Volume : 3 | Issue : 2 | Feb 2014 • ISSN No 2277 - 8160

Research Paper Botany

Investigation of Herbal Acid Base Indicator

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ABSTRACT

In acid- base titrations, indicators are used to show a sharp color changes at interval of pH. Natural pigments in plants are highly colored substances and may show color changes with variation of pH. Pulps of the fruit are pH sensitive and give different colors in acidic condition (pink) and basic condition (dark greenish). An attempt has been made to investigate the indicator activity of boil distilled water fruit extract of Citrullus lanatus and to replace the synthetic indicators as they have certain disadvantages like chemical pollution, availability problems and high cost. Distilled water fruit extract of m from family Citrullus lanatus gives sharp and intense color changes as compared to Phenolphthalein, Methyl Red and Phenol Red. Herbal indicators are evaluated by using strong acid-strong base, strong acid-weak base, weak acid-strong base and weak acid-weakbase. In all these titrations the extract was found to be very useful and accurate for indicating the neutralization point.

KEYWORDS :

Introduction

Indicators are substances which change colour according to the hydrogen ion (H) concentration of the liquid or solution to which they are added. Such indicators can be used to measure and to detect changes in Hydrogen ion concentration or pH. The measurement of hydrogen ion concentrations in solutions is important in obtaining values for the dissociation constants of acids. Many industrial and biological processes depend too, on hydrogen ion concentration and are controlled by its measurement . Indicators are either weak acid or bases and are therefore slightly dissociated in water.

One of the most commonly used indicators in acid-base titrations is methyl orange . This compound with molecular formula, C14H14N3SO3Na and molecular structure on figure 1, is amphoteric monoazo dye that is made by coupling dimethylanaline to diazotized sulphanilic acid and converting the coupled product to sodium salt (Budavari, 1989 and Green, 1990). Slightly soluble in water, it displays useful indicator properties and is sensitive to mineral acids but unaffected by carbonates. As every indicator has its definite range of hydrogen ion concentration or pH over which it changes colour. Methyl orange has a pH range of 2.9-4.6 and is orange in water, pink in acid, and yellow in bases (Heys, 1970 and Wellings, 1961).

Commercial indicators are expensive and some of them have toxic effects on users and can also cause environ-mental pollution . For these reasons there has been an increasing interest in searching for alternative sources of indicators from natural origins. These alternatives would be cheaper, more available, simple to extract, less toxic to users and environmentally friendly. Volumetric analysis is one of the key quantitative techniques used to analytically determine both inorganic and organic acid interaction with strong or weak acids and bases in raw materials, intermediates and finished products for quality assurance purposes . This is accomplished via the use of appropriate weak organic dyes or acids pH indicators. Most pH indicators are either weak organic acids or bases dyes which accept or donate electrons. The change in color at a marginal range is attributed to their acidity or basicity properties. Although there are automated titration apparatus that determine the equivalent points between reacting species, indicators are still needed for teaching and research laboratories for simple titration

Colours of substances make the world a wonderful place. Because of the colours and structures; flowers, plants, animals, and minerals show their unique characters. There are various organic and inorganic compounds responsible for natural colours. Some of the organic compounds i.e. flavonoids, flavonols, acylated flavonoids, anthocyanins, glucosylated acylated anthocyanin, quinines, imines, polymethines, napthaquinones, anthraquinonoids, indigoids; dihydropyrans diarylmethanes carotene etc. imparts colours to the flower. Among them anthocyanidins and flavones are main.

Flavanoids are colored compounds that can be isolated from various parts of plants like flowers, fruits and are pH sensitive. Therefore it has been hypothesized that the fruit extract could be utilized as an indicator for different types of acid base titrations. The pulps of the fruit are pH sensitive and give different colors in acidic condition (pink) and basic condition (greenish yellow). The equivalence points obtained by using fruit extract matched with the equivalence points obtained by standard indicators.

Theory

The fruit have been found to be effective in the treatment of arterial hypertension reported antifertility effect of fruit . In the Indian traditional system of medicine, Ayurveda, watermelon especially red and Pink , is considered to have medicinal properties. The roots are used to make various concoctions believed to cure ailments such as cough hair loss or hair greying. The fruit pulp are boiled in oil along with other species to make medicated hair oil for hair treatment . The leaves and flowers are ground into a fine paste with a little water, and the resulting latherry paste is used as a shampoo plus conditioner. The red fruit variety is preferred as medicine . The leaves and flowers have healing properties .

(a) The colour change is due to ionization of the acid base indicator. The unionized form has different colour than the ionized form.
(b) The ionization of the indicator is largely affected in acids and bases as it is either a weak acid or a weak base.

In case, the indicator is a weak acid, its ionization is very much low in acids due to common H+ ions while it is fairlyionized in alkalies similarly if the indicator is a weak base, its ionization is large in acids and low in alkalies due to common OH– ions. Considering two important indicators phenolphthlein (a weak acid) Methyl orange (a weak base), Ostwald theory can be illustrated as follows:

Phenolphthlein can be represented as Hph. It ionizes in solution to a small extent as:

HPh --------- *H* + + *Ph*-

Clourless Pink

The undissociated molecules of phenolphthlein are colourless while Ph– ions are pink in colour. In the presence of an acid the ionization of Hph is practically negligible as the equilibrium shifts to left hand side due to high concentration of H+ ions. Thus the solution would remain colourless. On addition of alkali, hydrogen ions are removed by OH– ions in the form of water molecules and the equilibrium shifts to right hand side. Thus, the concentration of Ph– ions increases in solution and they impart pink colour to the solution. The simple Ostwald theory of the colour change of indicators has been revised . Plant pigments in general are termed flavonoids .

These include flavone, flavonol, isoflavanol, anthocyanin, anthocyanidin etc. Anthocyanins occur as glycosides and their aglycones i.e. the free pigment are called anthocyanidins. The colour of flowers are due to the presence of anthocyanins. The colours of flower's are due to the presence of anthocyanins. *Hibiscus rosa sinensis* also known as Rakta shalmali, Silk cotton tree, Deokapas, Shimal, Tambdi-savaru, Lal katyan, is a species of the Hibiscus genus, belonging to the family malvaceae. The various shades of colour exhibited by all flowers are due to a very small number of different compounds or pigments. These different compounds contain the same carbon skeleton, and differed only in the nature of the substituent groups.ore of these naturally occurring plant pigments are anthocyanins. These are water soluble and generally occur in the aqueous cell sap, and are responsible for the large variety of colours in flowers. The acid salts of these pigments are usually red, their metallic salts usually blue and in neutral solution anthocyanins are violet.

Aims and objectives of the study

- To investigate environmental friendly acid base indicator.
- To investigate cost effective acid base indicator.
- To investigate natural /herbal acid base indicator.
- To investigate commonly found uniformly available acibase indicator
- To investigate non toxic acid base indicator .

Methodology

Plant materials

Fresh fruits of watermelon were purchased from local market and authenticated from Department of Botany, P.G. College. The fruits were cleaned with water and seeds were separated. 50 grams of pieces of fruits were macerated for 30 minutes with 100 mL solution containing nine parts of distilled water. After pressing the mark, filtrate was collected and used in the various titrations.

Reagents

Reagents of analytical grade were used. Sodium hydroxide, ammonia, hydrochloric acid, ethanoic acid and phenolphthalein were procured from Department of Chemistry Gyanodaya Vidya Mandir Narsingarh. The reagents and volumetric solutions were prepared as per Indian pharmacopeia IP 1996.

Glass wares

Burettes, pipettes etc were calibrated as per the procedures given in Indian pharmacopeia IP 1996.

Preparation of fruit extract

1 g fresh pulp of water melon were extracted with warm water for 15 minutes and the aqueous extract separate and were maintained

Experimental procedure

The fruit pulp of water melon were separated and cleaned with distilled water. It was then cut to small pieces and transferred to a clean beaker. 100 ml of distilled water was taken in another beaker and gently warmed and poured to the petals and kept aside for 15 minutes. The extract was then poured carefully to a glass container through a funnel and stored aside separately without exposing to direct sunlight

Test for color change

ml of the extract was added to 25 ml each of buffer solutions of pH ranging from 1.2 to 10.2. The results of the test arelis ed in table 5.Titrations

0.1 ml of the extract was added as indicator for each titration type- strong acid against strong base, strong acid against weak base. Weak acid against strong base and weak acid against weak base and the trials were repeated 5 times to check the precision. The titrations were again performed using phenolphthalein indicator as standard and the results obtained were compared with the results of titrations using plant extract indicator. The results for titrations are depicted in the tables 1a to 4b.

Results

Table 1a. Titration of HCl against NaOH using aqueous Citrullus lanatus fruit extract indicator

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.8	9.88
2	10	0.0	9.9	
3	10	0.0	9.9	
4	10	0.0	9.9	
5	10	0.0	9.9	

End point: Appearance of colorless

Table 1b. Titration of HCl against NaOH using Phenolphthalein indicator

S No	Vol. of acid (mL	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.8	9.88
2	10	0.0	9.9	
3	10	0.0	9.9	
4	10	0.0	9.9	
5	10	0.0	9.9	

End point: Appearance of colorless

Table 2a. Titration of HCl against NH3 using aqueous *Citrullus lanatus* fruit extract indicator

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.7	
2	10	0.0	9.8	
3	10	0.0	9.8	
4	10	0.0	9.8	
5	10	0.0	9.8	

End point: Appearance of colorless

Table 2b. Titration of HCl against NH3 using Phenolph-thalein indicator.

S No	Vol. of acid (mL	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.4	9.56
2	10	0.0	9.6	
3	10	0.0	9.6	
4	10	0.0	9.6	
5	10	0.0	9.6	

End point: Appearance of colorless

Table 3a. Titration of Acetic acid against NaOH using aqueous Citrullus lanatus fruit extract indicator.

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.4	9.68
2	10	0.0	9.5	
3	10	0.0	9.5	
4	10	0.0	9.5	
5	10	0.0	9.5	

End point: Appearance of colorless

Table 3b. Titration of Acetic acid against NaOH using Phenolphthalein indicator

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.6	
2	10	0.0	9.7	
3	10	0.0	9.7	
4	10	0.0	9.7	
5	10	0.0	9.7	

Table 4a. Titration of Acetic acid against NaOH using aqueous *Citrullus lanatus* fruit extract indicator

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.5	
2	10	0.0	9.6	
3	10	0.0	9.6	
4	10	0.0	9.6	
5	10	0.0	9.6	

End point: Appearance of colorless

4b. Titration of Acetic acid against NH3 using Phenolphthalein indicator

S No	Vol. of acid (mL)	Burette reading		Volume of titrant (mL) mean = £x/n
		Initial (mL)	Final (mL)	
1	10	0.0	9.6	
2	10	0.0	9.7	
3	10	0.0	9.7	9.68
4	10	0.0	9.7	
5	10	0.0	9.7	

End point: Appearance of colorless

Table 5. Color change of indicator with pH change

Buffer solution	Observed colour*
Acid – phthalate buffer, pH 3	Bright pink
Neutralized phthalate buffer, pH 5	Light pink
Phosphate buffer, pH 7	Pale pink
Alkaline borate buffer, pH 9	Dark green
Alkaline borate buffer, pH 10	Dark green

***On addition of the flower extract indicator**

Indicators and the Neutralization Process

The following chemical equations; Equations (1)-(4) were considered to be the reactions which proceed during the neutralization process, in the presence of the visual indicators at 25°C. The mole ratios of the stoichiometric equations were taken as the true mole ratio (with a value of 1.0). This was compared with the experimentally deter-mined mole ratios by deductions from the titre value values.

Indicator organic, 25°C

HCl + NaOH ----------àNaCl + H2O (1)

Indicator organic, 25°C

HCl+ NH_3 ----------à NH4Cl (2)

Indicator organic, 25°C

CH3COOH + NaOH ---------àCH3COONa + H2O (3)

Indicator organic, 25°C

CH3COOH + NH_3 ---------- >$CH3COONH_4$ (4)

Discussion

The equivalence point of the titrations using the flower extract either coincided or almost reached close to the equivalence point using the standard indicator, phenolphthalein for all the titrations. In several cases it proved to be more reliable than the standard indicator and gave sharp color change at equivalence point. It was also observed that the extract act reversibly and gave sharp color change in both the directions.

CONCLUSION

Thus the study helped to realize that the flower pigment of ***Citrullus lanatus*** could be effectively used as a substitute to the presently existing indicators owing to the factors like simple preparation, good performance and accurate and precise results.

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