

DETERMINATION OF IRON (Fe) CONTENT IN LEAF EXTRACT OF SWEET POTATO (*Ipomoea batatas*) USING COMPLEXOMETRY METHODS

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ABSTRACT

Background: Iron (Fe) is an essential mineral that plays a very important role in the formation of hemoglobin, oxygen transportation, and various metabolic processes of the body. Iron deficiency can cause serious health problems, one of which is iron deficiency anemia, which is widely experienced, especially in women of childbearing age. This condition can reduce the quality of life, productivity, and even affect the development of future generations. Therefore, the search for natural iron sources that are easily available, affordable and safe is needed. One of the potential plants is purple sweet potato leaves (*Ipomoea batatas*), which is known to have high nutritional content, including iron, but has not been optimally utilized. **Objective:** This study aims to determine the iron content in purple sweet potato leaf extract using the complexometric method with Na₂EDTA solution as titrant and Eriochrome Black T indicator. **Methods:** Extraction was carried out through maceration method using 96% ethanol, then iron levels were determined through complexometric titration. As a comparison, the drug Sangobion, which is known to contain iron, was used. **Results:** The results showed that the iron content in purple sweet potato leaf extract was 28.96 mg/mL, while in Sangobion it was 29.34 mg/mL. **Conclusion:** These results indicate that purple sweet potato leaf extract has a competitive iron content and has the potential to be an alternative natural iron source that is competitive, safe and has the opportunity to be further developed in the pharmaceutical and public health fields.

INTRODUCTION

Iron (Fe) is one of the essential minerals that plays an important role in the human body. It plays a role in the formation of hemoglobin, which is responsible for transporting oxygen in the blood, as well as being an important component in various enzymes that support the body's metabolic functions. Iron deficiency, which often leads to iron deficiency anemia, is a significant public health problem worldwide, especially in developing countries (Minsas & Warsidah, 2024). Iron deficiency anemia is a common problem in many countries. This condition occurs when the body lacks a sufficient number of healthy red blood cells due to a lack of iron. Healthy red blood cells are important for carrying oxygen throughout the body. Anemia in women of childbearing age (WUS) can cause fatigue, weakness, decreased work capacity/ability or productivity. The most common causes of anemia in pregnancy are iron deficiency, folic acid and acute bleeding can occur due to the interaction between the two (Astriana et al., 2017). One alternative to meet iron needs can be done by consuming green vegetables that are rich in iron, one of which is purple sweet potato leaves (*Ipomoea batatas*). Purple sweet potato leaves (*Ipomoea batatas*) are known to be rich in various essential nutrients. However, in-depth studies on the iron content of purple sweet potato leaves (*Ipomoea batatas*) are still limited (Okvitasari & Ulfah, 2021).

Purple sweet potato leaves (*Ipomoea batatas*) is a green vegetable that is obtained and can grow in various climates and places, as a source of nutrients and other bioactive compounds. Purple sweet potato leaves (*Ipomoea batatas*) are known to have higher antisionin than white sweet potato leaves. As well as containing higher vitamins and minerals than other varieties, even with other vegetable leaves. The presence of antisionins, flavonoids and polyphenols in purple sweet potato (*Ipomoea batatas*) leaves has provided health benefits including anticancer, antimodulation, antimutagenic, antihypertensive, antidiabetic, heart and liver protection. As a phytochemical-rich green vegetable, purple sweet potato (*Ipomoea batatas*) leaves are popular in many countries, but a study

found the fact that purple sweet potato (*Ipomoea batatas*) leaves, which are rich in polyphenols, are still underutilized, while also in some countries purple sweet potato (*Ipomoea batatas*) leaves have not been recognized for their benefits and uses so that the leaves are widely discarded and used as animal feed (Ranteallo et al., 2023). Purple sweet potato leaves (*Ipomoea batatas*) are consumed as a vegetable throughout the world, especially in Southeast Asia. This is because sweet potato leaves contain several nutrients including B vitamins, β -carotene, iron, calcium, protein and zinc, as well as bioactive components that are antioxidants, namely flavonoids and phenolic compounds such as caffeate, chlorogenic acid and tricaffeoylquinic acid (Sari et al., 2021). Traditionally, purple sweet potato (*Ipomoea batatas*) leaves are also useful as a medicine for ulcers to febrifuge. In addition, infusion of purple sweet potato leaves with moderate and heavy doses has the potential to cure dengue fever. Other research shows that the antioxidant activity in sweet potato leaves is stronger than the tubers (Carica Dewi & Mira Kusumaningtyas, 2021).

Ranteallo et al. (2023) conducted a study aimed at identifying and quantifying the mineral and vitamin content in purple sweet potato (*Ipomoea batatas*) leaves. The extraction methods used include ICP-MS for Fe, Zn, Cu, and Mn; AAS for K, Ca, Mg, and Na; and spectrophotometry for P, β -carotene, and vitamin C. The results showed that the Fe content was 22,014.5 times higher than the vitamin content of the sweet potato leaves. The results showed Fe content of 22,014.5 $\mu\text{g}/100\text{g}$, which indicates the potential of purple sweet potato leaves as a natural source of iron. Previous research by Solihah (2020) developed a colorimetric method for the determination of Fe(II) ions using purple cabbage extract as a natural reagent. Although different in plant type, this research shows the potential of using natural reagents in heavy metal analysis simply and economically. One of the analytical techniques that can be used is the complexometric method, which is a titration method that involves the formation of complexes between metal ions and ligands, such as EDTA (ethylenediaminetetraacetic acid). This method is known for its accuracy, high sensitivity, and relatively short analysis time. In addition, this technique is quite simple and suitable to be applied to various types of samples, including plant-based foods (Garini et al., 2018).

Complexometry method is one of the methods in quantitative analytical chemistry used to determine the concentration of metal ions in a solution through the formation of complexes between metal ions and complexing agents (ligands). In this method, the chemical reactions that occur are stoichiometric and take place quickly and reversibly, making it very suitable for the titration process. The complexes formed are generally colored, making it easier to observe the end point of the titration, both visually using color indicators and instrumentally (Taufik et al., 2018). By exploring the iron content in purple sweet potato (*Ipomoea batatas*) leaves through the complexometry method, this research is expected to make a significant contribution to the development of local food as an important source of nutrition, especially in the prevention of iron deficiency anemia. In addition, the results of this study can be the basis for the community and policy makers to utilize purple sweet potato leaves (*Ipomoea batatas*) as part of a healthy and nutritious diet (Wahyuni, 2024).

Based on this background, this research will focus on analyzing the iron content in purple sweet potato (*Ipomoea batatas*) leaves using the complexometry method, with the hope of revealing its potential as a source of iron that is easily accessible to the wider community.

METHODS

This study uses a laboratory experimental design, which aims to determine the iron (Fe) content in purple sweet potato leaves (*Ipomoea batatas*) by complexometry method. This research was conducted at the Baubau Polytechnic Pharmacy Laboratory and Mandala Waliya Laboratory, the research time from May 2025 to June 2025. The materials used in this study were distilled water, ammonia, ammonium chloride, 2N hydrochloric acid, sodium EDTA, Erichrome Black T (EBT) indicator, calcium carbonate and samples of purple sweet potato leaf simplisia (*Ipomoea batatas*) and sangpbion medicine. The tools used in this study were 50 mL burette, porcelain cup, spray bottle, glass funnel, filter paper, horn spoon, oven, spatula, 250 mL erlenmeyer, 100 mL beaker, 100 mL and 50 mL measuring cups, 500 mL volumetric flask, lumping and pestle, analytical balance and drop pipette.

Simplisia Preparation

Purple sweet potato leaves are selected fresh and healthy. Then washed with clean water to remove dirt and dust. Then dried purple sweet potato leaves by placing purple sweet potato leaves on a baking sheet then in the sun until the water content decreases. After that, grind the dried leaves into fine powder using a blender. Filter the leaf powder with a sieve or sieve to obtain a uniform particle size. Store the simplisia in a closed, dry container and avoid direct light (Kiko et al., 2023).

Extract Preparation (Mustiqawati et al., 2022)

The method used was maceration. A total of 250 grams of purple sweet potato leaf powder was macerated using 2,500 ml of 96% ethanol solvent, for 2 days with occasional stirring. This process was carried out twice to ensure that the active compounds were maximally extracted. The results of maceration were filtered to obtain the filtrate. The filtrate obtained from each maceration process was then combined. Furthermore, the solution was evaporated using a rotary evaporator until a thick extract of purple sweet potato leaves was obtained. The yield can be calculated by means of;

$$\text{Yield} = \frac{\text{extract weight}}{\text{Simplisia powder weight}} \times 100\%$$

Sangobion Medicine Tablets

The sample used was Sangobion medicine. Each sample was taken 10 tablets, then weighed and crushed until smooth, then weighed again with an amount equivalent to 1 tablet. Where the sangobion drug is weighed with an average amount of 100 mg. Then the sample was dissolved with distilled water until dissolved, then the solution was filtered into a 100 mL volumetric flask, added distilled water until the limit mark. Pipetted 20 mL of sample solution each, put in erlemeyer (Dinni Aulia Bakhtra & Pramudita, 2015).

Preparation of 0.01M sodium EDTA titer solution

Weighed carefully as much as 9.3 grams of Na₂EDTA then dissolved with distilled water in a 500 mL volumetric flask, homogenized, enough volume to the limit mark (Dinni Aulia Bakhtra & Pramudita, 2015).

Standardization of sodium EDTA titer solution

The standardization of 0.01 M Na₂-EDTA solution is carried out by pipetting 0.1 mg of calcium carbonate, then putting it into a 250 mL erlenmeyer, then adding 40 mL of distilled water and 10 mL of pH 10 buffer solution and adding an EBT indicator, then titrating with 0.01 M Na₂-EDTA solution, until a color change occurs and then recording the Na₂-EDTA titration volume used (Adriani et al., n.d. 2019).

Determination of Fe Levels in Purple Sweet Potato Leaf Samples and Sangobion Medicine

Each sample of 150 mL was put into an erlenmeyer and labeled, added 25 mL of distilled water and 3 mL of 2 N HCl, added 15 mL of pH 10 buffer solution and enough EBT indicators. Then titrated with Na₂EDTA standard solution until there is a color change from burgundy to dark blue. Titration is done 3 times repetition (Dinni Aulia Bakhtra & Pramudita, 2015).

Data Analysis

Based on the data obtained from the titration results, an analysis was carried out to determine the iron (Fe) content in purple sweet potato leaf extract using the complexometric method with Na₂EDTA reagent. The data were analyzed using a descriptive statistical approach including the calculation of the average, standard deviation (SD) and coefficient of variation (CV) to determine the measurement precision (Muliani et al., 2022).

RESULTS & DISCUSSION

Results

This study aims to determine the levels of iron (Fe) in purple sweet potato (*Ipomoea batatas*) dun extract using the complexometric method with EDTA as a titrant and Erichrome Block T (EBT) as an indicator. Sangobion drug was used as a positive control because it has been known to contain a certain amount of iron.

Extraction Results

Calculation of yield:

$$\begin{aligned} \text{Yield (\%)} &= \frac{\text{viscous extract weight (grams)}}{\text{Initial simplisia weight (grams)}} \times 100\% \\ \text{Yield (\%)} &= \frac{(371.9 \text{ g})}{(250 \text{ g})} \times 100\% \\ &= 148\% \end{aligned}$$

Table 1. Standardization of Na2EDTA Solution Using CaCO3

Replication	Na2EDTA Titer Volume (mL)	CaCO3 Weight (g)	Na2EDTA Concentration (M)
I	13,9 mL	0,1	0,07
II	13,9 mL	0,1	0,07
III	14,0 mL	0,1	0,07

Table 2. Determination of Iron content in Purple Sweet Potato Leaf Extract Samples (*Ipomoea batatas*)

Replication	Na2EDTA Titer Volume (mL)	Na2EDTA Concentration (mol/L)	MFe (g/mol)	Sample Volume	Fe Content (mg/mL)
I	7,5	0,07	55,85	25	29,34
II	7,3	0,07	55,85	25	28,58
III	7,4	0,07	55,85	25	28,96

Table 3. Determination of iron content in sangobion drug samples

Replication	Na2EDTA Titer Volume (mL)	Na2EDTA Concentration (mol/L)	MFe (g/mol)	Sample Volume	Fe Content (mg/mL)
I	19,5	0,07	55,85	25	29,34
II	19,4	0,07	55,85	25	29,14
III	19,6	0,07	55,85	25	29,55

Table 4. Data analysis of iron (Fe) determination results

Sample	Na2EDTA volume (mL)	Fe content (mg/mL)	Mean (mg/mL)	SD	CV (%)
Purple sweet potato leaf extract	7,5 ; 7,3 ; 7,4	29,34 ; 28,58 ; 28,96	28,96	0,38	1,31
Sangobion	19,5 ; 19,4 ; 19,6	29,34 ; 29,14 ; 29,55	29,34	0,20	0,68

Description:

1. Na2EDTA volume (mL): The amount of Na2EDTA solution used to titrate the sample in each replicate.
2. Fe content (mg/mL): iron concentration calculated based on the titration results using Na2EDTA solution.
3. Average (mg/mL): The average value of Fe content from three replications for each sample.
4. SD (Standard Deviation): describes the degree of dispersion of data from the average.
5. CV (%): Coefficient of variation; the smaller the value, the more precise the measurement results.

Discussion

Complexometric titration is a titration based on the formation of complex compounds between cations and complex-forming substances. As a complex-forming substance that is widely used in complexometric titration, namely sodium ethylenediamine tetracetate (Na2EDTA) salt (Harpolia, 2017). Na2EDTA has the advantage that one of them can form complexes when reacted with metal ions and can also react quickly with many metal ions. The purpose of this study was to determine the level of iron (Fe) in purple sweet potato (*Ipomoea batatas*) leaf extract samples using the complexometric titration method. In this study the samples used were purple sweet potato leaves (*Ipomoea batatas*) and sangobion drug as a positive control.

Purple sweet potato (*Ipomoea batatas*) leaves were chosen as the object of research because they are known to have a high content of nutrients, including important minerals such as iron (Fe). Iron is an essential element in the human body that plays an important role in the formation of hemoglobin, myoglobin, and various enzymes involved in oxidative metabolic processes. Iron deficiency is one of the main causes of anemia, especially in women of childbearing age, children, and adolescents in developing countries.

Purple sweet potato leaves (*Ipomoea batatas*) are one part of the plant that is rich in bioactive compounds such as anthocyanins, flavonoids, polyphenols, vitamin C, and minerals including iron (Fe). The content of these compounds makes purple sweet potato leaves have various health

benefits, especially as an antioxidant that can ward off free radicals and prevent damage. The antioxidant role of anthocyanins is important in the prevention of degenerative diseases such as cardiovascular disease, diabetes mellitus, and cancer triggered by oxidative stress (Li et al., 2019). In addition, the iron content in purple sweet potato leaves is useful to help the formation of hemoglobin, so it has potential in the prevention of iron deficiency anemia.

Some studies have also shown that purple sweet potato leaf extract can help lower cholesterol levels and improve immune function. The anti-inflammatory activity of its flavonoids may also contribute to reducing the risk of chronic inflammation, a risk factor for many chronic diseases. Thus, consumption or utilization of purple sweet potato leaf extract not only provides nutritional benefits, but also has potential as a preventive agent for degenerative diseases, anemia, and other metabolic disorders. This potential supports the use of purple sweet potato leaves as raw materials in the development of phytopharmaceutical preparations.

Making *simplicia* aims to produce dry material with low water content so that it is stable during storage. Purple sweet potato leaves were washed to remove impurities, cut, then dried in an oven until the moisture content was <10%. From this process, 250 g of dry *simplicia* yield was obtained. Extraction was carried out by maceration method using 96% ethanol which effectively dissolves polar and semi-polar compounds, including flavonoids. The filtrate from maceration was evaporated with a rotary evaporator at low temperature to obtain a yield of 371.9 g of extract. The good quality of *simplicia* and extracts greatly affects the results of Fe content analysis, because low water content prevents the degradation of active compounds and proper extraction methods maximize mineral solubility.

The complexometry method is one of the volumetric titration techniques used for metal ion analysis using EDTA (ethylenediaminetetraacetate) solution as a titrant. EDTA is a hexadentate ligand capable of forming stable complexes with metal ions. The titration process takes place by binding iron ions in the sample solution by EDTA until a colorless complex is formed. The indicator used in this method will show a color change at the equivalent point, indicating that all Fe ions have reacted (Wahyuni, 2024).

This method was chosen because it has a number of advantages, including a relatively simple procedure, low cost, and no need for sophisticated instruments. In addition, this method is able to provide fairly accurate results, provided that the pH condition of the solution is kept within the optimal range and the indicator is chosen appropriately. Another advantage of this method is that it is more environmentally friendly because it does not use organic solvents or harmful chemical reagents commonly found in spectroscopic or chromatographic methods. By considering all these aspects of efficiency, ease of use, accuracy, and environmental sustainability, it can be concluded that the complexometry method is still one of the right and feasible choices for determining the levels of metal ions such as iron in natural materials.

In this study, EDTA (ethylenediaminetetraacetate) solution was used as the main titrant in the complexometric method to determine the iron content in purple sweet potato leaf extract. The choice of EDTA is based on its highly effective ability to form stable complexes with metal ions, especially three-valence metal ions such as Fe. EDTA is a hexadentate ligand that has six electron donor sites, so it can form one-to-one complexes with metal ions in a very stable form. Under certain pH conditions set using buffers, EDTA will bind to iron ions to form colorless complexes. This process is the basis of quantitative measurement in complexometric titration.

The main purpose of using EDTA is to capture free iron ions in the sample specifically and accurately, so that the amount of iron content contained in the extract can be known. Compared to other reagents, EDTA has the advantage of not being easily degraded, soluble in water, and able to be used for various types of metal ions in a wide pH range. In addition, EDTA also produces a clear titration endpoint when used with certain metal indicators, making it easier to determine the volume of titrant needed to reach the equivalence point. The reliability of EDTA in forming stable complexes, as well as its ease of use in titration systems, are the main reasons this method was used in this study to measure iron levels efficiently and accurately.

At the stage of determining the iron content in the sample, a color change reaction has occurred. This color change occurs due to the complexometric reaction between metal ions and EDTA (Ethylenediaminetetraacetic acid) titrant solution under certain pH conditions with the help of Erichrome Block T (EBT) indicators. Initially, the EBT indicator forms a purple complex in the sample solution. However, with the addition of EDTA, there is a color change in the solution.

In this study, the iron content obtained from purple sweet potato leaf extract was 28.96 mg/mL, while the positive control in the form of Sangobion preparation produced levels of 29.34 mg/mL.

Based on the classification range of iron levels according to WHO, iron content is declared high if >25 mg/mL, medium if 10-25 mg/mL and low if <10 mg/mL. Thus, the iron content in purple sweet potato leaf extract is in the high category, which is almost equivalent to the iron content in the positive control product. This suggests that purple sweet potato leaves have great potential as a natural source of iron.

This research is reinforced by the results of a previous study conducted by Ranteallo et al. (2023), which examined the heavy metal content in purple sweet potato leaves using the ICP-MS (Inductively Coupled Plasma Mass Spectrometry) method. In that study, the iron content obtained reached 22,014 ug/100g, and this result is consistent with the content obtained in the current study using the complexometric method. ICP-MS is known as a metal analysis method with very high sensitivity, and can even detect levels on the nanogram scale. However, this method requires expensive equipment and complex operation.

The results of this study indicate that the iron (Fe) content in Sangobion tablet samples analyzed using the complexometric method (EDTA) obtained an average of 29.35 mg/mL. The complexometric method works based on the formation of a stable complex between Fe ions and EDTA ligand at a certain pH, where the end point of the titration is observed using an EBT indicator. This value reflects the total Fe ions that react with EDTA without distinguishing the form of oxidation. When compared with the results of research by Kurniawati & Sugiarto (2016) which determined Fe (II) levels in Sangobion tablets using the UV-Vis spectrophotometric method with 1,10-phenanthroline reagent, Fe (II) levels of 99.6 mg (23.7%) were obtained for preparation with wet destruction and 26.69 mg (6.36%) for preparation with dry destruction. This difference is quite significant, both in terms of the value of levels and units used.

This is an important finding as it shows that purple sweet potato leaf extract has a competitive iron content when compared to commercial blood supplement products. Although iron in natural plants may not be completely in its free form, the extraction process is able to release most of the metal content so that it can react in the titration process.

CLOSING

Based on the results of research that has been carried out using the complexometry method, it can be concluded that purple sweet potato leaf extract (*Ipomoea batatas*) has a fairly high iron content, with an average level of 28.96 mg/mL, while Sangobion drug as a positive control has a level of 29.34 mg/mL. The relatively small difference in levels indicates that purple sweet potato leaf extract has the potential to be a competitive alternative natural iron source. The limitation in this study is that it only uses one type of purple sweet potato leaf sample from a particular location, so the results obtained do not necessarily represent all variations in iron content in purple sweet potato plants from other regions.

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