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Potential of Andong Leaf Extract (*Cordyline fruticosa (L) A. Chev*) as an Indicator for Acidimetric Titration

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Abstract: Andong leaves have a red pigment that comes from flavonoid compounds, namely anthocyanin, which can be used as a natural dye. Anthocyanin pigments are secondary metabolites and are polar pigments that are naturally soluble in water so they have the ability to react both with acids and bases. Anthocyanin pigments will change to red if they are in an acidic environment and will turn green or yellow if they are in an alkaline environment. The characteristic color change of this anthocyanin pigment is the potential of andong leaf extract as a natural indicator in determining the end point in acidimetric titration. This study aims to determine whether there is a difference in the concentration of HCl titrated with the indicator methyl orange (MO) and andong leaf extract. The research design used was quasi-experimental with a purposive sampling technique. The sample is andong leaf extract with a concentration of 60%. Then the sample was applied as an acidimetric titration indicator for 32 titrations. Based on the results of acidimetric titration, the average HCl concentration value using the MO indicator was 0.0953 N and the average HCl concentration value using andong leaf extract was 0.0937 N. Based on the results of the Mann-Whitney test, a significance value of 0.000 (<0.05) was obtained, which means that there was a difference in the concentration of HCl titrated with the indicator MO and 60% andong leaf extract.

Keywords: andong leaf extract, indicator, acidimetric titration

A. Introduction

Acid-base titration is a conventional chemical analysis method used to determine the concentration of an acid or base. Acid-base titration is based on the equivalence point between the acid and the base. The equivalence point is determined by the end point of the titration which is marked by a color change around that point when an indicator is applied to that point. Indicators are used to see acidic or basic compounds (Ramadhani & Octarya, 2017).

Acidimetric titration is a titration process to determine the concentration of a base using an acid solution as a standard. The reaction that occurs is in principle a neutralization reaction, namely the formation of salt and neutral H_2O (pH 7) resulting from reactions including H^+ from an acid and OH^- from a base. In practice, this condition cannot be seen visually but is seen with the help of acid-base indicators which have specific colors at certain pH conditions (Ningsih et al., 2019).

An indicator is a substance added to a sample solution as a marker indicating that the end point of titration (TAT) has occurred in volumetric analysis. A substance can be said to be an acid-base titration indicator if it can give a color change to the sample along with changes in hydrogen ion concentration and changes in pH (Ratnasari et al., 2016). Currently, the acid-base titration indicators that are often used are usually synthetic indicators, for example the methyl orange (MO) indicator. This indicator is a synthetic indicator which is widely sold on the market at quite expensive prices, can cause chemical pollution, limited availability, the impact of chemical waste produced can pollute the environment and production costs are quite high (Yazid, 2018).

Natural indicators in the form of natural dyes found in plants can be used as alternative indicators to replace synthetic indicators. Dyes in plants are organic compounds that produce colors like those of synthetic indicators. Indicators found in plants are not only easy to make but also easy to obtain. Plants that can be used as natural indicators must have color characteristics so that the extract obtained from these plants can provide different color changes at each pH (Yulfriansyah & Novitriani, 2016).

The andong (*Cordyline fruticosa (L) A. Chev*) is a plant that is easily found in Indonesia. The red pigment produced from the leaves of this plant comes from flavonoid compounds, namely anthocyanin, which can be used as a natural dye (Utami, 2021).

In research by Ratnasari et al. (2016), Winarno stated that the compounds that play a role in changing the color of natural indicators are anthocyanin pigments which are secondary metabolites from the flavonoid group of compounds and are polar pigments that are naturally soluble in water so they have the ability to react with both acids and bases. Anthocyanin pigments will change to red if they are in an acidic environment and will change color to purple and blue if they are in an alkaline environment. The nature of anthocyanin pigments which can change color at different pHs makes it possible to apply them as indicators for acid-base titrations.

Research by Ratnasari et al. (2016) on the study of the potential of adam hawa leaf extract (*Rhoeo disolor*) as an acid-base titration indicator, the results obtained in acidimetric titration using the natural indicator adam hawa leaf extract showed the average volume of HCl needed to reach the end point of the titration, namely 10.90 ml with a pH of 3.752 and titration using the MO indicator with the average volume of HCl needed to reach the end point of the titration, namely 10.80 with a pH of 3.502, with a percent error of 0.925%.

Research on adam hawa leaf extract (*Rhoeo disolor*) as an alternative natural indicator for acidimetric titration has now been carried out. However, research on andong leaf extract as an alternative natural indicator in acidimetric titrations has never been carried out. This research aims to find out whether 60% andong leaf extract can be used as an alternative as a natural indicator in acidimetric titration.

B. Materials and Methods

This research was a quasi-experimental design with a purposive sampling technique. The sample is andong leaf extract with a concentration of 60%. Then the sample was applied as an acidimetric titration indicator for 32 titrations, where 16 samples used MO indicator and 16 samples used andong leaf extract. This research was conducted in March 2023 at the Laboratory of Chemistry, Poltekkes Kemenkes Pontianak.

Collected data processed and analyzed using the Mann-Whitney U test by SPSS application to determine whether there is a difference in the concentration of HCl titrated with the indicator MO and 60% andong leaf extract.

C. Results and Discussion

Research on andong leaf extract (*Cordyline fruticosa (L) A. Chev*) as a natural indicator in acidimetric titration was carried out on March 2023 at the Laboratory of Chemistry, Poltekkes Kemenkes Pontianak. This research aims to find out whether andong leaf extract can be used as an alternative as a natural indicator in acidimetric titration. In this study, the number of samples used was 32 samples, of which 16 samples were titrated using the synthetic indicator MO 1% and the other 16 samples were titrated using the indicator 60% andong leaf extract. The samples of andong leaves in this study were andong leaves taken in the Southeast Pontianak City area. After carrying out a qualitative test on the anthocyanin content in andong leaf extract, this test was carried out by taking 3 ml of diluted andong leaf extract, then adding 10 drops of 2M HCl then heating for 5 minutes, the presence of anthocyanin content in andong leaf extract was indicated by The red color in the andong leaf extract solution will not fade. The next qualitative test was by adding 2M NaOH solution drop by drop into 3 ml of andong leaf extract until the color of the andong leaf extract changed to green which then gradually faded to yellow.

The results of laboratory tests on HCl concentrations using the natural indicator andong leaf extract can be seen in Table 1 as follows.

Table 1. Laboratory Test Results

Replication	Titration Results (N)	
	A	B
1	0.0956 N	0.0938 N
2	0.0956 N	0.0943 N
3	0.0956 N	0.0934 N
4	0.0956 N	0.0934 N
5	0.0047 N	0.0938 N
6	0.0956 N	0.0943 N
7	0.0956 N	0.0947 N
8	0.0956 N	0.0934 N
9	0.0947 N	0.0934 N
10	0.0961 N	0.0938 N
11	0.0952 N	0.0938 N
12	0.0947 N	0.0934 N
13	0.0947 N	0.0938 N
14	0.0956 N	0.0934 N
15	0.0947 N	0.0934 N
16	0.0952 N	0.0938 N
Average	0.0953 N	0.0937 N

Table 1 shows the concentration results from acidimetric titration using 1% MO indicator and 60% andong leaf extract with 16 repetitions. From the 16 repetitions, the average concentration result from the acidimetric titration, namely using the 1% MO indicator, was 0.0953N (A), while using the 60% andong leaf extract indicator was 0.0937N (B).

The descriptive test results of andong leaf extract (*Cordyline fruticosa (L) A. Chev*) as a natural indicator in acidimetric titration can be seen in Table 2 below.

Table 2. Descriptive Test Results

	Range	Average
MO 1%	.0947 - .0961	.095300
Andong leaf extract 60%	.0934 - .0947	.093744

Based on the descriptive test results presented in Table 2, it can be seen that the concentration value from the acidimetric titration using the 1% MO indicator obtained a value range of 0.0947 to 0.0961, an average of 0.095300. Furthermore, the concentration value from acidimetric titration using the indicator 60% andong leaf extract obtained a value ranging from 0.0934 to 0.0947, an average of 0.093744.

The next stage is to carry out a statistical test to see the difference between the HCl concentration titrated with 1% MO indicator and 60% andong leaf extract, which includes the normality test (Table 3) and the Mann-Whitney test (Table 4).

Table 3. Normality Test

Indicator	Shapiro-Wilk
	Significance
MO 1%	0.003
Andong Leaf Extract 60%	0.003

Table 3 shows the results of the data normality test using Shapiro-Wilk. The Shapiro-Wilk test was used based on a total sample of ≤50 with a normal criterion value of ≥0.05 (Setianingsih & Nelmiawati, 2020). The significance value obtained from the 1% MO indicator and 60% andong leaf extract each is 0.003 (<0.05) so it can be concluded that the data is not normally distributed.

Table 4. Mann-Whitney U test

	Mann-Whitney U
	Significance
MO 1% - andong leave extract 60%	0,000

Based on the test above, a significance value of 0.000 (<0.05) was obtained, which means there is a significant difference between the concentration of HCl titrated with the MO indicator and andong leaf extract.

The andong plant (*Cordyline fruticosa (L) A. Chev*) has red leaves so it has the potential to be used as a natural dye or pigment. The chemical contents contained in this plant are tannins, flavonoids, saponins and alkaloids. The anthocyanin compound is a compound derived from the flavonoid group which acts as a dye and can produce a red color naturally, to be used as a food ingredient and can also be used as an alternative substitute for synthetic colors that are environmentally friendly and safe for health (Utami, 2021).

Anthocyanin compounds play an important role in changing the color of natural indicators, because these compounds are secondary metabolite compounds that can dissolve in water so they have the ability to react both with acids and bases. This anthocyanin pigment will be red in an acidic environment and will change color to purple or blue in an alkaline environment. The nature of anthocyanin pigments, which can change color at different pH levels, allows them to be applied as natural indicators for acid-base titrations (Ratnasari et al., 2016).

In this study, andong leaves were extracted using the maceration method which was carried out by soaking simplicia from andong leaves in ethanol solvent until the color of the macerate changed to clear. The use of ethanol as a solvent is because ethanol has polar properties which are able to dissolve anthocyanin compounds which are polar compounds. Maceration is carried out at room temperature and covered tightly because anthocyanins can be degraded by temperature and light. Degradation of anthocyanin compounds can occur during the extraction process. The factors that cause anthocyanin compounds to be degraded are pH, temperature, light and oxygen. Degradable anthocyanin compounds can changes form to anthocyanidins such as cyanidin, delphinidin, malvidin, pelargonidin, petunidin, and peonidin. Anthocyanidins are flavonoids that are often found in nature, especially in the form of glycosides called anthocyanins. In acidic conditions, anthocyanins are in the form of cations (flavilium ions), in acidic conditions they are red and if the pH is higher or alkaline, the color of the anthocyanin compound will change to chalcone, which means it is colorless, therefore anthocyanin compounds are more stable at low pH. (Ifadah et al., 2022).

Two kilograms of andong leaves were collected without the bones, the andong leaves were dried using an oven at 40℃ for 24 hours, the dried andong leaves were then blended until they became simplicia, after they became simplicia the weight of the andong leaves was 700 grams, the simplicia were macerated for 3 days using 4.8 liters of 70% ethanol solvent and obtained 195.5 grams of thick andong leaf extract and 96 grams of the andong leaf extract used in this research.

The andong leaf extract that has been obtained is then applied as a natural indicator for acidimetric titration, based on the results of an examination of the use of andong leaf extract as a natural indicator for acidimetric titration compared to the synthetic indicator MO. From the results of acidimetric titration using andong leaf extract as a natural indicator, it was found that the average number of ml of titrant was 10.65 ml with a color change from orange to reddish orange, with an average initial pH of 9.8 and an average final pH of 3.7 and the average HCl concentration was 0.0937 N, while titration using the MO indicator obtained an average number of ml of titrant of 10.48 ml with a color change from orange to reddish orange, with an average initial pH of 9.9 and the final average pH was 4.1 and the average HCl concentration was 0.0953 N.

The results of the Mann-Whitney test from the results of the HCl concentration titrated with the synthetic indicator MO 1% and the natural indicator andong leaf extract 60% obtained a value of 0.000 <0.05. These results can be concluded that there is a significant difference between the HCl concentration titrated with the 1% MO indicator and 60% andong leaf extract. Many factors cause differences in the concentration of HCl titrated with 1% MO indicator and 60% andong leaf extract, thus rejecting the hypothesis, one of which is the weakness of natural indicators, natural indicators in solution form do not last long, are easily damaged, and cause an unpleasant odor (Maulika et al., 2019).

The stability of anthocyanin compounds in andong leaf extract is also one of the causes of the difference in HCl concentration titrated with 1% MO indicator and 60% andong leaf extract. Several factors influence the stability of anthocyanin compounds, namely pH, pH can not only affect the color of anthocyanin compounds, but it also affects its stability, because anthocyanin compounds are more stable in acidic solutions than in alkaline solutions. Temperature also affects the stability of anthocyanin compounds, because very hot temperatures can cause damage to the structure of anthocyanin compounds, therefore during the drying process of horseradish leaves, an oven is used at a temperature of 40℃. The storage time of andong leaf extract can also affect the stability of the anthocyanin compound, because if the diluted andong leaf extract is stored for too long, the anthocyanin content in the andong leaf extract will be degraded and cause a decrease in the anthocyanin levels in the andong leaf extract. Light also affects the stability of anthocyanin compounds, because light plays a role in the rate of degradation of anthocyanin color, therefore anthocyanin compounds must be stored in a dark place. Oxygen also affects the stability of anthocyanin compounds, because oxygen can accelerate the degradation of anthocyanin compounds, degradation of anthocyanin compounds not only during the extraction process from plant tissue but also during processing and storage (Samber et al., 2013).

The effects of the active compounds contained in andong leaf extract also affect the stability of anthocyanin compounds, such as flavonoid compounds, these compounds are natural dyes that produce red, purple, blue and yellow dyes found in several plants. This compound plays an important role in determining the color, smell and nutritional quality of food. Flavonoid compounds are included in polyphenolic compounds so they are chemical, phenol compounds are slightly acidic and can dissolve in bases and these compounds are polyhydroxy compounds (hydroxyl groups) so they are also polar so they can dissolve in polar solvents such as methanol, ethanol, acetone, water and butanol. Anthocyanin compounds are derivatives of flavonoid compounds, therefore flavonoid compounds are very influential in the stability of anthocyanin compounds (Wardani, 2021). The alkaloid compounds contained in andong leaf extract act as natural antibacterials by interfering with the peptidoglycan components in bacterial cells. Alkaloids are a class of secondary metabolite compounds that are found in many plants. Alkaloid compounds do not have much effect on the stability of anthocyanin compounds found in andong leaves. Saponin compounds are natural glycosides that have amphiphilic surface properties, have a large molecular weight and a structure consisting of steroid or triterpenoid aglycones called sapogenins and glycones containing one or more sugar chains. The saponin compounds contained in andong leaves play a role in reducing the level of cholesterol absorption and increasing fecal excretion, so the saponin compounds contained in andong leaves have little effect on the stability of anthocyanin compounds (Andani et al., 2022).

According to research by Ratnasari et al. (2016)on the study of the potential of adam hawa leaf extract (*Rhoeo discolor*) as an indicator for acid-base titrations, the extract used as a natural indicator for acid-base titrations is concentrated undiluted, because the higher the concentration of the extract, the higher the anthocyanin content contained in the natural ingredient. The thing that makes the concentration of each replication different is that when weighing the andong leaf extract there is a slight difference in the value in each replication. Errors that occur during weighing greatly affect the resulting concentration value, because the concentration of andong leaf extract will affect the ml of titration produced to reach the end point of the titration (TAT).

D. Conclusion

Based on the research that has been carried out, it can be concluded that although statistical analysis shows the results there is a difference between the HCl concentration titrated with the synthetic indicator MO 1% and 60% andong leaf extract in the acidimetric titration. However, visually, 60% andong leaf extract has the potential as a natural indicator for acidimetric titration, because it meets the characteristics of the indicator, namely providing color changes in acidic conditions by having a consistent color in a stable compound, but in terms of the concentration of 60% andong leaf extract, it is not appropriate to use as a acidimetric titration.

Furthermore, it is recommended that research be carried out using the right concentration on the use of andong leaf extract as a natural indicator for acidimetric titration.

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