Advanced International Journal for Research (AIJFR)
E-ISSN: 3048-7641 ● Website: www.aijfr.com ● Email: editor@aijfr.com

Evaluation of Herbal Extracts as Natural PH Indicators in Acid-Base Titrations

Dr. Yaparthi Suneetha[1], Dasari Smily[2], J Akhila[3], CH. Hanumantha Revathi[4], M. Prabhavathi[5]

[1,2,3,4,5] Department Pharmaceutical Chemistry, Dr. samuel George institute of pharmaceutical sciences Markapur, Affiliated to Andhra kesari University, Ongole.

Abstract:

The present study aimed to evaluate the effectiveness of Beta vulgaris (Beetroot), Rosa indica (Rose), and Brassica oleracea (Red cabbage) extracts as natural PH indicators. The extracts were prepared using aqueous extraction and tested in various acid-base titrations. Distinct colour changes were observed at different PH levels and compared with synthetic indicators. The results demonstrated that all three extracts effectively indicated end points, with Rosa indica and Beta vulgaris showing sharper colour transitions. These natural indicators are economical, biodegradable, non-toxic, and environmentally friendly alternatives to synthetic indicators.

Keywords: Natural PH Indicator, Rosa Indica, Beta Vulgaris, Red Cabbage, Anthocyanins, BETALAINS, Acidic Solution, Basic Solution, Acid-Base Titration, Plant Extracts.

1. Introduction:

BETALAINS:

They are natural, water-soluble pigment occurring in nitrogen containing pigments found in beetroot. They can exhibit colour variations in response to changes in PH. They can be classified into two groups; Betacyanin which produce red to violet colour. Betaxanthins which produce yellow to orange colour. These are natural PH indicators. They can alter the synthetic indicators. Because these all non-toxic, biodegradable, eco-friendly nature.

ANTHOCYANIN:

These are naturally occurring colour pigment found in Rose, Red cabbage etc. These are glycosylated form and belongs to phenolic group. They give Red, Purple, Blue and Violet colours. They are highly sensitive to PH changes. In acidic solution, they give red and basic solution. They give blue or green for this colour changing they act as neutral PH indicator. It is non-toxic, ecofriendly and easily available.

2. INTRODUCTION OF HERBS:

1.BETA VULGARIS:

It is a scientific name of beetroot and they belong to family AMARANTHACEAE. They contain a natural colouring substance known as BETALAINS. They also contain some micronutrients such as Carotenoids, Vitamins, Minerals. They mainly composed of two groups such as Red betacyanin and Yellow betaxanthins. It is bluish red colour becoming blue violet when exposed to acidic or alkaline solutions. The colour of betanin depends mainly on PH.

Figure1:

2.ROSA INDICA:

It is a scientific name of Rose belongs to family Rosacea. It is always available plant in India. The petals of Rose contain natural pigment as anthocyanin, which is responsible for red and pink shades. These pigments show colour variations in acidic and basic solutions. For acidic solution shows in Red and Greenish in basic solution. The chemical constituents present for Rosa indica are flavonoids, anthocyanin.

Figure2:

3.BRASSICA OLERACEA:

It is scientific name of Red Cabbage belongs to family Brassicaceae family. It contains natural colouring pigment as anthocyanin which produce distinct colour changes in acidic or basic solutions. So, it is used as natural PH indicator. It is easily available in India and all over the world for a particular period.

Figure3:

MATERIALS:

Rose petals, Beaker, Beetroot, Red cabbage, Water, Funnel, Match box, Stirrer, Burner, Bottle container.

PREPARATION:

1.Preparation of Beta vulgaris:

Take required quantity of water in a beaker and add beetroot pieces then heat the mixture until the pigments (BETALAINS) can released into water. After heating, cool the solution then filter it. Then collect the filtrate in another beaker. Finally, the natural PH indicator is ready.

Figure4: Beet root indicator

2.Preparation of Rosa indica:

Take required quantity of water in a beaker and add Rose petals then heat the mixture until the pigment (anthocyanin) can released into water. After heating cool the mixture then filter it. Now collect the filtrate in another beaker. Finally, the natural PH indicator is ready.

Figure5: Rosa indica indicator

3.PREPARATION OF BRASSICA OLERACEA:

Take required quantity of water in a beaker and add chopped red cabbage then heat the mixture until pigment (anthocyanin) can released into water. After heating cool the mixture then filter it. Now, collect the filtrate in another beaker. Finally, the natural PH indicator is ready.

Figure6: Brassica oleracea indicator

RESULT:

Table1: beta vulgaris colour changes with titrant and titrate

TITRANT	INDICATOR	COLOUR	TITRATE	COLOUR
HCL	BETA VULGARIS	RED	NAOH	PINK
HCL	BETA VULGARIS	RED	NH4OH	PINK
CH3COOH	BETA VULGARIS	RED	NAOH	PINK
CH3COOH	BETA VULGARIS	RED	NH3	PINK

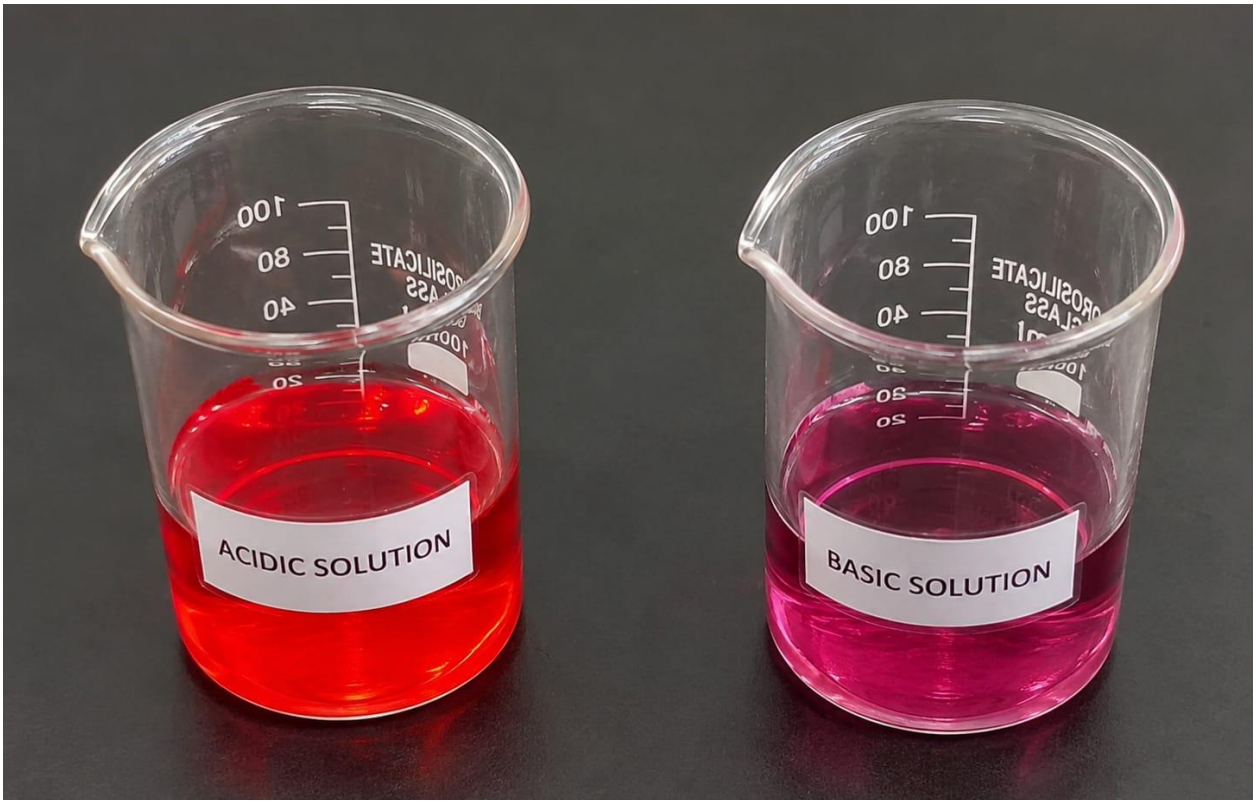

Figure7: Beta vulgaris colour changes with titrant and titrate

Table2: Rosa indica colour changes with titrant and titrate

TITRANT	INDICATOR	COLOUR	TITRATE	COLOUR
HCL	ROSA INDICA	PINK	NAOH	RED
HCL	ROSA INDICA	PINK	NH3	RED
CH3COOH	ROSA INDICA	PINK	NAOH	DARK PINK
CH3COOH	ROSA INDICA	PINK	NH3	DARK PINK

Figure8: Rosa indica colour changes with titrant and titrate

Table3: Brassica oleracea colour changes in titrant and titrate

TITRANT	INDICATOR	COLOUR	TITRATE	COLOUR
HCL	BRASSICAOLERACEA	YELLOW	NAOH	COLOUR LESS
HCL	BRASSICAOLERACEA	PINK	NH4OH	COLOUR LESS
CH3COOH	BRASSICAOLERACEA	PINK	NAOH	COLOUR LESS
CH3COOH	BRASSICAOLERACEA	PINK	NH4OH	RED

Figure9: Brassica oleracea changes with titrant and titrate

OBSERVATION OF VISIBLE COLOUR CHANGES IN HERBAL INDICATOR

EXTRACT	OBSERVATION
BETA VULGARIS	Clear and distinct colour transition, effective natural indicator
ROSA INDICA	Sharp colour and effective natural indicator
BRASSICA OLERACEA	Good visible colour changes and effective natural indicator

The comparative results of all herbal extract as Beta vulgaris, Rosa indica and Brassica oleracea worked as natural PH indicators. Each extract produces a colour changes in response to acidic and basic solutions. But, the intensity and clarity of colour transition were not identical in all cases. The equivalence-point for all types of titrations by water with herbal extract was very close to equivalent point obtained by synthetic phenolphthalein indicator, Rosa indica and Beta vulgaris shows more end point changes. But the brassica oleracea shows different colour responses as clear or visible responses.

BENEFITS OF HERBAL INDICATOR:

They are safe, non-toxic, pollution-free in expensive, easily available. They also prepared quickly and easy to identify the changes in different PH solutions as acidic or basic solutions.

DRAWBACKS OF HERBAL INDICATOR:

The main drawbacks are lower stability, short storage life and their colour responses may depends the freshness of a plant. So, the selected plant has freshness, concentration and proper extraction conditions we can vary drawbacks of herbal indicators.

CONCLUSION:

The present study highlights that selected herbal extracts as Rosa indica, Beta vulgaris, Brassica oleracea passes potential natural PH indicator in acid base titrations with acids and bases. The three extracts changed colour clearly and the colour change will persist with the various acids and bases. The colour changes were easy to observe and give the accurate results. So, the herbal indicators are safe, low cost and non-toxic as compared to synthetic indicators. Therefore, the use of natural indicators also supports the promoting safer and environmentally responsible scientific practices. These herbal indicators are used effectively for research, laboratories and educational institutes for replacement of a synthetic indicator.

References:

1. Bhagat V, Patil R, Channekar P, Shetty S, Akarte A. Herbal indicators as a substituent to nsynthetic indicators, Int. J Green Pharm. 2008;2(3):162.
2. Heriette MC, Azeredo. Betalains: Properties sources applications, and stability: A review,International Journal of Food Science and Technology. 2009;44(1):2365-2376.
3. Jeiyendira D, Dave K. A Novel, Inexpensive and Less Hazardous Acid-Base Indicator, J Lab. Chem. Educ. 2013;2:3438.
4. Kadam S, Yadav A, Raje V, Waghmare K. Comparative study of natural and synthetic indicators, Der Pharma Chem. 2013;5(1):296-299.
5. Kapilraj N, Keerthanan S, Sithambaresan M. Natural Plant Extracts as Acid-Base Indicator and Determination of Their pKa Value, J Chem; c2019.
6. Bhagat V, Patil R, Channekar P, Shetty S, Akarte A. Herbal indicators as a substituent to synthetic indicators, Int. J Green Pharm. 2008;2(3):162.
7. Musale Archita Y, Wagh Prajwal S. International Journal of Advance Research, Ideas and Innovations in Technology. Review on Anthocyanins as herbal pH indicators. 2019;6(1);73-76.
8. Boyle R. Experiments upon Colours; c1663
9. Indrayan AK, Guleria BS. J Indian chem Soc, 2001;78:476.
10. Forster M. J Chem Educt, 1978;55:107.
11. Cabrita L, Fosson T, Andersen OM. Food Chem. 2000;68:101-107.
12. Tatsuzawa F, Mikanagi Y, Saito N, Shinoda K, Shigihara A, Honda T, et al. Biochemical Systematics and Ecology. 2005;33(8):789-798.
13. Honda T, Tatsuzawa F, Kohayashi N, Nagumo HKS, Shigihara A, Saito N, et al. Phytochem. 2005;66(15):1844-1851.
14. Takeda K, Osakabe A, Saito S, Furuyama D, Tomita A, Kojima Y, et al. Phytochem. 2005;66(13):1607-1613.
15. Paula A, Vaz A, Decassia RL, Ribeiro F, Gilberto Kerbauy B. Plant Physiology and Biochem. 2004;42(5):411-415.

16. Kuang-Liang H, Miyajima I, Okubo H, shen TM, Ta-shiung H. Scientia Horticulturae. 2001;88(3):235-241.
17. Toki K, Sito N, Shigihara A, Honda T. Phytochem. 2001;56(7):711-715.
18. Reuveni M, Evernor D, Artzi B, Perl A, Erner Y. J of Plant Physiology. 2001;258(8):991-998.
19. Zhao M, Ito Y, Tu P. Journal of Chromatography A. 2005;1090(1-2):193-196.
20. Seeram NP, Lee R, Scheuller HS, Heber D. Food Chemsitry. 2006;97(1):1-11.
21. Jia-Ping L, Lim YH, Su J, Han-Ming S, Ong CN. Journal of Chromatography B. 2007;848(2):215-225.
22. Iqbal Z, Muhammad L, Jabbar A, Muhammad G, Khan MN. Journal of Ethnopharmacology. 2005;102(2):256-261.
23. Herrera-Ruiz M, García-Beltrán Y, Mora S, Díaz-Véliz G, Viana GSB, Tortoriello J, et al. Journal of Ethnopharmacology. 2006;107(1):53-58.
24. Matich AJ, Bunn BJ, Hunt MB, Rowan DD. Phytochemistry. 2006;67(8):759-763.
25. Hao S, Wu J, Huang Y, Lin J Solar Energy. 2006;80(2):209-214.
26. Shanker R, Vankar PS. Dyes and Pigments. 2007;74(2):464-469.
27. Pale E, Koura-Bonafos M, Nacro M, Vanhaelen M, Vanhaelen-Fastre R. Phytoche. 2003;64(8):1395-1399.
28. Yashida K, Mori M, Kawachi M, Okuno R, Kameda K, Kondo T, et al. Tetrahedron Lett. 2003;44(43):7875-7880.
29. Filippini R, Caniato R, Piovan A, Cappellletti EM. Fitoterapia. 2003;74(1-2):62-67.
30. Indrayan AK, and Guleria BS. J Indian chem Soc Analytical application of plant extract as natural ph, 2001; 78: 476
31. Swain T ―chemistry and biochemistry of Plant pigments‖ T. W. Goodwin academic London 1976; 425-463.
32. Indrayan AK and Yadav V. Asian J Chem,Green Indicators-An Ecofriendly Endpoint1999; 11: 611.
33. Cutright Robert Rynearson Anthrocynins model compound for learning about more than ph J.CHEM EDU 1996,73(4) ,306
34. Tate J. "Labs Alive" Achimoa School, Ghana,2000.emphasizing chemistry with some physics and life science USA, 1994.
35. Allan Holm Nielsen, Carl Erik Olsen and Birger Lindberg Moller. Phytochem, 2005; 67(24): 2829-2835.
36. Tamaki Mishio, Tamaki Honma and Tsukasa Iwashina. Biochemical systematics and Ecology, 2006; 34(2): 180-184.
37. Melanie K Gatt, Keith R W Hammet, Kenneth R Markham and Brian G Murray. Scientia Horticulturae, Yellow pinks: Interspecific hybridization between Dianthus plumarius and related species with yellow flowers 1998; 77(3-4): 207-218.
38. TadigoppulaNarender, Tanvir Khaliq, Anju Puri, Ramesh Chander. Bioorganic & Medicinal chemistry letters, 2006; 16(13):3411-3414.
39. Agostino MD, Senatore F, De Feo V and De Simone F. FitoterapiaThree new trixane glycosidesobtained from the leaves of Jungia sellowii Less. using centrifugal partition chromatography, 1995;66:283.
40. Chulia AJ, Bennini B, Kaoudadi M, DP „Allais and Delage C. JNat Prod, Journal of Advanced Scientific Research 1995; 58: 560.

41. LI CJ, Elgamal MH, Sharker KH, Ahmed AA and Mabry TH. Nat prod Lett, Analytical Applications of Plant Extract as Natural pH Indicator: A Review1996; 8: 281.
42. Cabrita L, Fosson T, Andersen OM. Food Chem, Herbs as a natural pH indicators2000; 68: 101-107.
43. Jamaluddin AFM, Fumio Hashimoto, Toshiki Miwa, Katsuhiro Ohbo and Yusuke Sakata. Scientia HorticulturaeSeasonal variation in pigmentation and anthocyanidin phenetics in commercial Eustoma flowers, 2004; 100(1-4):103-115.
44. Kuang-Liang Huang, IkuoMiyajima, Hiroshi Okubo, Tsai Mu shen and Ta-shiung Huang. Scientia Horticulturae,Flower colours and pigments in hybrid tuberose (Polianthes) 2001; 88(3):235-241.
45. Kenjiro Toki, Norio Sito, Atsushi Shigihara and Toshio Honda Phytochem, The blue anthocyanin pigments from the blue flowers of Heliophila coronopifolia L. (Brassicaceae)2001; 56(7): 711-715.