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Gitanjali Pandit
B. Pharm Scholar, Smt. R. D. Gardi B. Pharmacy College, Gujarat Technological University, Rajkot, Gujarat, India

Krishna Satasiya
B. Pharm Scholar, Smt. R. D. Gardi B. Pharmacy College, Gujarat Technological University, Rajkot, Gujarat, India

Pooja Khanpara
Associate Professor, Department of Pharmacognosy, Smt. R. D. Gardi B. Pharmacy College, Gujarat Technological University, Rajkot, Gujarat, India

Dr. Shital Faldu
Principal, Smt. R. D. Gardi B. Pharmacy College, Gujarat Technological University, Rajkot, Gujarat, India

Corresponding Author:
Pooja Khanpara
Associate Professor, Department of Pharmacognosy, Smt. R. D. Gardi B. Pharmacy College, Gujarat Technological University, Rajkot, Gujarat, India

Herbs as a natural pH indicators

Gitanjali Pandit, Krishna Satasiya, Pooja Khanpara and Dr. Shital Faldu

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Abstract
A pH indicator is a halochromic chemical compound added in small amount of solution like acidic or basic to determine the physical property of the solution. Generally, in acid-base titration synthetic indicators are used to identify colour change at different pH intervals. Many herbs exhibit natural colour pigment which help to identify pH naturally. Hereby, we discuss few herbs like Rose, Beetroot and Red Cabbage, to replace synthetic pH indicators. Synthetic indicator causes chemical and environmental pollution, they are toxic, costly, and rarely available. Water extract of Rose, Beetroot and Red Cabbage shows sharp and intense colour change in comparison to standard synthetic indicators like Methyl Orange, Phenolphthalein, Methyl Red etc. Herbal indicators are non-toxic, pollution free, cost effective, and easily available at home also.

Keywords: Herbs, pH indicator, anthocyanin, plant extract

1. Introduction
1.1 Anthocyanin
It is a coloured water-soluble pigment belonging to the phenolic group. The pigments are in glycosylated forms. Anthocyanins responsible for the colours, red, and blue, are in fruits and vegetables. Red to purplish blue-coloured leafy vegetables, grains, roots, and tubers are the edible vegetables that contain a high level of anthocyanins. Among the anthocyanin pigments, cyanidin-3-glucoside is the major anthocyanin found in most of the plants [1].

1.2 What is indicator?
It is a chemical compound that changes its colour in presences of an acidic and basic medium. Natural indicator is a type of indicator found naturally and can determine whether the substances in an acidic or basic. The colour and stability of these pigments are influenced by pH, light, temperature, and structure. In acidic condition, anthocyanin appear as red but turn blue when the pH increases (1). Examples of Anthocyanin Containing species: Flowers: Rose, Hibiscus, Kachnar, Butterfly Pea. Fruits: Apple, Strawberries, Pomegranates, Raspberries. Vegetables: Red Cabbage, Beetroot, Red Onion, Purple Cone [5, 8].

2. Introduction of plant
2.1 *Rosa indica*
The *Rosa indica* is a yearly flowering plant that belongs to the family Rosacea and is well known for various pharmacological activities. It is easily available in India as well as throughout the world in enough quantity. The presences of colour pigment and chemical constituents like anthocyanin, flavonoids are accountable for thought about it use as an herbal indicator [2].

2.2 *Beta vulgaris*
The *Beta vulgaris* of family Chenopodiaceae, contains bioavailable compounds and micronutrients such as phenolic compounds, carotenoids, betalains, vitamins and minerals [3]. Beetroot is a potential source of valuable water-soluble nitrogenous pigments, called betalains, which are composed of two main groups, the red betacyanins and the yellow betaxanthins. The colour of Betanin depends on pH. It is bright bluish-red, becoming blue-violet as the pH increases. Once the pH reaches alkaline levels Betanin degrades by hydrolysis, resulting in yellow-brown colour [4].

2.3 *Brassica Oleracea*
The *Brassica Oleracea* is a vegetable that belongs to the family Crucifers and is well known for various pharmacological activities. It is easily available in India as well as throughout the

world in enough quantity. The presences of colour pigment and chemical constituents like anthocyanin, flavonoids are accountable for thought about it use as an herbal indicator [11].

3. Material and Method [9, 37]

3.1 Materials required for *Rosa indica*
Rose Petals, Beaker, Bottle Container, Water, Burner, Funnel, Matchbox, Stirrer.

3.2 Material Required for *Beta vulgaris*
Beetroot, Water, Beaker, Bottle Container, Funnel, Burner.

3.3 Material Required for *Brassica Oleracea*
Red Cabbage, Water, Beaker, Bottle Container, Funnel, Burner.

3.4 Method for *Rosa indica*
Take required quantity of water in a beaker. Add Rose Petal into that beaker. Now, put the beaker for heating until active phytoconstituents (Anthocyanin) comes out from the herbs and mixed fully with water. After that cool the solution and filter out it. Now, collect the filtrate into another beaker so pH indicator is ready to use.

3.5 Method for *Beta vulgaris*
Take required quantity of water in a beaker. Add Beetroot into that beaker. Now, put the beaker for heating until active phytoconstituents (Anthocyanin) comes out from the herbs and mixed fully with water. After that cool the solution and filter out it. Now, collect the filtrate into another beaker so pH indicator is ready to use.

3.6 Method for *Brassica Oleracea*
Take required quantity of water in a beaker. Add Chopped Red Cabbage into that beaker. Now, put the beaker for heating until active phytoconstituents (Anthocyanin) comes out from the herbs and mixed fully with water. After that cool the solution and filter out it. Now, collect the filtrate into another beaker so pH indicator is ready to use.

4. Result and Discussion

4.1 Result and Discussion for *Rosa indica*

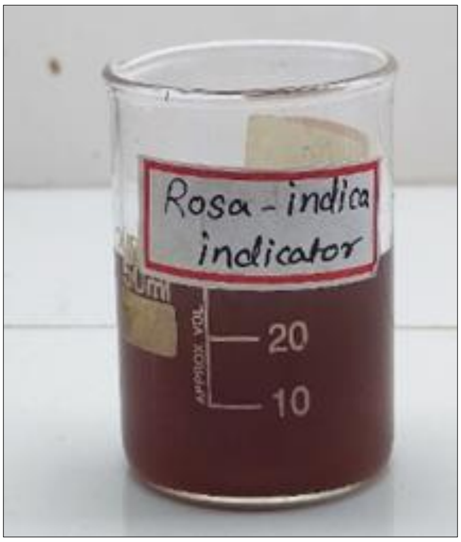

Fig 1: *Rosa indica* Indicator

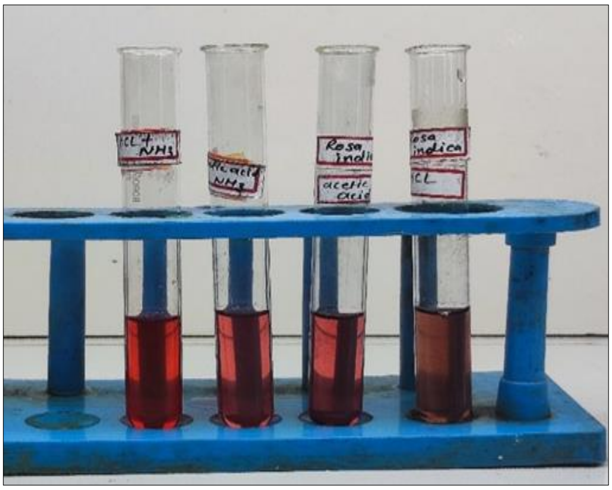

Fig 2: *Rosa indica* colour change with titrant and titrate

Equivalence point obtain for all type of titration by water extract of *Rosa indica* either exactly coincided or was very close to the equivalent point obtained by standard synthetic indicator phenolphthalein. This exemplifies that the watery flower extract is advantageous as an indicator of acid-base titrations. As it gives sharp colour change at the equivalence point, its use in strong acid-strong base titration was found to be more significant over the standard synthetic indicator. If it was observed that indicators act reversibly and give a sharp colour change in both directions. The obtained results indicated that substituted of the routinely used indicators can be done successfully by flower extract as they are simple, less hazardous to humans, cost-effective, readily available, eco-friendly, accurate, and precise and can be prepared just before the experiment**.**

Table 1: *Rosa indica* colour change with titrant and titrate

Titrant	Indicator	Colour	Titrate	Colour
HCL	*Rosa indica*	Pink	NaOH	Red
CH_3COOH	*Rosa indica*	Pink	NaOH	Dark Pink
HCL	*Rosa indica*	Pink	NH_3	Red
CH_3COOH	*Rosa indica*	Pink	NH_3	Dark Pink

4.2 Result and Discussion for *Beta vulgaris*

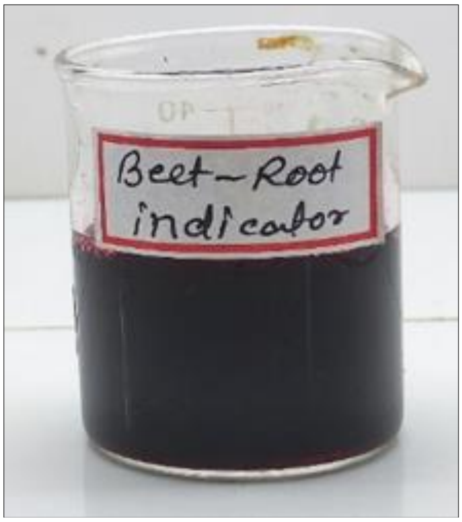

Fig 3: *Beta vulgaris* Indicator

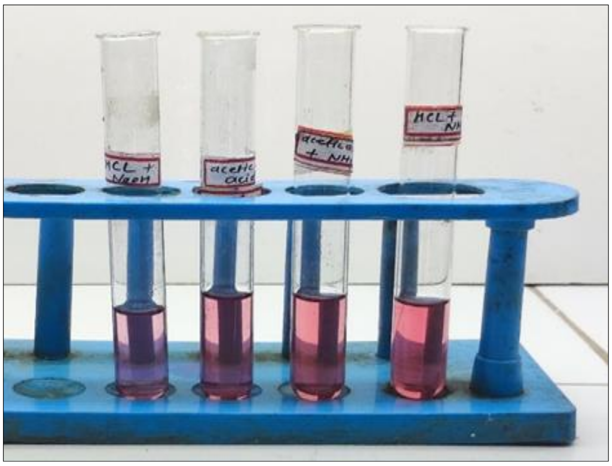

Fig 4: *Beta vulgaris* colour change with titrant and titrate

Equivalence point obtain for all type of titration by water extract of *Beta vulgaris* either exactly coincided or was very close to the equivalent point obtained by standard synthetic indicator phenolphthalein. This exemplifies that the watery extract is advantageous as an indicator of acid-base titrations. As it gives sharp colour change at the equivalence point, its use in strong acid-strong base titration was found to be more significant over the standard synthetic indicator. If it was observed that indicators act reversibly and give a sharp colour change in both directions. The obtained results indicated that substituted of the routinely used indicators can be done successfully by, extract as they are simple, less hazardous to humans, cost-effective, readily available, eco-friendly, accurate, and precise and can be prepared just before the experiment**.**

Table 2: *Beta vulgaris* colour change with titrant and titrate

Titrant	Indicator	Colour	Titrate	Colour
HCL	*Beta vulgaris*	Red	NaOH	Pink
CH_3COOH	*Beta vulgaris*	Red	NaOH	Pink
HCL	*Beta vulgaris*	Red	NH_4OH	Pink
CH_3COOH	*Beta vulgaris*	Red	NH_3	Pink

4.3 Result and Discussion of *Brassica Oleracea*

Equivalence point obtain for all type of titration by water extract of *Brassica Oleracea* either exactly coincided or was very close to the equivalent point obtained by standard synthetic indicator phenolphthalein. This exemplifies that the watery extract is advantageous as an indicator of acid-base titrations. As it gives sharp colour change at the equivalence point, its use in strong acid-strong base titration was found to be more significant over the standard synthetic indicator. If it was observed that indicators act reversibly and give a sharp colour change in both directions. The obtained results indicated that substituted of the routinely used indicators can be done successfully by, extract as they are simple, less hazardous to humans, cost-effective, readily available, eco-friendly, accurate, and precise and can be prepared just before the experiment**.**

Table 3: The obtained results indicated that substituted of the routinely used indicators

Titrant	Indicator	Colour	Titrate	Colour
HCL	*Brassica Oleracea*	Yellow	NaOH	Colourless
CH_3COOH	*Brassica Oleracea*	Pink	NaOH	Colourless
HCL	*Brassica Oleracea*	Pink	NH_4OH	Colourless
CH_3COOH	*Brassica Oleracea*	Pink	NH_4OH	Red

5. Advantages of Herbal indicator

- These are pollution free
- These are non-toxic
- Easily available
- Cost effective
- Easy to prepare

5.1 Disadvantages of synthetic indicator

1. **Methyl Orange:** Harmful if swallowed. Causes eye, skin, and respiratory tract irritation.
2. **Phenolphthalein:** Harmful if swallowed. May causes irritation of the digestive tract. Ingestion may cause Fever, Blood Pressure increases and other unspecified vascular effect.
3. **Methyl Red:** Also can produce cancer, Neurological disorder and cause toxic effect. Causes environmental and chemical pollution, toxic, expensive and rarely available.

6. Conclusion

The current study's results indicate the highly prospective analytical potential of the herb extracts when used in acid-base titrimetry. In comparison to weak acid-strong base titration, it was discovered that the extracts perform better in strong acid-strong base titration with a distinct and obvious color change. With acids and bases, all three extracts clearly changed color, and the color change persisted with various acids and bases. The pigment was appropriate for use as acid-base indicators due to the stark contrast between their colors in acid and base.

Natural herbal indicators are a good replacement for synthetic indicators used in many labs and research institutes due to their availability, ease of extraction, high performance, and accurate results.

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