Malaysian Journal of Chemistry, 2023, Vol. 25(5), 207-215
(Special Issue: *The 4th International Conference on Chemistry and Material Sciences 2022*)

Flower Extract Tapak Dara (*Catharanthus roseus* L) as Acid–Base Indicator

Sitti Rahmawati[1]*, Sitti Aminah[1], Siti Nuryanti[1], Vivi Dia Afrianti Sangkota[2] and Hapsarina[1]
[1]Chemistry Education Program, Mathematics and Sciences Educational, Faculty of Teacher Training and Educational Sciences, Universitas Tadulako, Jl. Soekarno Hatta Km 9 Tondo Palu 94118, Indonesia
[2]Department of Chemistry, Faculty of Mathematics and Natural Science, Universitas Negeri Gorontalo, Bone Bolango, Gorontalo, 96119, Indonesia
*Corresponding author (e-mail: sittirahmawati.q3a@gmail.com)

The aim of this research is to extract the tapak dara flower and prove it as an acid-base indicator. The tapak dara flower was washed with distilled water until clean, then ethyl acetate solvent was added and macerated. Subsequently filtered, then the filtered residue was extracted again with absolute methanol solvent. The extraction results were filtered using a gauze filter, then filtered again with filter paper. The filtered filtrate is ready to be used as an acid-base indicator. Then evaluated with a comparison indicator phenolphthalein and methyl orange for acid-base titration, namely a strong base with a strong acid, a weak base with a strong acid and a strong base with a weak acid. From the results of the study, it is known that the indicator of the extract of the tapak dara flower to show the equivalence point in the titration gives results that are equivalent to the comparison indicators. The results showed that indicators from tapak dara flower extract could be used instead of the synthetic indicators (phenolphthalein and methyl orange) that had been used so far.

Keywords: Flower tapak dara (*Catharanthus roseus L*); acid-base indicator

Received: September 2022; Accepted: December 2022

Tapak dara is shrub yearly originating from Madagascar, but has spread to various regions tropics . This type of shrub can grow in the lowlands to an altitude of 800 meters above sea level. Plant height is approximately 0.2-1 meters. The leaves are green with an oval shape. Leaf size, length 2-6 cm, width 1-3 cm. The flowers emerge from the leaf axils (axial). The color of the flowers can vary, some are white, blue, pink or purple depending on the cultivar.

The tapak dara flower plant (Figure 1) has the following classifications: Kingdom: *Plantae* (plants) Subkingdom: *Tracheobionta* (vessels) Superdivisio: *Spermatophyta* (seed-bearing), Divisio: *Magnoliophyta* (flowering) Class: *Magnoliopsida* (dicotyledonous), Subclass: *Asteridae*, Order: *Gentianales*, Family: *Apocynaceae*, Genus : *Catharanthus*, Species: *Catharanthus roseus (L.)*.

Tapak dara flower *(Catharanthus roseus L)* has been widely known to the public only as a wild plant. Sometimes people don't take advantage of this plant so they just leave it alone. In fact, this tapak dara flower plant has many benefits, namely the flowers and leaves have the potential to be a source of medicine for diabetes leukemia and Hodgkin's disease. The chemical ingredients are *vincristine, vinblastine, reserpine, ajmalicine*, and *serpentine*. Other ingredients are *catharanthine, leurosine, norharman, lochnerine, tetrahydroalstonine, vindoline, vindolinine, akuammine, vincamine, vinleurosin*, and *vinrosidin (*Nejat, N¸ et al, 2015).

In the flower of *Hibiscus sabdariffa* which has the division *Magnoliophyta* contains anthocyanin pigments (Nuryanti et al, 2013). Tapak dara flower belongs *Magnoliophyta* , so there may be color pigments, namely anthocyanins. Anthocyanins are organic compounds that are very unique in red acid solution, colorless neutral and blue in alkaline conditions (Torskangerspoll and Andersen, 2005, Fitrianto et al, 2020). Anthocyanins from various plants are increasingly being used in the food and medicine industry because of their attractive colors and safe for health. The color of anthocyanins is strongly influenced by the anthocyanin structure and the degree of acidity (pH). Anthocyanins tend to be colorless in the neutral pH area, in a solution with a very acidic pH (pH < 3) giving the maximum red color, while in an alkaline solution (pH 10.5) the anthocyanin pigment changes color to blue (Nuryanti, et al., 2010, Ogawa et al, 2017, Vankar, PS, & Srivastava, J, 2010).

An acid-base indicator is a substance that gives different colors to acidic and basic solutions and can be used to predict the pH of the solution. Indicators that are often used include litmus paper, phenol-phthalein, methyl red and bromine thymol blue. These indicators are usually known as synthetic indicators. This synthesis indicator is very much needed at the

†Paper presented at the 4th International Conference on Chemistry and Material Sciences 2022 (IC2MS2022)

secondary school to tertiary level. Synthetic indicators have several weaknesses, such as availability and high production costs, so they are relatively expensive and very difficult to obtain, especially in rural schools. Therefore, other alternatives are needed so that the learning process continues to run smoothly, synthetic indicators can be replaced with other alternatives in the form of acid-base indicators from natural or plant materials. Natural acid-base indicators use materials from nature such as hibiscus flowers (Dewi et al., 2022), hydrangea flowers, purple cabbage, turmeric, paper flowers, waru flowers (Nuryanti, et al. 2010) and several other plant species. Therefore, the authors feel the need and interest to conduct research on extracts of tread dara flower (*Catharanthus roseus L)* as an acid-base indicator.

EXPERIMENTAL

Chemical and Materials

The tools used in this study were scissors, filter paper, gauze, funnel, aluminum foil, beaker, stirrer, dropper, measuring cup, test tube, burette, stative, erlenmeyer, analytical balance, evaporator and pH-meter.

The materials used in this study were pink tread flower, aquades, ethyl acetate, absolute methanol, 0.1 M HCl, 0.1 M NaOH, 0.1 M NH_4OH, 0.1 M CH_3COOH, indicator methyl orange (MO), and phenolphthalein indicator (PP).

Characterization Methods

Extraction of Tapak dara Flowers

Weighed as much as 13.5 grams of tapak dara flowers, then washed with distilled water until clean, cut into small pieces, then added 50 mL of ethyl acetate solvent and macerated for 20 hours and then filtered. The residue was then re-extracted with 50 mL absolute methanol and macerated for 20 hours. The extraction results were filtered using a gauze filter, then filtered again with filter paper. The filtered filtrate is ready to be used as an acid-base indicator (Nuryanti et al., 2010, Dewi et al, 2022).

The Color Testing on Acid and Base Solutions

Extract of the tapak dara flower obtained was tested by dripping 3 drops into 0.1 M acetic acid (CH_3 COOH) solution and 0.1 M ammonium hydroxide (NH_4OH) base solution and then observed the changes the color.

Color Testing with Buffer Solution

5 drops of buffer solution were added to the drip plate with different pH, namely pH 1 to pH 14. Then 3 drops of the extract of the tapak dara flower were added to the buffer solution. Next note the color changes that occur.

Testing on Acid-Base

Titration of a Strong Base with a Strong Acid with an Indicator of Tapak Dara Flower Extract

Measured as much as 25 mL of standardized NaOH solution, then put in an erlenmeyer, then added 5 drops of indicator extract of the tapak dara flower. Before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M HCl solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

Titration of a Strong Base with a Strong Acid with Phenolphthalein Indicator

Phenolphthalein indicator is an acid-base titration indicator that has a pH range of 8.0-9.6, this indicator is used as a comparison (Nuryanti et al., 2010). The same research was carried out by replacing the indicator of tapak dara flower extract with a comparison indicator of phenolphthalein. Measured as much as 25 mL of standardized NaOH solution, then put in an Erlenmeyer, then added 3 drops of phenolphthalein indicator. Before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M HCl solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

Titration of a Weak Base with a Strong Acid with an Indicator of the Extract of the Tapak Dara Flower

Measured as much as 25 mL of 0.1 M NH_4OH solution, then put it in an erlenmeyer, then added 5 drops of indicator extract of the tapak dara flower. Before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M HCl solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

Titration of a Weak Base with a Strong Acid with Methyl Orange Indicator

Methyl orange indicator is a weak base-strong acid titration indicator which has a pH range of 3.1-4.4, this indicator is used as a comparison (Nuryanti et al., 2010, Dewi et al., 2022). The same research was carried out by replacing the indicator of tapak dara flower extract with a comparison indicator of methyl orange. $NH_4$0.1 M before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M HCl solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

Titration of a Weak Acid with a Strong Base with an Indicator of the Extract of the Tapak Dara Flower

Measured as much as 25 mL of 0.1 M CH_3COOH solution, then put it in an erlenmeyer, then added 5 drops of indicator extract of the tapak dara flower. Before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M NaOH solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

Titration of a Weak Acid with a Strong Base with Phenolphthalein Indicator

The same research was carried out by replacing the indicator of tapak dara flower extract with a comparison indicator of phenolphthalein $NaOH_3$ 0.1 M. Before titrating the mixture, the pH value was first measured using a pH-meter. Then it was titrated with 0.1 M NaOH solution. Every 2 mL titer, the pH value of the mixture was measured until a color change occurred.

RESULTS AND DISCUSSION

Extraction of Tapak dara Flowers

A total of 13.5 grams of fresh tapak dara flowers were macerated in ethyl acetate for 20 hours. This is intended to take the color components contained in the tapak dara flower. Then the filtered residue was macerated again in absolute methanol for 20 hours. In general, tapak dara flowers contain flavonoid compounds that are easily soluble in methanol, therefore the solvent used in this extraction is absolute methanol. Then the macerate was filtered to separate the residue and the filtrate. From the filtering results, the extract of the tapak dara flower was obtained as shown in Figure 1. The presence of colored extracts may contain anthocyanin pigments in the tapak dara flower because anthocyanins are pigments that provide color on flower, fruit, dan leaf green plants. This pigment is soluble in water (Harborne, JB 1996: 76, Fitrianto et al, 2020).

The Color Testing in Acid and Base Solutions

Results of the indicator test from the extract of the tapak dara flower obtained as shown in Figure 2, showed a color change, namely the acid solution (CH_3COOH 0.1 M) gave a pink color, while in the alkaline solution (NH_4OH 0.1 M) is green. The color change of the tapak dara flower extract in acid and alkaline solutions was due to the presence of anthocyanins. Anthocyanins are flavonoid compounds which when dissolved in acid turn red and change color with increasing pH (Fitrianto et al, 2020).

Figure 1. Tapak dara flower extract.

Figure 2. The color of the tapak dara flower indicator in an acid and base solution.

Color Testing with Buffer Solution

A buffer solution is a solution of a weak acid and its conjugate base or a weak base with its conjugate acid. The main property of a buffer solution is its resistance to changes in pH due to the addition of a little acid or a little base (Wojtkowiak, 2011). Color testing was carried out by dripping tapak dara flower extract into a buffer solution that has a pH of 1 to pH 14. This aims to see the color changes that occur due to the administration of tapak dara flower extract, it turns out from a buffer solution with a pH of 1 to pH 14. The data gives 4 colors, namely the buffer solution with a pH of 1 to pH 4 is yellow, the buffer solution with a pH of 5 to pH 6 is yellow, the buffer solution with a pH of 7 to pH 8 is greenish yellow, the buffer solution with a pH of 9 to pH 11 is green and buffered oceans with a pH of 12 to 14 are yellowish green. From the results obtained, it is necessary to find a route from the extract of the tapak dara flower because the eye's ability to distinguish colors is very limited (Nejat et al, 2015). The results of testing the color of the tapak dara flower using a buffer solution are presented in Figure 3 and Table 1.

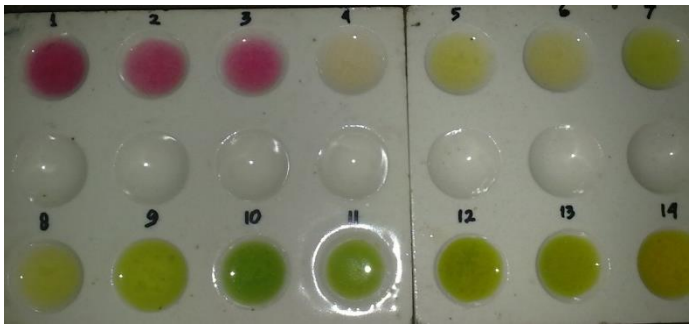

Figure 3. Color test with buffer solution.

Table 1. Results of color testing with buffer solution.

Buffer Solution	Volume Tapak dara Flower Extract	Solution Color of Tapak dara Flower Extract
pH 1	3 drops	Pink
pH 2	3 drops	Pink
pH 3	3 drops	Pink
pH 4	3 drops	Pink very light
pH 5	3 drops	Light yellow
pH 6	3 drops	Yellow
pH 7	3 drops	Yellow greenish
pH 8	3 drops	Yellow greenish
pH 9	3 drops	Light green
pH 10	3 drops	Green
pH 11	3 drops	Green
pH 12	3 drops	Green
pH 13	3 drops	Green
pH 14	3 drops	Green yellowish

Table 2. The results of the titration of 25 mL NaOH 0,1 M and HCl 0.1 M with an indicator of tapak dara flower extract.

Volume NaOH (mL)	Volume HCl (mL)	Total Volume (mL)	pH of Solution	Solution Color
25	0	25	12,0	Green
25	2	27	11,9	Green
25	4	29	11,9	Green
25	6	31	11,8	Green
25	8	33	11,7	Green
25	10	35	11,6	Green
25	12	37	11,5	Green
25	14	39	11,3	Green
25	16	41	11,1	Green
25	18	43	10,8	Green
25	20	45	9,9	Green
25	22	47	8,6	Green
25	24	49	5,9	Kuning kehijauan
25	26	51	4,2	Light yellow
25	28	53	2,5	Light pink
25	30	55	2,2	Light pink
25	31	56	2,1	Light pink
25	32	57	2,0	Light pink

Table 3. The results of the titration of 25 mL NaOH 0,1 M and HCl 0,1 M with phenolphthalein indicator.

Volume NaOH (mL)	Volume HCl (mL)	Total Volume (mL)	pH of Solution	Solution Color
25	0	25	12,0	Pink
25	2	27	11,9	Pink
25	4	29	11,9	Pink
25	6	31	11,8	Pink
25	8	33	11,7	Pink
25	10	35	11,6	Pink
25	12	37	11,5	Pink
25	14	39	11,4	Pink
25	16	41	11,2	Pink
25	18	43	11,0	Pink
25	20	45	10,5	Pink
25	22	47	9,6	Pink
25	24	49	7,0	Pink
25	25	50	6,2	Colorless

Testing on Acid–Base

Titration of Strong Bases with Strong Acids

Tapak dara flower extract as an indicator because it contains anthocyanins, which can experience equilibrium by forming anhydrobase compounds. In the titration of a strong base (NaOH) by a strong acid (HCl) with a tread flower indicator. The color of the solution before the titration is green and the solution only contains NaOH, when during the titration and between pH 12.00-2.00 there is a color change little by little from green to light pink. While the test using the phenolphthalein indicator as a comparison indicator, the solution during the titration changes color little by little from pink to colorless at a pH between 12.00-6.20. The results of the titration of 25 mL NaOH 0.1 M and HCl 0.1 M with an indicator of tapak dara flower extract and phenolphthalein indicator are presented in Table 2 and Table 3.

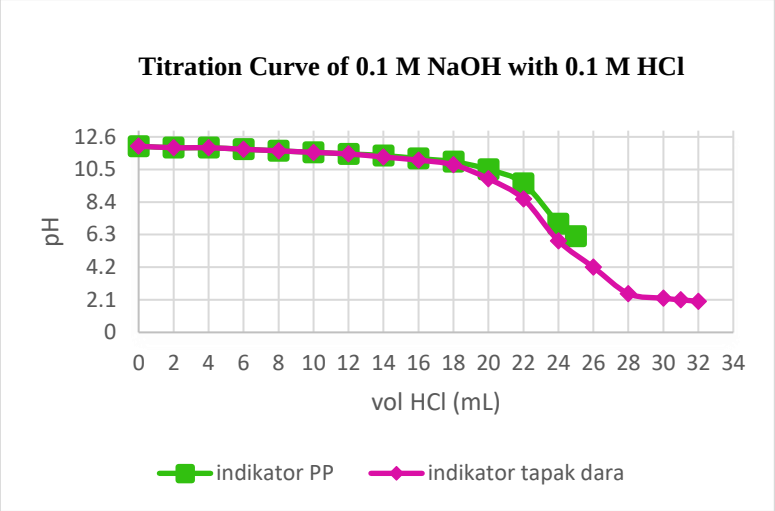

Figure 4. Titration curve of 25 mL 0.1 M NaOH with 0.1 M HCl.

The results of the 0.1 M NaOH titration curve by 0.1 M HCl using different acid-base indicators, namely the extract of the tapak dara flower and the phenolphthalein indicator, showed that the resulting pH value difference was not much. From the curve, it is known that when adding HCl to a volume of 20 mL, the two curve lines show values that tend to coincide, which means that the resulting pH values are not much different. The striking difference only appears when the addition of HCl volume reaches 22 mL until the end point of the titration occurs at a volume of 28 mL for the tapak dara flower extract indicator and a volume of 25 mL for the phenolphthalein indicator. The results of the titration curve by NaOH 0.1 M and HCl 0.1 M using different acid-base indicators, namely the extract of the tapak dara flower and the phenolphthalein indicator are shown in Figure 4 below.

In an acid-base titration, an acid-base indicator serves as a determinant of the end point of the titration. The end point of the titration is the experimentally measured volume at which the indicator changes color and the solution being titrated will experience a change in pH. For example, when an acid solution is titrated with a basic solution, the pH of the solution is initially low and during the titration it will increase continuously. pH during the titration was measured using a pH meter. The indicator must change color right at the time of the equivalent titration between the titrant and the titrate, and the given color change must occur quickly or suddenly (Nejat et al, 2015).

Table 4. The results of the titration of 25 mL NH_4OH 0.1 M and 0.1 M HCl with an indicator of tapak dara flower extract.

Volume NH_4OH (mL)	Volume HCl (mL)	Total Volume(mL)	pH of Solution	Solution Color
25	0	25	9,6	Green
25	2	27	9,2	Green
25	4	29	8,9	Green
25	6	31	8,6	Green
25	8	33	8,4	Green
25	10	35	8,0	Green
25	12	37	6,8	Light green
25	14	39	3,0	Light pink
25	16	41	2,1	Light pink
25	18	43	1,9	pink
25	20	45	1,8	pink

Table 5. The results of the titration of 25 mL NH_4OH 0.1 M and HCl 0.1 M with methyl orange indicator.

Volume NH_4OH (mL)	Volume HCl (mL)	Total Volume (mL)	pH of Solution	Solution Color
25	0	25	9,8	Yellow
25	2	27	9,3	Yellow
25	4	29	9,0	Yellow
25	6	31	8,8	Yellow
25	8	33	8,5	Yellow
25	10	35	8,2	Yellow
25	12	37	7,7	Yellow
25	14	39	6,0	Yellow
25	16	41	2,5	Red
25	18	43	2,3	Red
25	20	45	2,0	Red

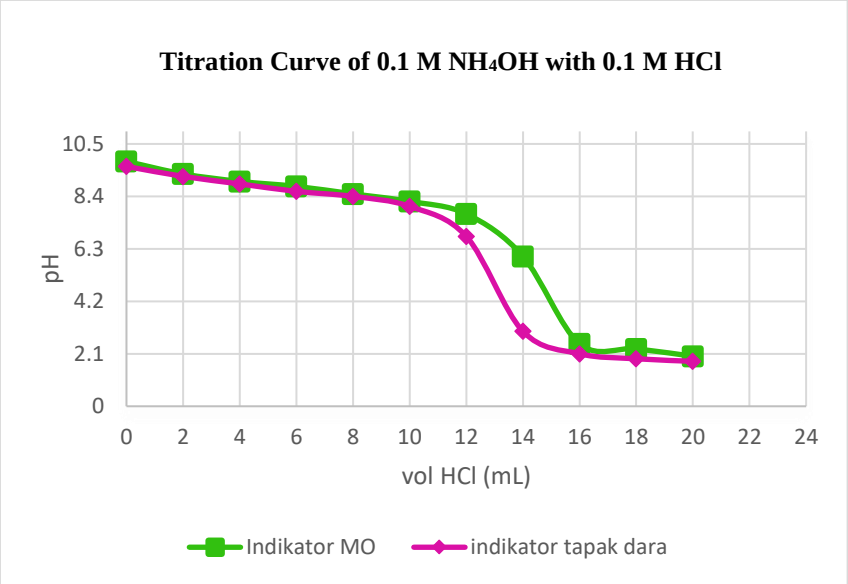

Figure 5. Titration curve of 25 mL 0.1 M NH_4OH with 0.1 M HCl.

Titration of a Weak Base with a Strong Acid

The results of a titration of a weak base with a strong acid, using an indicator of the extract of the tapak dara flower, show that the pH above 9.6 is green, between pH 9.6-1.8 there is a gradual change from green to pink . While the titration with methyl orange indicator as a comparison indicator, the results obtained showed a yellow pH above 9.8, between pH 9.8-2 there was a gradual change from yellow to red. In this test, tapak dara flower extract can be used to titrate a weak base with a strong acid. This is evidenced by the results of the titration using the extract giving results that are equivalent to the methyl orange indicator. The results of the titration of 25 mL NH_4OH 0.1 M and HCl 0.1 M with an indicator of tapak dara flower extract and methyl orange indicator are presented in Table 4 and Table 5.

The results of the titration curve of NH_4OH 0.1 M and HCl 0.1 M using different acid-base indicators, namely the extract of the tapak dara flower and the methyl orange indicator, showed that the pH value difference was not much. From the curve, it is known that with the addition of HCl to a volume of 10 mL, the two curve lines show values that tend to coincide, which means that the resulting pH values are not much different. A striking difference only appears when the addition of HCl volume reaches 12 mL until the end point of the titration occurs at a volume of 16 mL. At this point the pH value indicated by the curve with the methyl orange indicator is higher

than the curve value indicated by the tapak dara flower extract indicator. After that the curve again shows the value that coincides. The results of the titration curve by NH_4OH 0.1 M with 0.1 M HCl using different acid-base indicators, namely the extract of the tapak dara flower and methyl orange indicator are shown in Figure 5 below.

Titration of a Weak Acid with a Strong Base

The titration of a weak acid with a strong base, using an indicator of the extract of the tapak dara flower, shows that the pH is below 3.9 and is red, between pH 3.9-9.5, there is a gradual change from pink to green, and a pH above 9.5 the solution is green. While titration with phenolphthalein indicator as a comparison indicator, the results obtained between pH 3.6-9.8 change gradually from colorless to pink at pH 9.8. In this test, tapak dara flower extract can be used to titrate a weak acid with a strong base. The results of the titration of 25 mL CH_3COOH 0.1 M and NaOH 0.1 M with an indicator of tapak dara flower extract and phenolphthalein indicator are presented in Table 6 and Table 7.

The results of the titration curve of CH_3COOH 0.1 M and NaOH 0.1 M using different acid-base indicators, namely the extract of the tapak dara flower and the phenolphthalein indicator, showed that the resulting pH values were not much different. From the curve, it is know that with the addition of NaOH from a volume of 0 mL to a volume of 10 mL, the two curve lines show values that tend to coincide, which means that the resulting pH values are not much different. The results of the titration curve by CH_3COOH 0.1 M and NaOH 0.1 M using different acid-base indicators, namely the extract of the tapak dara flower and the phenolphthalein indicator are shown in Figure 6 below.

Based on the data above, there are similarities (almost the same) between the phenolphthalein indicator, the methyl orange indicator and the tapak dara flower extract indicator. This shows that the tread flower indicator can be used as an acid-base indicator instead of a synthetic acid-base indicator.

Table 6. The results of the titration of 25 mL CH_3COOH 0.1 M and NaOH 0.1 M with an indicator of tapak dara flower extract.

Volume CH_3COOH (mL)	Volume NaOH (mL)	Volume total (mL)	pH of Solution	Solution Color
25	0	25	3,5	Pink
25	2	27	3,9	Light pink
25	4	29	4,2	Light yellow
25	6	31	4,4	Yellow
25	8	33	4,6	Yellow
25	10	35	4,9	Yellow
25	12	37	5,1	Yellow
25	14	39	5,4	Yellow
25	16	41	6,2	Greenish yellow
25	17	42	9,5	green

Table 7. The results of the titration of 25 mL CH_3COOH 0.1 M and NaOH 0.1 M with phenolphthalein indicator.

Volume CH_3COOH (mL)	Volume NaOH (mL)	Total volume (mL)	pH of Solution	Solution Color
25	0	25	3,6	Colorless
25	2	27	4,2	Colorless
25	4	29	4,4	Colorless
25	6	31	4,6	Colorless
25	8	33	4,8	Colorless
25	10	35	5,1	Colorless
25	12	37	5,6	Colorless
25	14	39	5,9	Colorless
25	16	41	6,7	Colorless
25	17	42	9,8	Light Pink

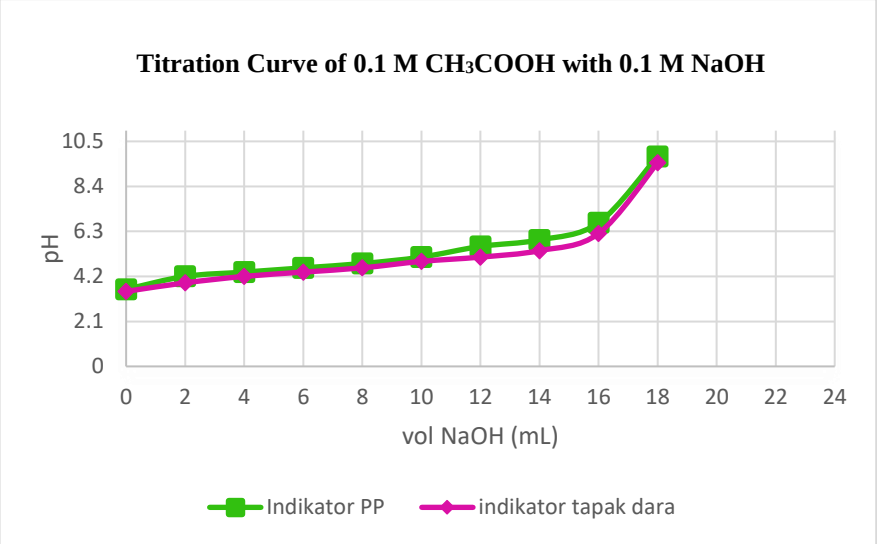

Figure 6. Titration curve of 25 mL of 0.1 M CH_3COOH with 0.1 M NaOH.

CONCLUSION

From the results of the research and discussion, the following conclusions can be : flower extract can be used as an indicator for acid-base titrations (strong acid-strong base, weak acid-strong base and weak base-strong acid).

The color change in acid is pink and base is green. The color change occurred because the tapak dara flower extract contained anthocyanins, which in its structure contained flavilium cations to form anhydrobase due to changes in pH.

The indicator of tapak dara flower extract has similarities with phenolphthalein and methyl orange indicators, so it can be used as a substitute for these indicators.

REFERENCES

1. Nuryanti, S., Matsjeh, S., Anwar, C. dan Raharjo, J. T. (2010) Indikator Titrasi Asam-Basa dari Ekstrak Bunga Sepatu (Hibiscus rosa sinensis L). *AGRITECH, Yogyakarta: Universitas Gadjah Mada*, **30**, 3, Agustus 2010.

2. Nejat, N., Valdiani, A., Cahill, D., Tan, Y. H., Maziah, M. & Abiri, R. (2015) Ornamental exterior versus therapeutic interior of Madagascar periwinkle (Catharanthus roseus): the two faces of a versatile herb. *The Scientific World Journal*, *2015*.

3. Fitrianto, N., Proklamasiningsih, E. & Muljowati, J. S. (2020) Phytochemical diversity and anti-microbial properties of methanol extract of several cultivars of Catharanthus roseus using GC-MS. *Biodiversitas Journal of Biological Diversity*, **21(4)**.

4. Ogawa, M., Takee, R., Okabe, Y. & Seki, Y. (2017) Bio-geo hybrid pigment; clay-anthocyanin complex which changes color depending on the atmosphere. *Dyes and Pigments*, **139**, 561–565.

5. Vankar, P. S. & Srivastava, J. (2010) Evaluation of anthocyanin content in red and blue flowers. *International Journal of Food Engineering*, **6(4)**.

6. Dewi, S. H., Sudarmin, S., Haryani, S. & Sulistyaningsih, T. (2022) Laboratory Course During Pandemic Covid-19: Do Lab at Home to Promote Creative Thinking Skill. *International Journal of Active Learning*, **7(1)**, 69–76.

7. Wojtkowiak, J. W., Verduzco, D., Schramm, K. J. & Gillies, R. J. (2011) Drug resistance and cellular adaptation to tumor acidic pH micro-environment. *Molecular pharmaceutics*, **8(6)**, 2032–2038.