivalent point when cola acuminate was used as indicator in comparing with Methyl orange and Phenolphthalein indicators. However, the ethanolic fruit extract of *C. acuminate* shows very slight variation with Phenolphthalein at 0.1M and 0.5M concentrations of HCl and NaOH respectively.

Conclusion

Chemistry is a practical oriented and this means that objects and tangible materials are needed to make chemistry teaching and learning fun laden and exciting. But the absence of standard materials or where they are harmful to health has been bane to fulfilling chemistry teaching - learning process. This calls for improvisation process as part of the roles of the chemistry teacher. The synthetic indicators are very hazardous to health and causes pollution (More and Ghumoore, 2014). Therefore, to solve this problem, ethanolic fruit extract of *C. acuminate* can be used in the place of both indicators

Table 7. Mean equivalent point, standard deviation, EFECA, Methyl orange and Phenolphthalein indicators use for titration of 0.1M and 0.5M HCL and NaOH respectively.

S/No.	Titration: Titrant Vs Titrand	Strength (M)	Indicator	Reading with $\overline{X}$ ±S.D
1.	HCl Vs NaOH	0.1	Methyl Orange	24.17 ± 0.05cm^3
			EFECA	24.01 ± 0.23 cm^3
			Phenolphthalein	23.17 ± 0.05cm^3
2.	HCl Vs NaOH	0.5	Methyl Orange	16.53 ± 0.05 cm^3
			EFECA	16.87 ± 0.05 cm^3
			Phenolphthalein	16.23 ± 0.05 cm^3

HCl – Hydrochloride Acid, NaOH – Sodium Hydroxide, EFECA – Ethanolic Fruit Extract of Cola Acuminata, S.D. – Standard deviation, $\overline{X}$ – Mean equivalent point

(methyl orange and phenolphthalein for titration of strong acid and strong base. Ethanolic fruit extract of *C. acuminate* is simple to extract and is readily available in the local market. It is affordable and students also enjoy working with it as they realized the importance of natural resources in chemistry learning.

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