INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN CHEMISTRY AND PHARMACEUTICAL SCIENCES
(p-ISSN: 2348-5213: e-ISSN: 2348-5221)
www.ijcrcps.com
Coden: IJCROO(USA) Volume 3, Issue 4 - 2016
Research Article
SOI: http://s-o-i.org/1.15/ijcrcps-2016-3-4-4

Alkalinity Determination of Water using various Natural extracts as indicators.

Shobharani Panchagnula and Shanthi Vunguturi.

Department of Chemistry, Muffakhamjah College of Engineering and Technology (Affiliated to Osmania University), Telangana, India.
*Corresponding Author: shobharani@mjcollege.ac.in

Abstract

The present study evaluated the role of natural indicators for estimating the alkalinity of water. The study was carried out volumetrically and the indicators used were the extracts of red cabbage , red radish and cherries. Carbonate and bicarbonate alkalinity of water was estimated by titrating an aliquot of water sample with a standard acid using the above indicators. The predominant chemical system present in natural waters is one where carbonates, bicarbonates and hydroxides are present. Any changes in the pH of water, alkalinity acts as a buffer protecting the water from sudden shifts in pH. Highly alkaline waters are unpalatable. An attempt was made in our study to identify the alkalinity of water using naturally available indicators.

Keywords: Alkalinity, natural indicators, pH.

1. Introduction

The alkalinity of water is its quantitative capacity to buffer or neutralize an acid. Alkalinity is a measurement of water's ability to resist changes in pH. This term is used interchangeably with acid-neutralizing capacity (ANC) (1).

There are several types of alkalinity that are encountered in water. Each of these is a measure of how much acid (H^+) is required to lower the pH to a specific level (2).

Alkalinity not only helps regulate the pH of a water body, but also the metal content. Bicarbonate and carbonate ions in water can remove toxic metals (such as lead, arsenic, and cadmium) by precipitating the metals out of solution (3).

Knowledge of the parameters such as acidity and alkalinity of water is important because, Alkalinity controls corrosion, Carbonates and Bicarbonates may complex with other elements altering the toxicity.

Alkalinity is often related to hardness, Water with less hardness indicates low alkalinity.(4)

Total alkalinity is defined as the amount of acid required to lower the pH of the sample to the point where all of the bicarbonate [HCO_3^-] and carbonate [CO_3^{--}] could be converted to carbonic acid [H_2CO_3]. This is called the carbonic acid equivalence point or the carbonic acid endpoint. These equations show what happens to carbonate and bicarbonate as acid is added.

(1) $H^+ + CO_3 ==> HCO_3^-$
(2) $H^+ + HCO_3^- ==> H_2CO_3$

Alkalinity varies greatly due to differences in geology and so there are no general standards for alkalinity [5,6].Levels of 20-200 mg/L are typical of fresh water. A total alkalinity level of 100-200 mg/L will stabilize the pH level in a stream. Levels below 10 mg/L indicate that the system is poorly buffered, and is very susceptible to changes in pH from natural and human-caused sources.

Above pH 8.3, alkalinity is mostly in the form of carbonate (CO_3^{2-}) below 8.3, alkalinity is present mostly as bicarbonate (HCO_3)[4,5,6].

Materials and Methods

The alkalinity of water can be determined by titrating the water sample with standard acid solution(HCl). Alkalinity of water is attributed to the presence of OH^-, CO_3^{2-} and HCO_3^- ions [7].

The titration was performed volumetrically using natural indicators such as red cabbage, red radish and cherries, in place of conventionally used phenolphthalein and methyl orange indicators.

2.1. Extraction Methodology:

Fresh red cabbage , red radish and cherries were purchased from a local market , Banjara Hills , Hyderabad, Telangana ,India .10 ml of 50 % -70 % ethyl alcohol (ethyl alcohol was used instead of isopropyl alcohol since it is less toxic to humans (8). Isopropyl causes kidney damages if used externally over a longer period of time. Short exposure of a hand or the inhalation of the vapor for a few minutes is supposedly not dangerous but ethanol is for sure less dangerous) was added to finely chopped cabbage, radish and cherries and macerated. After 15 minutes macerated mixture was filtered using muslin cloth.

2.2. Experimental procedure

Standard alkaline water was prepared by dissolving a known amount of Na_2CO_3 (A.R) in distilled water.

The extent of alkalinity present in the water sample was conveniently determined by titrating 100ml of the sample with standard HCl using extracts of cabbage, radish and cherries as indicators. The conventionally used indicators, phenolphthalein and methyl orange have been replaced by the above said indicators. The pH range of red radish is similar that of red cabbage.

To 100 ml of standard water sample few drops of red cabbage indicator / red radish indicator were added and titrated against standard HCl. (color change was observed as shown in table: 2) .Titration was continued by adding cherries extract as indicator until a sharp colour change was observed (Table :2)

Table – 1 pH ranges of the indicators.

S.No	Indicators	pH range
1.	Red Cabbage	2 -9
2.	Red Radish	2 -9
3.	Cherries	2.5 -4.5
4.	Phenolphthalein	8.3 - 10
5.	Methyl Orange	3.1 – 4.4

Table – 2 Colour changes of the indicators in Alkaline water

S.No	Indicators	colour change	
		Carbonate end point	Bicarbonate end point
1.	Red Cabbage	Violet to red	-----
2	Red Radish	Pink to orange	-----
3	Cherries		Orange to red
4	Phenolphthalein	Pink to colourless	-----
5	Methyl orange	-------	Yellow to red

Results and Discussion

The reaction taking place may be represented by the following equations

$$[CO_3^{2-}] + [H^+] \rightarrow [HCO^{3-}] \text{ ------- } 1$$
$$[HCO^{3-}] + [H^+] \rightarrow H_2O + CO_2 \text{ ------- } 2$$

The volume of HCl run down upto red cabbage or red radish end point corresponds to the completion of equation 1, whilst the volume of acid run down after the end point corresponds to completion of equation 2 .The total amount of acid used from the beginning of the experiment corresponds to total alkalinity and represents the completion of both the equations 1 and 2 .

Red cabbage juice contains anthocyanin and can be used as a pH indicator. It is red, pink, or magenta in acids, (pH < 7), purple in neutral solutions (pH ~ 7), and ranges from blue to green to yellow in alkaline solutions (pH > 7). The juice of red cabbage can be used as a home-made pH indicator, turning red in acid and green/yellow in basic solutions (9). It was observed from our studies that blueberries can accurately determine acidity while cherries can determine alkalinity. Cerry juice is bright red in acidic solution but purple to blue in basic solution. (9)

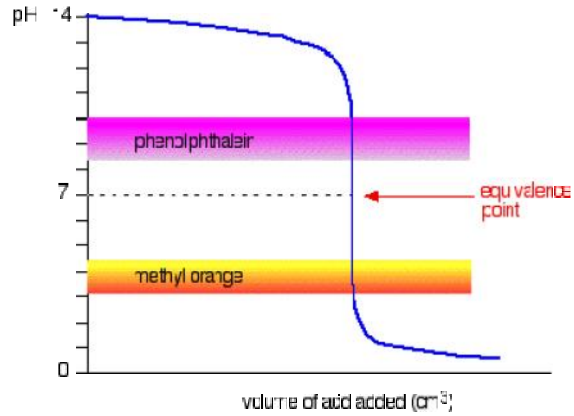


Figure :1 Plots showing the colour changes at different pH ranges for phenolphthalein and methyl orange as indicators.

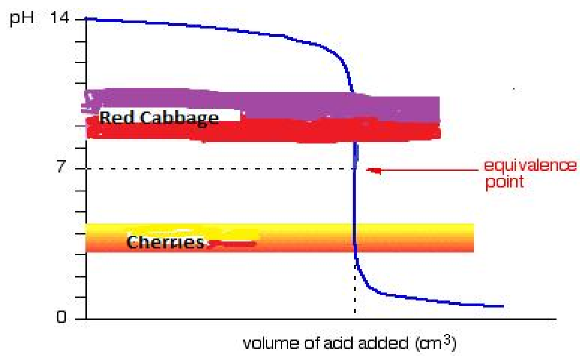


Figure: 2 Plots showing the colour changes at different pH ranges for red cabbage and cherries as indicators

Phenolphthalein

Phenolphthalein is a commonly used indicator for titrations, and is a weak acid.

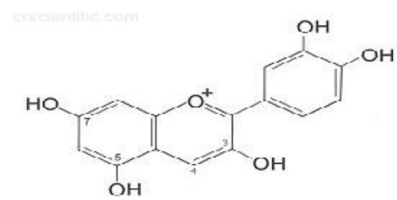
$$H\text{-}phph_{(aq)} \rightleftharpoons H^{+}_{(aq)} + phph^{-}_{(aq)}$$

Phenolphthalein is colorless and its ion is bright pink. Adding extra hydrogen ions shifts the position of equilibrium to the left, and turns the indicator colorless. Adding hydroxide ions removes the hydrogen ions from the equilibrium which tips to the right to replace them - turning the indicator pink.

Red cabbage (Anthocyanins)

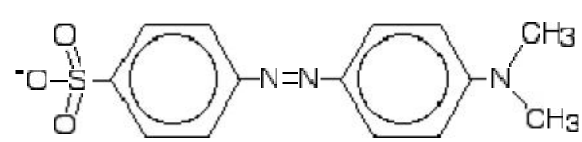
Anthocyanins can be used as pH indicators because their color changes with pH; they are pink in acidic solutions (pH < 7), purple in neutral solutions (pH ~ 7), greenish-yellow in alkaline solutions (pH > 7), and colourless in very alkaline solutions, where the pigment is completely reduced.[9]

Anthocyanins form oxonium (flavylium) cation configuration in acidic medium which is responsible for colour change at low pH ranges.

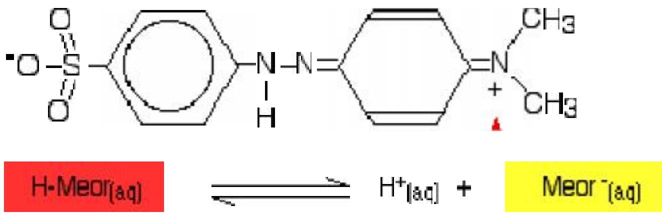


Methyl orange

Methyl orange is one of the indicators commonly used in titrations. In an alkaline solution, methyl orange is yellow and the structure is:



In acid medium, the hydrogen ion attaches to one of the nitrogens in the nitrogen-nitrogen double bond as shown below which gives red colour .



Cherries (Anthocyanins)

Anthocyanins, belonging to the group of flavonoids, are responsible for the orange, red colors in cherries at different pH ranges

Conclusion

The results obtained for determining the alkalinity of water by using red cabbage , red radish and cherries as indicators were found to be comparable(10) to those obtained when phenolphthalein and methyl orange were used.

Alkalinity in water causes nutritional imbalance to human health.(11) Highly alkaline water may lead to caustic embrittlement and deposition of precipitates and sludges in boilers(12). Bicarbonates of calcium and magnesium induce temporary hardness in water, which if untreated, causes scale formation . For water softening processes as well as boiler feed water analysis , it is essential to have an idea about the nature and extent of alkalinity present.

Therefore an attempt was made to estimate the alkalinity of water using simple, easily available, homemade indicators such as the above said indicators .The results were found to be more accurate and reproducible, with the natural indicators used showing a sharp colour change at the end points, than when phenolphthalein and methyl orange were used .

References

1.Boyd, Claude E. 1979. Water Quality in Warmwater Fish Ponds. Auburn University Agricultural Experiment Station.
2.Tucker, C.S. 1984. Carbon dioxide. in T.L. Wellborn, Jr. and J.R. MacMillan (eds.) For Fish Farmers 84-2. Mississippi Cooperative Extension Service.
3.“PH and Alkalinity” CELS, NRS, Rhodeisland, Kellyaddy, lindagreen, Elizabethherron, URIWW-3,july 2003
4 United States Geological Survey (USGS). 1998."National Field Manual for the Collection of Water-Quality Data.”
5. U.S. EPA Office of Water, Current Drinking Water Standards. http://www.epa.gov/safewater/mcl.html
6. Standard methods for the examination of water and waste water, 17th edition. American Public Health Association; American Water Works Association; and Water Pollution Control Federation, U.S.A.
7.P. W. Atkins, Molecules ,W. H. Freeman, Oxford, England, (1987).
8. Trullas JC, Aguilo S, Castro P, Nogue S (October 2004). "Life-threatening isopropyl alcohol intoxication: is hemodialysis really necessary?". *Vet Hum Toxicol* **46** (5): 282–4.
9.K. C. Li, A. C. Wagenknecht, "Anthocyanin Pigments Of Sour Cherries", *Journal Of The American Chemical Society*, **78**, 979 (1956).
10.Shanthi vunguturi and P Shobharani Int. J. Curr. Res. Chem. Pharma. Sci. 1(8): (2014):151–157
11.Cannon, Walter B. Acid closure of the cardia. Am. J. Physiol. 23: 105-14, 1908.
12. *"Total Alkalinity". United States Environment Protection Agency. Retrieved 6 March 2013.*

Access this Article in Online	
	Website: www.icrcps.com
	Subject: Plant Chemistry
Quick Response Code	

How to cite this article:
Shobharani Panchagnula and Shanthi Vunguturi. (2016). Alkalinity Determination of Water using various Natural extracts as indicators. Int. J. Curr. Res. Chem. Pharm. Sci. 3(4): 29-32.