Curcuma Longa: The Dye as a Potential Indicator in Titrimetric Analysis

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Abstract

Curcuma longa is the botanical name of a ginger plant belonging to the family of zingiberaceae. It contains a colourful condiment with a distinctive pungent flavour. The natural product (curcuma longa) has a pH range of 8 to 9. The quantitative evaluation gave a percentage yield of 15.2. On Thin-layer chromatographic analysis, the dye gave R_f(methanol) value as 0.83. The ultra-violet visible (UV) spectra of the dye also showed absorption of 480nm corresponding to the region of dyes. Infra-red (IR) spectra of the dye from methanol extract showed intense peaks at 3423.8, 2961.7, 1739.5 and 1380.9 corresponding to O-H stretching of alcohol, C-H stretching of methyl and methylene groups, C=O of amides stretching and C-H bending vibrations of methyl and methylene groups respectively. An extraction was conducted where a colourful yellow dye was produced from powdery curcuma longa with methanol as solvent. The indicator property of the extracted dye was investigated using methyl orange as a reference indicator. It was observed that the titrimetric end-points obtained for the dye present in curcuma longa compared reasonably with those of methyl orange. I strongly recommend that the dye from curcuma longa can be used as alternative to methyl orange during titrimetric analysis.

Introduction

Indicators are substances which change colour according to the hydrogen ion (H) concentration of the liquid or solution to which they are added (Brown, 1972). Such indicators can be used to measure and to detect changes in Hydrogen ion concentration or pH. The measurement of hydrogen ion concentrations in solutions is important in obtaining values for the dissociation constants of acids. Many industrial and biological processes depend too, on hydrogen ion concentration and are controlled by its measurement (Odilora, 2001) Indicators are either weak acid or bases and are therefore slightly dissociated in water@ One of the most commonly used indicators in acid-base titrations is methyl orange(Holderness, 1982 and Jenkins, 1966). This compound with molecular formula, $C_{14}H_{14}N_3SO_3Na$ and molecular structure on figure 1, is amphoteric monoazo dye that is made by coupling dimethylanaline to diazotized sulphanilic acid and converting the coupled product to sodium salt (Budavari, 1989 and Green, 1990). Slightly soluble in water, it displays useful indicator properties and is sensitive to mineral acids but unaffected by carbonates. As every indicator has its definite range of hydrogen ion concentration or pH over which it changes colour. Methyl orange has a pH range of 2.9-4.6 and is orange in water, pink in acid, and yellow in bases (Heys, 1970 and Wellings, 1961).

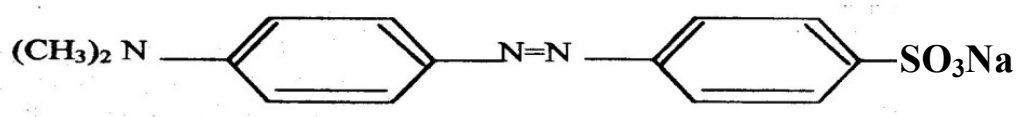

Figure 1: Methyl Orange

Curcuma longa is the botanical name of a ginger plant belonging to the family of zingiberaceae(Merck, 1989 and Kochlar, 1986). It contains a colourful condiment with a distinctive pungent flavour. The natural product (curcuma longa) has a chief colourant as curcumin (turmeric yellow) soluble in alcohols and insoluble in water and ether and the pH range is 8.0-9.0. The plant is propagated in Nigeria by using the bulbs and fingers in April or May on ridges and usually harvested nine to ten months after planting (Bradbury, 1988). The plant is largely used as a spice in cooking, colouring varieties of materials such as foods, drugs and textiles (Odilora, 2001). Medicinally, curcuma longa is used to aid digestion and as blood purifier when the water solution is drank. In addition, the yellow turmeric paper can be used for testing alkalinity. Curcuma longa is pink in base and yellow in acid (Gill, 1992). The structure of the curcumin is shown in figure 2 below. This paper presents the report of extraction and investigation into the indicator property of the dye present in curcuma longa.

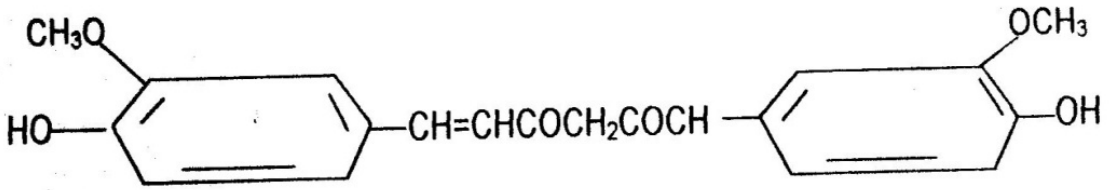

Figure 2: Curcumin

Materials and Methods

A fresh sample of curcuma longa was obtained from Ekpoma market in Edo-state, Nigeria. The stock sample was prepared for extraction by peeling the outer layers with a sharp knife, sliced to smaller portions, thoroughly dried in the sun at a moderate temperature for about 10 days and pulverized into powder with electric blender. 20g of powdered sample was dissolved in 120cm^3 of methanol in a 250cm^3 conical flask and corked. The mixture was allowed to stand in flask for two weeks with occasional swirling of the flask and was filtered with a Whatman filtered paper No. 1(11cm size) to produce a methanol extract (filtrate) of the curcuma longa. The filtrate obtained was preserved for titrimetric analytical experiment.

The Thin-layer Chromatographic (TLC) analysis was conducted by carefully spotting methanol extract on one end of a rectangular TLC plate (3.5cm by 10cm). The spotted end of the TLC plate was immersed in a TLC tank containing ethanol as the mobile solvent such that the plate rested on the side of tank. The solvent then moved the sample until there was clear separation between the solvent front and the sample front and was removed from the tank and allowed to dry in air. The R_f value was calculated by a formula:

$$R_f = \frac{\text{Distance moved by the sample}}{\text{Distance moved by the solvent}}$$

The Visible Spectra of methanol extract of curcuma longa was ran in a rectangular UV/visible gel tank in a Jenway UV/vis spectrophotometer (Model 6405) manufactured by Janway, England. The

concentrated dye extract was diluted with absolute ethanol before adding into the tank and the spectra then scanned using ethanol as reference. The absorption showed was 480nm.
For Infra-red (IR) spectra, two equal sizes of flat IR transparent circular cells of 2cm in diameter were thoroughly cleaned with solvent, toluene. A drop of methanol dye extract of curcuma longa was added to one of the cells with a glass rode and carefully covered with other cell. The covered cell was inserted into the IR Buck scientific spectrophotometer, Model No. M500 and serial No.731, USA. Subsequently, the computerized monitoring unit of the instrument scanned the sample, the spectra printed out and interpreted as: 3423.8, 2961.7, 1739.5 and 1380.9.

Meanwhile, 0.1 M NaOH solution was prepared by dissolving 4.0g in 1000cm^3 of water in a 1000cm3 of volumetric flask. Then the acid, HCl (s.g. 36.5) solutions of various concentrations were prepared by dissolving 4.24cm3 in 1000cm^3 of distilled water in a 1dm3 volumetric flask to give 0.05M solution. Similarly, 6.78, 8.50, 16.95, 25.42, 42.37, 67.80 and 84.75cm^3 of the acid, were dissolved in 1000cm^3 of solution to give 0.08, 0.1, 0.2, 0.3, 0.5, 0.8 and 1.0 Molar solutions of hydrochloric acid (HCl) respectively.

Twenty five (25.0) centimeter cube(cm3) of 0.1M solution of sodium hydroxide was pipette into a 250cm^3 conical flask and two drops of the methanol-dye extract were added to the content in the flask. Hydrochloric acid solution (0.05M) was used to neutralize the solution of the base in the flask. The volume of the acid corresponding to the end point was noted by the colour of the base changing from yellow to pink. Similarly, 0.08, 0.1, 0.2, 0.3, 0.5, 0.8 and 1.0MHCl solutions were titrated against 0.1M solution of sodium hydroxide using two drops of methanol-dye extract as indicator respectively. The corresponding volumes of the acid that neutralized the base were recorded in Table 1. In order to compare these results with a standard, the whole titration experiments were repeated using methyl orange as indicator instead of the dye extract and the volumes were recorded in Table 2.

Table 1: Titration data of HCL versus NAOH using *curcuma longa* dye as indicator

Molar Conc. Of Acid (M)	Equivalent Volume of Acid (cm^3)
0.05	45.95
0.08	32.35
0.1	25.45
0.2	12.25
0.3	8.35
0.5	5.00
0.8	3.10
1.0	2.40

Table 2: Titration data of HCL versus NAOH using methyl orange as indicator.

Molar Conc. Of Acid (M)	Equivalent Volume of Acid (cm^3)
0.05	45.85
0.08	32.55
0.1	24.95
0.2	12.25
0.3	8.65
0.5	5.00
0.8	3.15
1.0	2.40

Results and Discussion

Tables 1and 2 above show the results obtained from titrations using the curcuma longa-dye extract and methyl orange as indicators respectively. From the tables, it can be seen that volumetric analysis involving the use of the dye from curcuma longa as indicator give comparably similar end point values with that which methyl orange acts as indicator. This also shown that in any analytical work involving titrimtric analysis, curcuma longa dye can be reliably employed as indicator in place of methyl orange- as both gave the same results

Conclusion

An investigation was carried out on the possibly of using curcuma longa dye as an indicator volumetric analysis. To this end, several molar concentrations of HCl were titrated against a 0.1M standard solution of NaOH using two drops of the dye as indicator respectively. The result obtained in this titration experiment was compared with that in which methyl orange was employed as indicator. It was found that the titration result obtained on using the dye from curcuma longa as indicator was approximately the same as that on using methyl orange as indicator. This result shows that the methanol-dye extract from curcuma longa can be reliably used as a substitute for methyl orange in any analytical work involving volumetric titrations. This recommendation can also be upheld based on the results from UV/visible, Infra-red and percentage yield therefore, it is economically cheap to produce.

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