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Peels of Fruits and Vegetables as Eco-Friendly Natural Indicator in Acid-Base Titrations

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ABSTRACT

The commonly used indicators for acid–base titrations are synthetic, namely phenolphthalein / methyl orange.But there are some limitations like environmental pollution, availability and higher cost which lead to utilization for natural compounds as acid base indicators. Hence this work was aimed to identify the eco-friendly natural indicators using some waste of vegetables and fruits. The potential of the peels is very promising as seen in acid-base titrimetry at room temperature. Peels from some fruits and vegetables were extracted, separated, and purified. These indicators which were used in acid-base titrations show sharp color changes at the equivalence point. The result proved to be acceptable in introducing natural pigments as suitable acid-base indicators. These natural indicators are found to be a very helpful, inexpensive, simple, accurate and nature-friendly.

KEYWORDS: Acid–base titration, Synthetic indicators, Natural indicator, Phenolphthalein, Methyl orange

INTRODUCTION: Titration which is additionally acknowledged as titrimetry is a chemical qualitative evaluation approach that is used to calculate the concentration of a given analyte in a mixture. Titration is an essential method in the area of analytical chemistry and is often referred to as volumetric evaluation also.Acid base titrations mainly depend on the neutralization between an acid and a base when mixed in solution.Acids can be classified into strong or weak acids depending on the amount of dissociation to give H^+ ions when dissolved in water.The chemical substances possess an apparent change in colour of the analyte and titrant reacting mixture very close to the point in the ongoing titration known as indicator, which helps to examine and determine the equivalence point in acid-base titrations. Each indicator exhibits a diffferent range of colours at different pH values.

Acid base indicators are compounds that change color when they become protonated or deprotonated. Because this color change occurs over a specific pH range, indicators can be used to approximate the equivalence point of an acid base titration.In other words acid base indicator is a dye or another chemical that aids in the distinction between the two. They come in two varieties: synthetic indicators and natural indicators. The natural indicators come through environmental resources like plants,

but the synthetic indicators are created in a lab.Examples of synthetic indicators include phenolphthalein, methyl orange, ext.,

Many fruits and vegetables contain pigments that change color in response to pH, making them natural and edible pH indicators.

Materials and Methods

Reagents: Analytical grade(AR) of Hydrochloric acid, Sodium hydroxide, Acetic acid , Ammonium hydroxide, Phenopthalein and Methly orange were used. All the volumetric solutions and reagents were prepared as per Indian Pharmacopoeia, IP 1996.

Peel materials: Fresh fruits and vegetables (beetroot, onion, carrot, banana and orange) were purchased from the local market of Vellore, Tamil Nadu, India and the outer skin of the fruits were removed and used for extraction. The fresh fruit and vegetable peels of beetroot, onion, carrot, banana and orange (10g each)were cleaned with distilled water and cut into small pieces and boiled with 100 mL of distilled water for 20 minutes and the aqueous extract was filtered using whatmann filter paper. After filtration the pH of the extract was measured using pH meter. The extract was stored in a dark container in a refrigerator.

Glass wares : Standard flasks, burettes, pipettes, conical flasks, beakers, glass rods and funnel were used to carry out the experiment.

Titrations: 1 ml of the aqueous extract of beetroot, onion, carrot, banana and orange(taken separately in different conical flasks) was added as an indicator for all the type of titrations such as strong acid (HCl) against strong base (NaOH), strong acid (HCl) against weak base (NH4OH), weak acid (CH3COOH) against strong base(NaOH) and the trials were repeated five times to check the precision. The titrations were again carried out using the standard(synthetic) indicators phenolphthalein and methyl orange. The results obtained were compared with the results of titrations using the natural indicator. Titration results were depicted in the tables 1a to 1c and figures 1a to 1c.

Result and Discussion

The titration results showed that the end point of the titration of strong acid against strong base(HCl Vs NaOH) , weak acid against strong base (CH3COOH Vs NaOH) and weak acid against weak base (CH3COOH Vs NH4OH using the natural indicator either coincide or almost reached close to the end point obtained by the standard indicator phenolphthalein and it give sharp colour change at the end point. The titration of strong acid against weak base (HCl Vs NH4OH) using the natural indicator didn't give a sharp color change whereas the standard indicator give a sharp color change.

Table 1a: Titration of HCl against NaOH using aqueous extract of beetroot, onion, carrot, banana and orange

Indicator	Volume of acid (mL)	Burette reading (mL)		Volume of titrant, mean value(mL)	Colour change	Mean ± std. dev. Of the titre value (mL)
		Initial	Final			
Phenolphthalein	20	0.0	23.2	23.22	Colourless to pink	23.33±0.044
	20	0.0	23.2			
	20	0.0	23.3			
	20	0.0	23.2			
	20	0.0	23.2			
Methly orange	20	0.0	23.7	23.62	Red to yellow	23.62±.045
	20	0.0	23.6			
	20	0.0	23.6			
	20	0.0	23.6			
	20	0.0	23.6			
Beetroot extract	20	0.0	23.6	23.7	Red to brown	23.7±0.071
	20	0.0	23.7			
	20	0.0	23.7			
	20	0.0	23.7			
	20	0.0	23.8			
Onion extract	20	0.0	22.6	22.52	Orange to green	22.52±.045
	20	0.0	22.5			
	20	0.0	22.5			
	20	0.0	22.5			
	20	0.0	22.5			

Carrot extract	20	0.0	23.2	23.12	Colourless to green	23.12±0.045
	20	0.0	23.1			
	20	0.0	23.1			
	20	0.0	23.1			
	20	0.0	23.1			
Banana extract	20	0.0	23.6	23.62	Colourless to green	23.62±0.045
	20	0.0	23.6			
	20	0.0	23.7			
	20	0.0	23.6			
	20	0.0	23.6			
Orange extract	20	0.0	23.2	23.22	Colourless to green	23.22±0.045
	20	0.0	23.2			
	20	0.0	23.2			
	20	0.0	23.2			
	20	0.0	23.3			

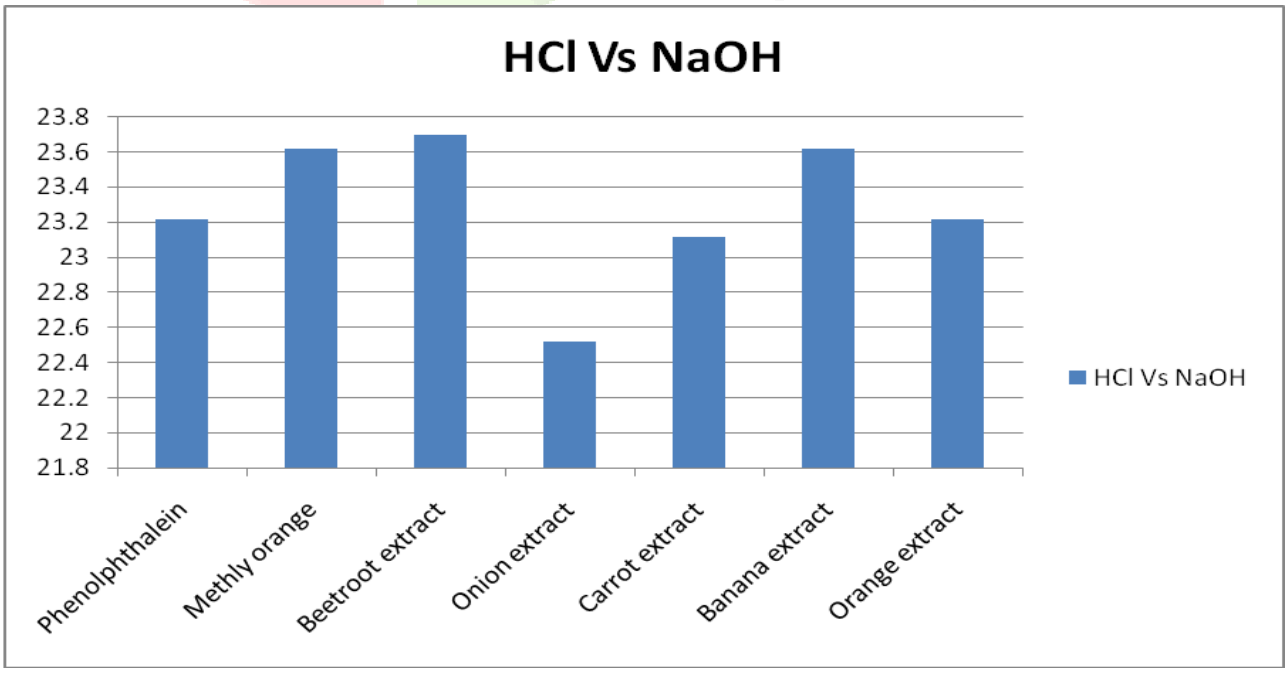

Figure 1a:Strong acid Vs Strong base

Table 1b: Titration of CH_3COOH against NaOH using aqueous extract of beetroot, onion, carrot, banana and orange

Indicator	Volume of acid (mL)	Burette reading (mL)		Volume of titrant, mean value(mL)	Colour change	Mean ± std. dev. Of the titre value (mL)
		Initial	Final			
Phenolphthalein	20	0.0	21.8	21.76	Colourless to pink	21.76±0.055
	20	0.0	21.8			
	20	0.0	21.8			
	20	0.0	21.7			
	20	0.0	21.7			
Methly orange	20	0.0	16.5	16.54	Red to yellow	16.54±0.055
	20	0.0	16.5			
	20	0.0	16.6			
	20	0.0	16.5			
	20	0.0	16.6			
Beetroot extract	20	0.0	23.2	23.18	Red to yellowish green	23.18±0.045
	20	0.0	23.2			
	20	0.0	23.1			
	20	0.0	23.2			
	20	0.0	23.2			
Onion extract	20	0.0	21.5	21.48	Orange red to green	21.48±0.045
	20	0.0	21.5			
	20	0.0	21.5			
	20	0.0	21.4			
	20	0.0	21.5			

Carrot extract	20	0.0	22.8	22.78	Colourless to light green	22.78±0.045
	20	0.0	22.7			
	20	0.0	22.8			
	20	0.0	22.8			
	20	0.0	22.8			
Banana extract	20	0.0	25.5	25.48	Colourless to light green	25.48±0.045
	20	0.0	25.4			
	20	0.0	25.5			
	20	0.0	25.5			
	20	0.0	25.5			
Orange extract	20	0.0	24.9	24.86	Colourless to light green	24.86±0.089
	20	0.0	24.9			
	20	0.0	24.7			
	20	0.0	24.9			
	20	0.0	24.9			

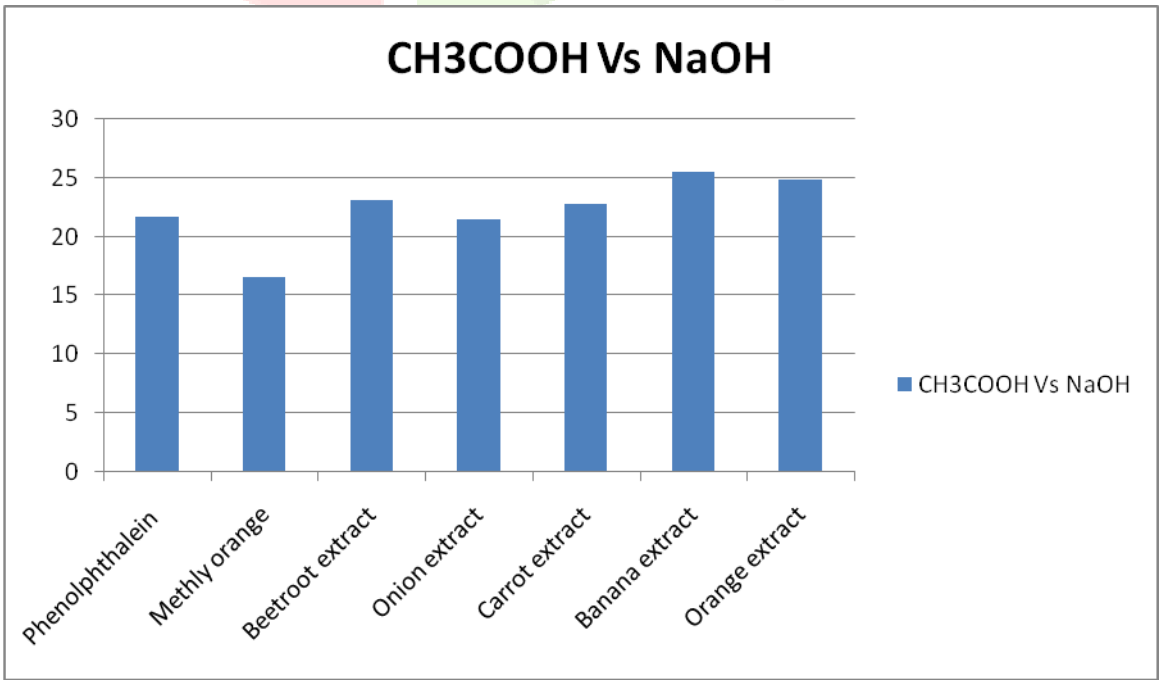

Figure 1b:Weak acid Vs Strong base

Table 1c. Titration of CH_3COOH against NH_4OH using aqueous extract of beetroot, onion, carrot, banana and orange

Indicator	Volume of acid (mL)	Burette reading (mL)		Volume of titrant, mean value(mL)	Colour change	Mean ± std. dev. Of the titre value (mL)
		Initial	Final			
Phenolphthalein	20	0.0	22.1	22.02	Colourless to pink	22.02 ±0.045
	20	0.0	22			
	20	0.0	22			
	20	0.0	22			
	20	0.0	22			
Methly orange	20	0.0	18.2	18.22	Yellow to red	18.22 ±0.045
	20	0.0	18.2			
	20	0.0	18.3			
	20	0.0	18.2			
	20	0.0	18.2			
Beetroot extract	20	0.0	18.5	18.52	Red to orange	18.52±0.045
	20	0.0	18.5			
	20	0.0	18.6			
	20	0.0	18.5			
	20	0.0	18.5			
Onion extract	20	0.0	17.7	17.78	Orange to yellow	17.78±.0045
	20	0.0	17.8			
	20	0.0	17.8			
	20	0.0	17.8			
	20	0.0	17.8			

Carrot extract	20	0.0	22	21.98	Colour less to light green	21.98±0.045
	20	0.0	21.9			
	20	0.0	22			
	20	0.0	22			
	20	0.0	22			
Banana extract	20	0.0	20.1	20.12	Brown to colourless	20.12±0.045
	20	0.0	20.2			
	20	0.0	20.1			
	20	0.0	20.1			
	20	0.0	20.1			
Orange extract	20	0.0	22.1	22.18	Colourless to light green	22.18±0.045
	20	0.0	22.2			
	20	0.0	22.2			
	20	0.0	22.2			
	20	0.0	22.2			

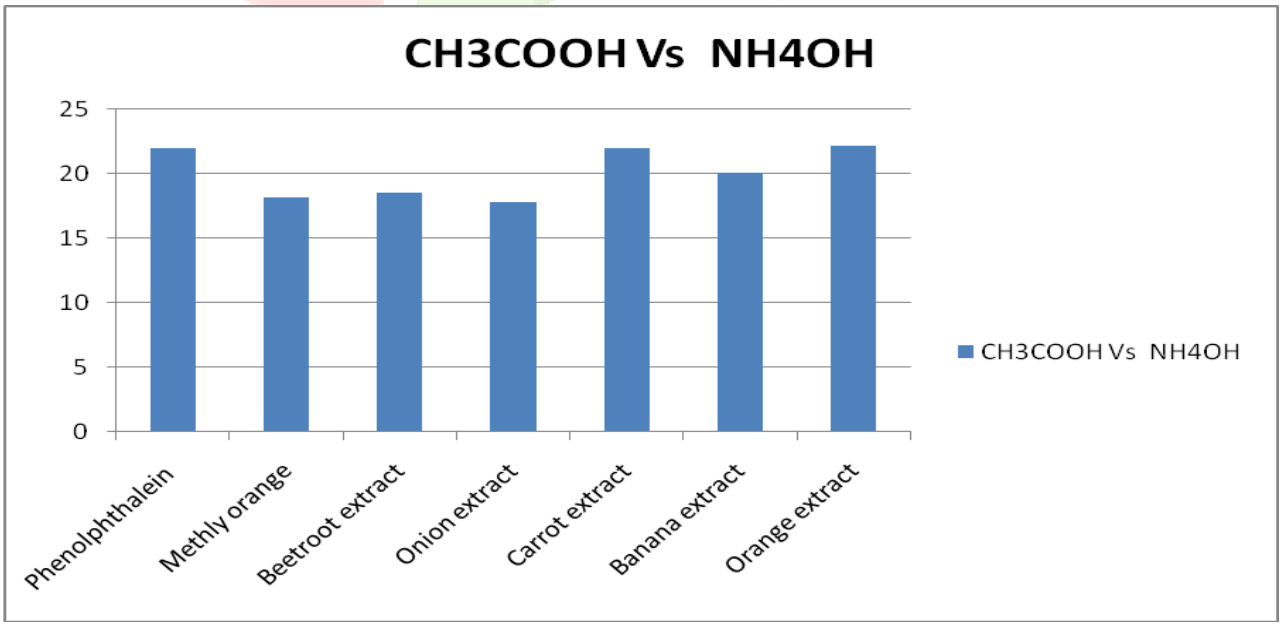

Figure 1c:Weak acid Vs Weak base

Conclusion

The natural indicators extracted from the peels was found to be a potential substitute for methyl orange and phenolphthalein for titrations of strong acid versus weak base and strong acid versus strong base. Hence, the peel extract as a natural indicator is found to be a very useful, readily available, non-hazardous, economical, simple to prepare and accurate for the acid-base titrations.

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