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Assessing the Efficacy of Anthocyanin Based Natural pH Indicator against Phenolphthalein

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ABSTRACT

The color of acid-base indicators changes when the medium's pH changes, and the extracts of different plants exhibit sharp color changes when the reacting medium's pH changes. Because synthetic acid base indicators have some drawbacks, such as a difficult manufacturing process, high cost, and the potential to pollute the environment or injure users, a study has been conducted to replace them with natural extract. To find out their indicator activity, Hibiscus, Butterfly pea flower, Pomegranate, Red onion, Grape, and Dragon fruit extracts are compared to phenolphthalein indicator. Four different types of neutralization titrations like HCl Vs NaOH, HCl Vs NH_3, CH_3COOH Vs NaOH, and CH_3COOH Vs NH_3 are done to get precise and accurate results. This research work proves that we can use natural extract as a substitute for synthetic acid base indicator in various acid-base titrations.

Keywords: pH indicator, Phenolphthalein,Anthocyanin, Hibiscus, Butterfly pea, Pomegranate, Red onion, Dragon fruit, Grapes.

I. INTRODUCTION

INTRODUCTION TO NATURAL pH INDICATORS

A natural indicator is a type of indicator found in nature that may determine whether a chemical is acidic or basic. Plant dyes and pigments are brilliantly colored chemicals that change color when the pH changes. Flavonoids, Flavonols, Acylated flavonoids, Anthocyanins, Glucosylated acylated anthocyanin, Quinines, Imines, Polymethines, Napthaquinones, Anthraquinonoids, Indigoids, Dihydropyrans, Diarylmethanes, and Carotene are examples of organic and inorganic compounds that contribute to the color of plant tissues . Some of these compounds change color with pH, which can be used as a natural indicator. The hue and stability of these pigments are influenced by pH, light, temperature, and structural features. Anthocyanins are strong, water-soluble pigments that give many fruits, vegetables, and flowers their red, purple, and blue hues.

The majority of commercially available standard synthetic indicators are expensive. Additionally, they are both poisonous and combustible. They also demonstrate downsides such as availability, environmental pollution, and chemical pollution. Furthermore, the use of synthetic markers in food applications is being avoided or reduced to a greater extent due to their possibly harmful effects on humans. To solve the shortcomings of synthetic indicators, scientists are conducting substantial research in the field of natural materials, which are less dangerous to humans, cost-effective, readily available, and environmentally acceptable.Natural pigments or dyes found in plants are rarely harmful, pollution-free, and simple to make or extract.

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Examples of Anthocyanin Containing species: Flowers: Hibiscus, Butterfly pea,Rose. Fruits: Grapes, Pomegranates, dragon fruit, Apple, Strawberries. Vegetables: Red Cabbage, Red Onion, Beetroot.

INTRODUCTION TO PLANTS

- **HIBISCUS**

Fig no:1 Hibiscus

Scientific Name: Hibiscus sabdariffa L
Family: Malvaceae

- **BUTTERFLY PEA**

Fig no:2 Butterfly pea

Scientific Name: Clitoria ternatea L.
Family: Fabaceae

- **POMEGRANATE**

Fig no:3Pomegranate

Scientific Name: Punica granatum
Family: Lythraceae

- **GRAPES**

Fig no:4 Grapes

Scientific Name: Vitis vinifera L.
Family: Vitaceae

- **RED ONION**

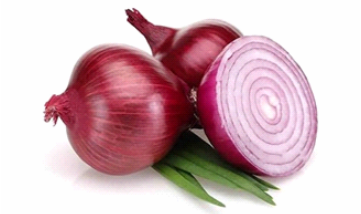

Fig no:5 Red onion
Scientific Name: Allium cepa
Family: Amaryllidaceae

- **DRAGON FRUIT**

Fig no:6 Dragon fruit

Scientific Name: Hylocereus spp.
Family: Cactaceae

ANTHOCYANIN

The fundamental C skeleton that makes up anthocyanin structure is C6-C3-C6. The primary distinctions between the more than 600 different forms of anthocyanins are the number and location of hydroxyl groups, the degree of methylation of the hydroxyl groups, the type and quantity of sugar

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molecules, and the acids that are attached to the sugars.

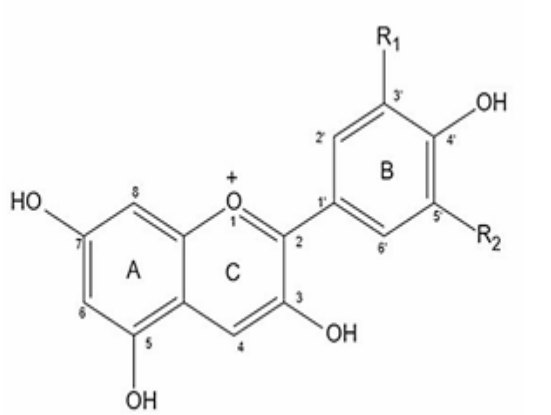

Fig no:7 Structure of Anthocyanin

The red, purple, and blue hues of fruits, vegetables, flowers, and red wine are caused by a class of water-soluble pigments called anthocyanins.

II. METHODOLOGY

Materials:

Hibiscus, Butterfly pea flower, Pomegranate, Conical flask, Beaker , Funnel, Mortar and pestle, Burette, What man filter paper, Tripod stand, Burner.

Reagents:

Phenolphthalein, Sodium hydroxide, Hydrochloric acid, Acetic acid, Ammonia, Distilled water.

Sample collection:

Hibiscus and Butterfly pea flower are collected from adjacent area of college. Pomegranate is collected from supermarket. Red onion is collected from vegetable stall.

Preparation of extract:

- **For Hibiscus:**

20 gm of fresh hibiscus was collected. Boiled it in 200 ml water and left overnight. On the following day, decanted into clean beaker.

- **For Butterfly pea flower:**

20 gm of fresh butterfly pea was collected. Boiled it in 200 ml water and left overnight. On the following day, decanted into clean beaker.

- **For Pomegranate:**

Hot water extraction: Collected 75gm of pomegranate arils. Transferred to mortar and pestle and add 10ml of hot water. Triturated the mixture well. Filtered the mixture using Whatman filter paper.

- **For Red onion:**

Hot water extraction: 100 gm of red onion was cut into small pieces. Transferred to mortar and pestle and add 15 ml hot water. Triturated the mixture well. Filtered the mixture using Whatman filter paper.

- **For Dragon fruit:**

Collected 20 gm peels of fresh dragon fruit. Boiled in 100 ml distilled water and filtered using Whatman filter paper.

- **For Grapes:**

Hot water extraction: 100 grams of grapes was cut into small pieces. Transferred to mortar and pestle and add 15 ml of hot water. Triturated the mixture well. Filtered the mixture using Whatman filter paper.

TITRATION PROCEDURE:

- HCl Vs NaOH

0.1 ml of natural indicators as indicator in the titration of HCl Vs NaOH and these titrations repeated for 3 times to get precise results. Same titrations are done using phenolphthalein as indicator then both results obtained from titration using plant extract and titration using phenolphthalein are compared.

- HCl Vs NH_3

0.1 ml of natural indicators as indicator in the titration of HCl Vs NH_3 and these titrations repeated for 3 times to get precise results. Same titrations are done using phenolphthalein as indicator then both results obtained from titration using plant extract and titration using phenolphthalein are compared.

- CH_3COOH Vs NaOH

0.1 ml of natural indicators as indicator in the titration of CH_3COOHVs NaOH and these titrations repeated for 3 times to get precise results. Same titrations are done using phenolphthalein as indicator then both results obtained from titration using plant extract and titration using phenolphthalein are compared.

- CH_3COOH Vs NH_3

0.1 ml of natural indicators as indicator in the titration of CH_3COOH Vs NH_3 and these titrations repeated for 3 times to get precise results.

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Same titrations are done using phenolphthalein as indicator then both results obtained from titration using plant extract and titration using phenolphthalein are compared.

III.

IV. OBSERVATION

pH TESTING

SL NO	NATURAL pH INDICATOR	pH
1.	HIBISCUS	6.40
2.	BUTTERFLY PEA	7.14
3.	POMEGRANATE	4.76
4.	RED ONION	6.56
5.	DRAGON FRUIT	6.51
6.	GRAPES	4.76

Table no: 1 pH of natural indicators

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COLOR CHANGE

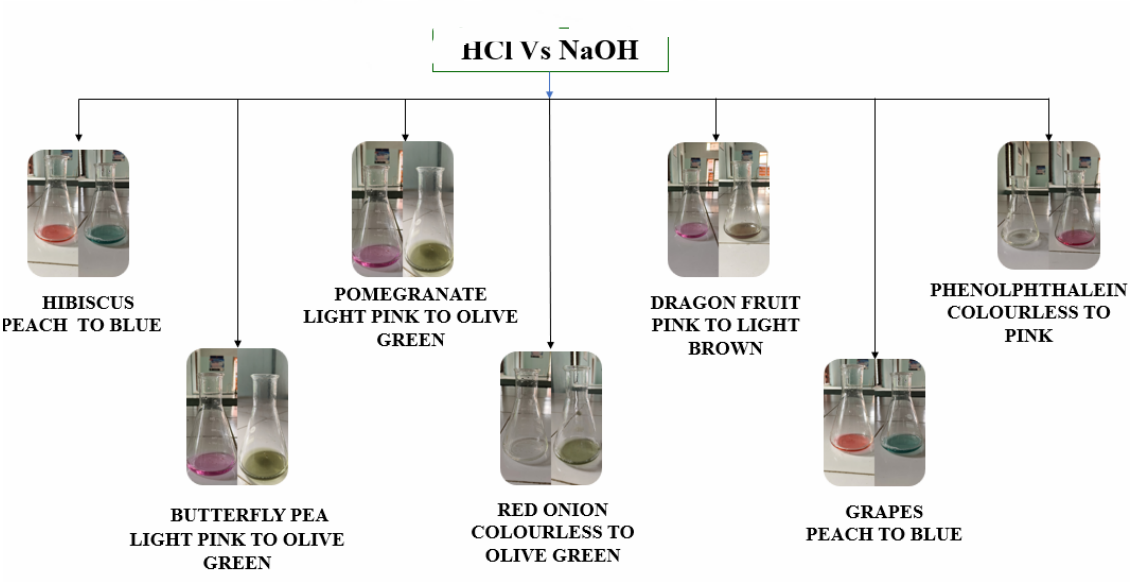

Fig no:8HCl Vs NaOH

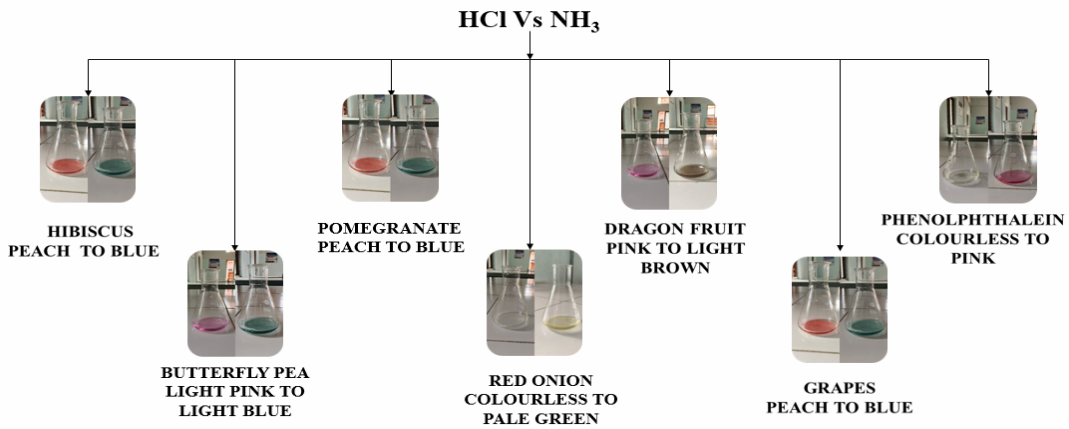

Fig no:9HCl Vs NH_3

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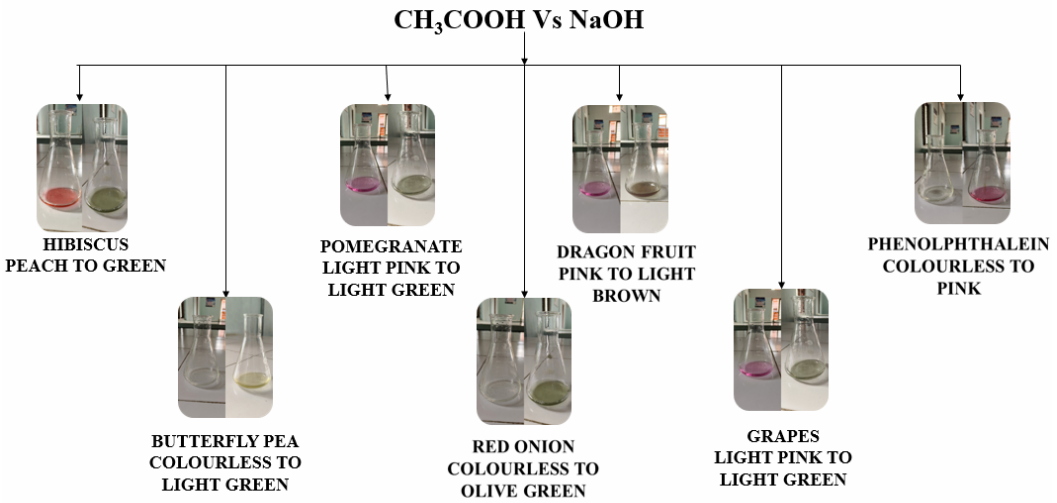

Fig no:10 CH_3COOH Vs NaOH

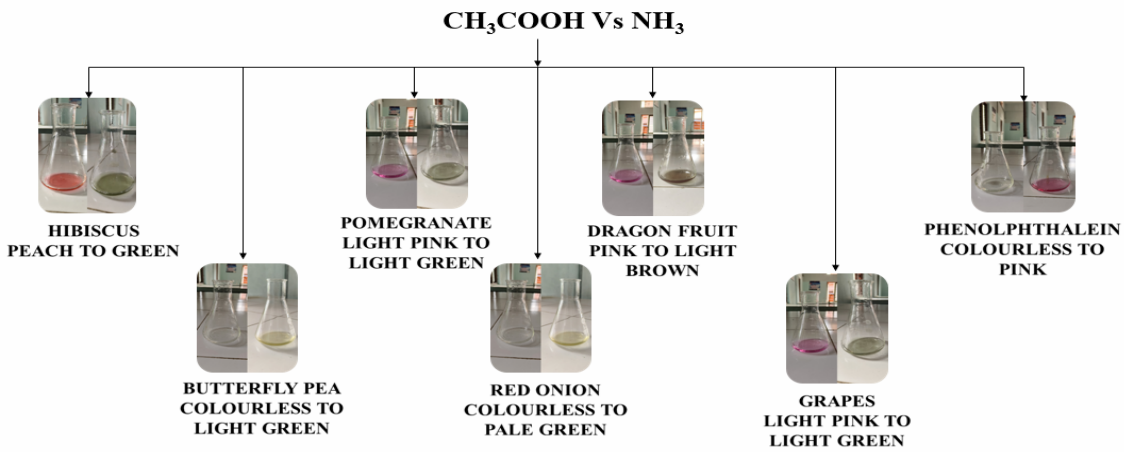

Fig no:11 CH_3COOH Vs NH_3

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TITRATION

SL NO	TITRATION	INDICATOR						
		PHENOLPH-THALEIN	HIBISCUS	BUTTERFLY PEA	POMEGR-ANATE	RED ONION	DRAGON FRUIT	GRAPES
1	HCl Vs NaOH	8.6ml	7.2ml	9.6ml	8.9ml	9.1ml	7.8ml	8.3ml
2	HCl Vs NH_3	9ml	9ml	9.4ml	8.1ml	11.2ml	9.4ml	9ml
3	CH_3COOH Vs NaOH	8.9ml	10.6ml	9.6ml	8.9ml	9ml	10.5ml	10.2ml
4	CH_3COOH Vs NH_3	9.9ml	11.4ml	9.5ml	9.6ml	12.1ml	12ml	12.8ml

Table no:2 Titration values of indicators

➢

➢ **HCl Vs NaOH**

In HCl Vs NaOH titration, natural pH indicator pomegranate have nearest value to that of phenolphthalein.

➢ **HCl Vs NH_3**

In HCl Vs NH_3 titration, natural pH indicators hibiscus and butterfly pea flower have nearest value to that of phenolphthalein.

➢ **CH_3COOH Vs NaOH**

In CH_3COOH Vs NaOH titration, natural pH indicators pomegranatehave nearest value to that of phenolphthalein.

➢ **CH_3COOH Vs NH_3**

In CH_3COOH Vs NH_3 titration, natural pH indicators pomegranate and butterfly pea flower have nearest value to that of phenolphthalein.

V. CONCLUSION

- In case of strong acid Vs strong base titration [HCl Vs NaOH] the natural pH indicator pomegranate can be used instead of phenolphthalein.
- In case of strong acid Vs weak base titration [HCl Vs NH_3] the natural pH indicators hibiscus and butterfly pea flower can be used instead of phenolphthalein.
- In case of weak acid Vs strong base titration [CH_3COOH Vs NaOH] the natural pH indicator pomegranatecan be used instead of phenolphthalein.
- In case of weak acid Vs weak base titration [CH_3COOH Vs NH_3] the natural pH indicators pomegranate and butterfly pea flower can be used instead of phenolphthalein.

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