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Use of Butterfly Pea (Clitoria ternatea) Extract as an Indicator in Acid Base Titration

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Abstract. Butterfly pea flowers are native plants from Southeast Asia that have two colors, purple and blue. This striking color is known to contain anthocyanin and chlorophyll. Anthocyanin compounds give different color responses to different pH conditions, so with these properties butterfly pea flower extract can potentially be a bioindicator of acid-base titration. The anthocyanin content of butterfly pea flower extract depends on the solvent used in the extraction process. In this experiment, dried butterfly pea flowers were extracted with 70% ethanol and 25% acetic acid with a ratio of 7: 1. The experimental results showed that the type of anthocyanin contained in dried butterfly pea flower extract in ethanol and acetic acid solvents was cyanidin. The pH range of the dried butterfly pea flower indicator for acidimetry at pH 3-5 by showing purple color, while for alkalimetry at pH 8-9 with yellowish green color. A pH below 3 indicates red while pH above 9 will show yellow and PH 6-7 shows a turquoise color. Indicator solutions still provide good results after a four-week storage period. This shows that the application of butterfly pea flower extract bioindicator is quite good in alkalimetry titration.

Keywords: Acid base titration, Butterfly pea flowers, , Extracts Indicators

1 Introduction

An acid-base titration is an analysis for the determination of acid/base based on the volume of an acid/base solution that is concentrated according to what is determined, which is needed to obtain a complete agreement with a substance that will require its concentration. In the implementation of this titration, an acid-base indicator is needed as a sign that the][reaction has been running perfectly (reaching the equivalent point). This indicator is a composition that can change color when an equivalence point is obtained (acid/base excess occurs). The synthetic indicators commonly used are phenolphthalein and methyl orange.

The use of synthesis indicators has limitations such as limited availability in schools, can cause environmental pollution, and require high costs in producing it [1]. Therefore, another alternative is needed to replace the synthesis indicator, so that acid-base learning can be done. One of them is by using bioindicators derived from plant pigments, for example from dragon fruit skin [2] and the heart of banana [3]. Almost all plants and fruits have the potential as bioindicators, but the color changes are not clear. The causes of discoloration in bio-indicators

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of acid-base are anthocyanin, pigments from the flavonoid group which is generally soluble in water, can be in several colors such as red, blue, violet and usually found in flowers, fruits, and vegetables [4].

Almost all plants that produce color can be used as an indicator because they can change color in an atmosphere of acid and base even though sometimes the color changes are less clear or almost similar for certain changes in pH. Natural indicators can be made from colored plants such as Jacaranda acutifolia[5], four o'clock flowers (Miriabilis Jalapa), roses, and kana flowers (Cana indica) [6]. Besides, natural indicators can also be made from purple cabbage leaves [7], secang logs, rosella flowers (hibiscus sabdariffa), and red spinach (Bisella alba) [8].

Lusia has succeeded in developing natural indicators of secang wood extract, leaf croton, turmeric rhizome, water girlfriend, discolor rhoeo, ginger rhizome, cemondelan flower, soka flower, bougenvile flower, and frangipani flower [9]. Some of these natural indicators can be made quickly, easily and simply but in the form of indicator solutions, they are not durable, easily damaged, and smell bad [9]. Extracts of dyes used to make acid-base indicators must have different color characteristics at each change in pH. The characters of acid-base indicators include: 1) pH route, 2) Absorption spectrum and maximum wavelength of indicators, 3) Value of pK indicators, 4) Level of accuracy and accuracy of indicators, and 5) Level of the durability of indicators [10].

One of the plants containing anthocyanins is butterfly pea flowers (Clitoria ternatea) [11-14]. So that butterfly pea flower (Clitoria ternatea) can be used as an alternative bioindicator of acid-base titration. Utilization of butterfly pea flowers (Clitoria ternatea) as the basic material for making bioindicators of acid-base titration, because the butterfly pea flower (Clitoria ternatea) is very easily found in the environment, this plant is usually used as an ornamental plant for the garden.

Based on the background above, a potential study of butterfly pea flower extract (Clitoria ternatea) in a mixture of 70% ethanol and 25% acetic acid with a ratio of 7: 1 as a bioindicator of acid-base titration was carried out. This study expected can provide an alternative use of acid-base titration indicators in practical activities. Natural indicators can be used as alternative indicator materials that are easily obtained by comparison of costs that are more economical than synthetic indicators, but still, have the same benefits and objectives as a practicum of acid-base titration in general

2 Materials and Methods

2.1 Tools and Material

The sample used is dried butterfly pea flower. The materials used as extraction solvents were 70% commercial ethanol and 25% commercial acetic acid. The chemicals used in titration are NaOH (99%, Merck), HCl (36%, Merck), $H_2C_2O_4.2H_2O$ (Merck), $Na_2CO_3.10H_2O$ (Merck). Other ingredients used are commercial aquadest, phenolphthalein (Merck) indicators, methyl orange indicators (Merck) and pH 1-12 solutions.

The tools used included blender, analytic balance (Ohaus PA213), pH-meter (ATC pH-2011), filter paper (Whatman 40), beaker (250 mL, 500 mL and 1000 mL), measuring cup (10 and 50 mL), volumetric flask (25 and 50 mL), Erlenmeyer (100 mL), burette (50 mL), statif and clamp, volume pipette (10 mL), drop pipette, spatula, stirring rod and vial bottle.

Instrumentation used included, UV-Vis spectrophotometer (Agilent Cary 60) for testing the maximum wavelength of each sample extract with wavelengths between 400 - 700 nm, identifying compounds and components contained in the sample with FTIR spectrophotometer (Agilent 680).

2.2 Preparation of Butterfly pea Flower Extract

One gram of dried butterfly pea dried flower was macerated for 24 hours with a solvent mixture of 70% ethanol and 25% acetic acid (7: 1) as much as 40 mL, then extracted.

2.3 Testing pH Route of Butterfly pea Flower Extract at various pHs

5 mL of buffer solution pH 1-12 was put into a test tube and 10 drops of butterfly pea flower extract were added to each sample and observed changes in color occurred.

2.4 Acid Base Titration using bioindicator Butterfly pea Flower Extract

Acid base titration was carried out (0.1 N HCl and 0.1 N NaOH) using butterfly pea extract indicator and then a color change are seen. Titration repeated 3 times.

2.5 Test Time to Save Bioindicator Butterfly pea Flower Extract

Butterfly pea flower extract was inserted into a dark bottle and then the sample endurance test was carried out using Uv-Vis spectro by looking at changes in peak and absorbance and acid-base titration for 4 weeks with 5 repetitions.

3 Results and Discussion

3.1 Determine pH route of Butterfly pea Flower

To determine the pH indicator path, it is done by looking at the indicator color changes at various pHs. The results of the color changes in the buffer solution can be seen in Figure 1 in general, the colors displayed on each PH series are pink, purple, blue, green and yellow which have different color gradations.

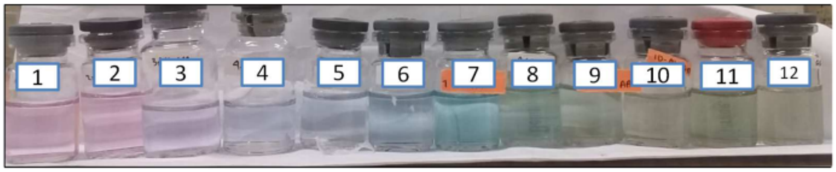

Figure 1. A series of pH 1-12 which has been added to the indicator sample

Butterfly pea flower extract in 70% ethanol and 25% (7: 1) acetic acid at pH 1-12 produces several color variations. The resulting color variations are pink at pH 1-2, purple at pH 3-5, bluish-purple at pH 6, blue at pH 7, bluish-green at pH 8-9, and brownish-green at pH 10-12. This butterfly pea flower extract can be used for acidimetric titration with a pH of 3-5 and can be used for alkalimetric titration with a pH range of 8-9. Testing the absorbance of butterfly pea flower extract at various pH can be seen in Table 1 below

Table 1. pH Route of Butterfly pea Flower Extract

pH	Λmax(nm)	Abs	Color
1	546.0095	0.087585	Pink
2	546.9858	0.067366	Pink
3	569.0053	0.061415	Purple
4	574.0069	0.067748	Purple
5	574.0069	0.05978	Purple
6	619.989	0.093285	Bluish purple
7	619.989	0.170499	Blue
8	625.9916	0.127406	Bluish Green
9	617.9982	0.089866	Bluish Green
10	600.996	0.089952	Brownish Green
11	596.993	0.094044	Brownish Green
12	604.9948	0.021219	Brownish Green

Anthocyanins are red at acidic pH by producing a flavium cation effect of the resonance of anthocyanins in acidic solutions [11,17]. In the subsequent reaction, the flavium cation changes into a quinoidal base which is esterified by acetic acid[15]. Then it becomes quinoidal anionic which produces a blue color in the solution caused by an electron attack from a base solution in a hydrogen group. Then, if base (OH-) attacks the hydrogen atom from the hydroxyl group, quinoid will form. The quinoid formation will expand delocalisation into green in basic conditions. The form of the quinoid compound undergoes delocalisation until equilibrium occurs. In a more basic solution, it will produce a yellow color.

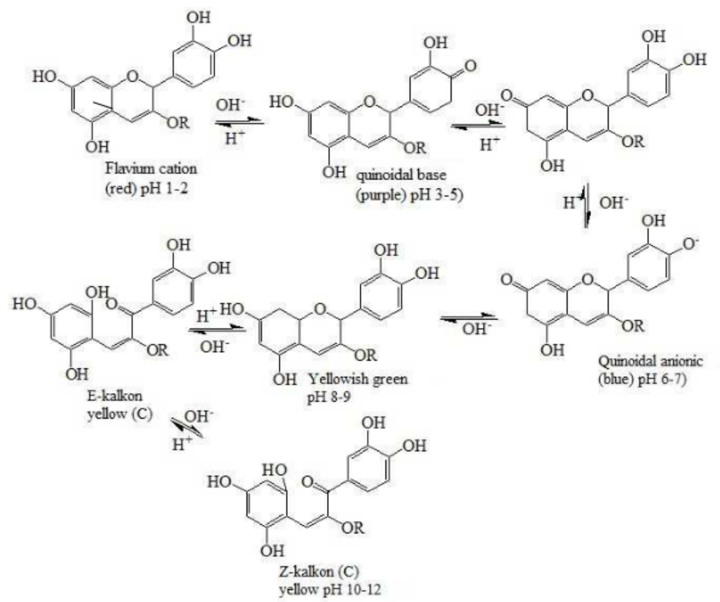

Figure 2. Changes in Anthocyanin Cyanidin Structure of in Various pHs[16]

3.2 Bioindicator Testing of Butterfly pea Flower Extract in Acid-Base Titration

Based on the results of pH route testing, butterfly pea flower extract can be used as an indicator for acidimetry and alkalimetry titration. The types of titration carried out include strong acid-base titration (NaOH & HCl) and weak acid-strong base (NaOH & CH_3COOH) titration for alkalimetry titration, and strong strong base-acid titrations (HCl & NaOH) and weak base-strong acids (HCl-NH_4OH) for acidimetric titration. The titration results are shown in Table 2.

Table 2. Results of Acidimetry and Alkalimetry Titration with Bunga Butterfly pea Indicators compared to Commercial Indicators

Type of Titration	Alkalimetry, V NaOH (mL)		Acidimetry, VHCl (mL)	
	SB-SA	SB-WA	SA-SB	SA-WB
PP/MJ Indicator	10	9.46	10.44	10.2
Butterfly pea Flower Indicator	10.08	9.66	10.44	10.1
Accuration (%)	100.8	102	100	99
Presision (%RSD)	0.07937	0.14493	0.03831	0

Alkalimetry and acidimetry titrations using butterfly pea bioindicator compared to commercial indicators provide good accuracy results, this can be seen from the proximity of the titrant volume needed to titrate the sample using commercial indicators and butterfly pea flower indicators. In addition to the results of accuracy, precision values are important for determining the validity of a method. From the repetition of several titrations performed, the value of precision is good, meaning that the data deviation between one titration and the other titration is very small.

3.3 Save Time Test

Save time test was carried out by examining absorbance changes using UV-Vis spectrophotometry and titration for 4 weeks. From the first week to fourth week there was a decrease in absorbance of the sample, but in general there was no change in wavelength. Butterfly pea flower extract gives a maximum wavelength of around 515-545 nm, which indicates the presence of anthocyanins[18,19]. Anthocyanin is a semipolar compound which will be more suitable soluble with 70% ethanol which has almost the same level of polarity. Giving acetic acid (AA) 25% as much as 5 mL in the sample aims to maintain anthocyanin compounds found in the sample. So that it can be seen during a four-week storage period, anthocyanin is still present in butterfly pea flower extract samples

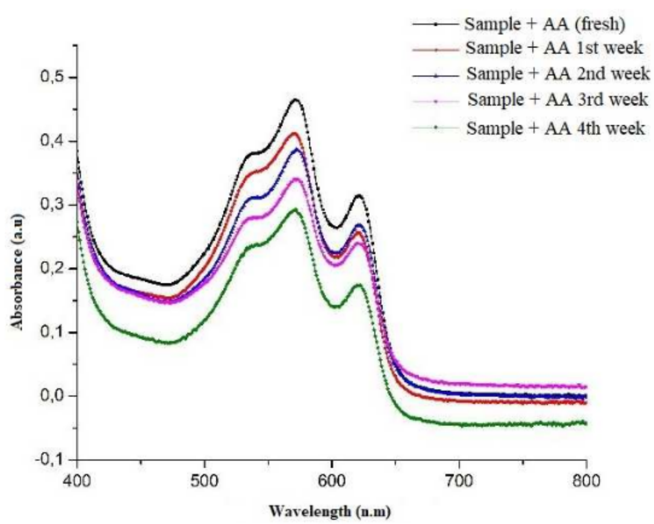

Figure 3. Butterfly pea Flower Extract Absorbance for 4 weeks

Butterfly pea flower extract samples at the first week to the fourth week of storage, then applied in alkalimetry and acidimetry titration. The experimental results show that butterfly pea flower extract is still worthy of being used as an indicator after four weeks of storage, this can be seen from the volume of titrant used in the first week to the fourth week which shows a good presisis value. The precision values of the titrant volume are shown in the following Table 3.

Table 3. Results of Acidimetry and Alkalimetry Titration with Bunga Butterfly pea Indicators in Four Weeks

Weeks	Alkalimetry, V NaOH (mL)		Acidimetry, VHCl (mL)	
	Average	Precision	Average	Precision
1	9,66	0,66253	10,925	2,52646
2	10,26	0,01462	10,35	0,14493
3	10,12	0,05929	10,56	0,2983
4	10,16	0,1624	10,3	0,14493
Average	10,05	0,22471	10,5463	0,77866

4 Conclusion

The experimental results showed that butterfly pea flower extract in a solvent mixture of 70% ethanol and 25% acetic acid (7: 1), could be used as an indicator for acid-base titration. Butterfly pea flower extract provides colour changes at pH 3-5 and at pH 8-9, so it can be used as an indicator for alkalimetry and acidimetry titration. In addition, butterfly pea flower extract can still be used as an indicator of acid-base titration after four weeks of storage. Thus, this butterfly pea flower extract can be used as an alternative to the use of indicators for acid-base titration in lab work.

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