JOURNAL OF TROPICAL PHARMACY AND CHEMISTRY
https://jtpc.ff.unmul.ac.id
Volume 10.1

Research Article

Proximate and Iron (Fe) Analysis of Moringa Leaf Simplicia (Moringa oleifera Lam.) under Different Drying Temperatures

Siti Jubaidah[1*], Atika Ramadhaniah[1], Risa Supriningrum[1]
[1]Study Program of Pharmacy Sekolah Tinggi Ilmu Kesehatan Samarinda
Email : ida_mapro13@yahoo.com

Abstract

Moringa (*Moringa oleifera* Lam.) is a plant rich in nutrients, including protein, iron, and vitamin C. Moringa leaves have a higher iron content than other plants and a vitamin C content that can increase iron absorption in the body. The drying temperature of herbal medicine can affect the levels of certain substances or compounds contained therein. This study aims to determine the results of proximate analysis and iron content in moringa leaf simplisia based on variations in drying temperature using the ICP-MS method, namely at temperatures of 45°C, 50°C, and 55°C. The objects of this study are the drying shrinkage, total ash content, and iron content of moringa leaf simplisia with variations in drying temperature. The research stages included plant identification, simplisia preparation, determination of drying shrinkage, total ash content test, qualitative Fe analysis, and iron content analysis.. The results showed that the drying shrinkage test of moringa leaf simplisia at all temperatures met the requirement of <10%. The highest total ash content was found at 50°C at 11.91%, and the highest Fe content was obtained at 55°C at 2.0226 mg/L. Statistical analysis showed significant differences in drying shrinkage at a significance level of 0.05, total ash content at 0.046, and iron content at 0.027.

Keyword : moringa leaves, drying temperature, proximate analysis, Iron, ICP- MS

Accepted: 24 March 2026
Approved: 29 March 2026
Publication: 31 March 2026

Citation : S. Jubaidah, A. Ramadhaniah, and R. Supriningrum, “Proximate and iron (Fe) analysis of moringa leaf simplicia (Moringa oleifera Lam.) under different drying temperatures,” Journal of Tropical Pharmacy and Chemistry, vol. 10, no. 1, pp. 1–9, Mar. 2026, doi: 10.30872/jtpc.v10i1.324.

Doi:10.30872/jtpc.v10i1.324

1 Introduction

Indonesia is a rich country will diversity biological. Various types of plants that grow have the potential to provide benefits to human life, one of which is Moringa. In Indonesia, Moringa plants are spread from Sumatra, Java, Kalimantan, Sulawesi, NTT, NTB and others[1]. Moringa (*Moringa oleifera* Lam.) is a plant that grows easily in tropical areas such as Indonesia and various other regions. tropical other in world [2]. Leaf Moringa is rich in nutrients such as vitamin C, vitamin A, calcium, substance iron (Fe), And protein [3]. Moringa leaves contain very complete active compounds compared to other plants, with various benefits such as reducing inflammation, controlling blood sugar, fighting bacteria, and protecting cells from damage [4]. Moringa is said to be the most economical plant and contains excellent nutritional value so it can be used as an alternative in overcoming nutritional problems [5].

Moringa leaves have the highest iron (Fe) content compared to other plants, namely 17.2 mg/100 grams. spinach as big as 8.3 mg/100 grams, cassava leaves are 7.6 mg/100 grams, katuk leaves are 6.25 mg/100 grams, water spinach are 2.5 mg/100 grams [6]. Mun'im *et al* ., (2016) stated that the protein and fatty acid content amino in leaf moringa Also Functions in blood cell proliferation and differentiation. The vitamin C content in moringa leaves also increases iron absorption. in body. Substance iron play a role important in the body because it helps the blood's ability to carry oxygen to all parts of the body [7].

The iron content of moringa leaves, based on drying methods, showed significant differences. Natural drying (air-dried) showed the highest iron content, at 1.5%. 11.41 mg %, whereas Drying using natural methods (sunlight) shows the highest Fe content. low as big as 4.95 mg% with using the Atomic Absorption Spectrophotometry (AAS) method [8].

One of the important parameters in assessing the quality of simple drugs is proximate analysis. Objective analysis proximate is to find out the main components of a material food. Analysis proximate includes water, ash, fat, protein, and carbohydrate content. In this study, only drying loss and total ash content tests were conducted because both are standards for the Indonesian Herbal Pharmacopoeia and Indonesian Materia Medica. Drying loss is important to determine the water content that affects the stability of the simplicia, shelf life and prevents microbial growth, while the total ash content indicates the internal and external mineral content that can be an indicator of the quality and purity of the simplicia [9]. Drying simplicia aims to reduce the water content and can inhibit enzymatic reactions in the simplicia material, so that simple ingredients can stored in time years old [10]. Drying leaf Moringa is needed to prevent damage and extend shelf life. The workmanship not enough appropriate can influence properties of materials, such as aroma, color, texture, and physical changes [11] .

Research by Murdiana *et al.,* (2022) tested the iron content of dried moringa leaves using the Absorption Spectrophotometry method. Atom (SSA) on temperature drying 50°C during 48 O'clock own level substance iron (Fe) of as high as 244.42 mg/kg. In a study by Amoah *et al* . (2024), it was reported that moringa leaf extract using the AAS method had a total iron content of 133.72 mg/kg. AAS is a widely used method for analyzing iron levels due to its ability to measure the concentration of various elements, including Fe, with principle absorption light by atoms in sample [12]. This method has several limitations, such as its inability to analyze isotopes and its lack of effectiveness for multi-element analysis. in a way simultaneous. Along with developments in the pharmaceutical industry, analytical methods Which more advanced, like *Inductively Coupled Plasma-Mass Spectrometry* (ICP-MS), is increasingly being used for the analysis of chemical compounds.

ICP-MS is a more sensitive analytical technique and can measure Fe concentrations in very small amounts with high accuracy [13]. ICP-MS has several advantages, including high sensitivity in detecting Fe content. metal in a way multi-element, Faster analysis time, less sample required, capable of analyzing liquid samples at very low concentrations, down to ppt (*parts per trillion*) level.The aim of this study was to determine the results of proximate analysis and iron content contained in Moringa leaf simplicia with variations in drying temperature using the ICP-MS method.

2 Methods

2.1 Tool And Material

Tools used in this study is aluminum foil, 60 mesh sieve, tray, 50 mL beaker glass (*pyrex* ®), blender (*Philips* ®), desiccator, hot plate (*Lab Tech* ®), glassware, crucible porcelain, volumetric flask 10 mL (*pyrex* ®), spirit lamp, *microwave digestion (Anton Paar* ®), analytical balance (*Ohaus*®), oven (*Mammert*®), pipette, horn spoon, spatula, ICP-MS spectrophotometer (*Thermoscientific* ®), test tube, vessel tube, electric furnace (*Mammert* ®).

The materials used in this study were Moringa leaf simplicia, concentrated nitric acid (HNO 3), distilled water, distilled water, $Fe(NO_3)_3$, $K_3[Fe(CN)_6]$ solution, $K_4[Fe(CN)_6]$ solution and 10% NaOH.

2.2 Research Stages of Data Collection Sample

Moringa leaves are obtained from Bangun Rejo Village, Tenggarong Seberang District, Kutai Kartanegara Regency.

2.3 Determination Plant

This determination is carried out to ensure that the plants taken are correct. is moringa (*Moringa oleifera* Lam.), then done determination in Tropical Forest Ecology and Biodiversity Conversion Laboratory, Faculty of Forestry, Mulawarman University, Samarinda City.

2.4 Making Simple ingredients

Done collection sample 3 kg of moringa leaves, then divided into three group that is each 1 kg based on different drying temperature treatments and wet sorting, which separates undesirable plant parts, such as leaf stalks, twigs, and yellow leaves. The moringa leaves are then washed with running water and drained. The drying method used in this study was tool dryer (oven) with variations in drying temperature of 45 °C, 50 °C, and 55 °C. After the dry simplicia is carried out dry sorting to separate the simplicia from other impurities that are still left in the simplicia. The simplicia is then ground using a blender. Then the simplicia powder is sieved using a 60 mesh sieve, the purpose of 60 mesh sieving is to reduce the size of the simplicia.

2.5 Determination Loss On Drying (LOD)

Weigh 1-2 grams of powdered simplicia into a shallow, closed weighing bottle. The weighing bottle used is first heated for 30 minutes at 105 °C and then tared. simple ingredients flattened in weigh the bottle by shaking it. Then, deep closed state bottle opened, drying is carried out at a temperature of 105°C until constant weight, namely two consecutive weighings No more from 0.25% with an oven. Before drying in the oven, the bottles are closed and allowed to cool in desiccator during 15 minute. The drying loss alculation was carried out using the following formula Veninda *et al* ., (2023):

$$\text{Loss On Drying} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Final Weight}} \text{ x } 100\%$$

2.6 Test Level Total Ash

Each simple powder was weighed as much as 2 g, put into a porcelain crucible of known weight and then calcined. above a spirit lamp and cooled in a desiccator and then weighed. The porcelain crucible was placed in an electric furnace at a temperature of 550 °C for 4 hours until complete ashing. The ashing results were cooled in a desiccator. Then weighed until constant weight [14]. Ash content is calculated using the equation:

$$\text{Level Ash (\%)} = \frac{\text{Ash Weight (g)}}{\text{Initial Sample Weight (g)}} \text{ x } 100\ \%$$

2.7 Analysis Qualitative Iron (Fe) Sample Preparation

Weighed 0.4 g of simple powder leaf Moringa, Then was put into a 100 mL beaker and 10 mL of HNO_3 was added . The mixture was then heated on a hot plate for 1 hour until a few milliliters remained and the solution became clear. Next, the solution was filtered and the filtrate was put into a 10 mL volumetric flask. Aquadest was added up to the mark and homogenized [15].

2.8 Analysis Qualitative

Qualitative analysis of iron (Fe) according to Svehla (1985 and 1990) is as follows:

1) The prepared sample was pipetted as much as 3 drops into a test tube, then $K_3[Fe(CN)_6]$ solution was added. 1% as much as 3 drops. If a blue color forms, it means it contains Fe.
2) Drops of the sample were pipetted into a test tube, then 3 drops of 5% $K_4[Fe(CN)_6]$ solution were added. If a dark blue color forms, it is positive for Fe.
3) Pipette 3 drops of the sample into a test tube, then add 3 drops of 10% NaOH solution. If a precipitate forms white Which oxidized becomes a dirty green sediment, then it is stated contain ion iron (ii) or Ferro (Fe^{2+}). Meanwhile, if a reddish brown precipitate forms, then stated contain ion iron (iii) or Ferry (Fe^{3+}).

2.9 Iron Analysis Using *Inductively Coupled Plasma-Mass Spectrometry* (ICP-MS) Method Preparation Sample

The sample preparation stages according to Creed *et al.,* (1994) with modifications are:
A total of 0.5 grams of moringa leaf crude extract was weighed. The sample was then placed in a vessel tube, and 5 mL of HNO_3 was added to the tube in a fume hood to prevent exposure to harmful acid vapors. The vessel tube was then tightly closed to prevent leakage during the digestion process. The sample tube containing the sample and HNO_3 solution was placed in *a microwave digestion chamber* and heated at 220 °C for 30 minutes.

2.10 Making Solution Standard Fe

According to Harahap (2017), the stages of iron analysis are:

1) Preparation of standard solution $Fe(NO_3)_3$ 100 ppm. Pipette 5 ml solution stock Fe 1000 mg/L and placed in a 50 mL volumetric flask. Next, the solution was diluted with distilled water until it reached the mark and shaken until homogeneous.
2) Making solution standard Fe 10 mg/L. Pipette 5 ml of standard Fe 100 mg/L solution, then put it into In a 50 mL measuring flask, the solution is then diluted with distilled water to the mark and shaken until homogeneous.
3) Making solution series standard Fe 0.05 ; 0.1 ; 0.15 And 0.2 mg/L. Pipette each 0.25 mL, 0.5 mL, 0.75 mL, And 1 mL solution Fe standard 10 mg/L and put into a 50 mL measuring flask, diluted with distilled water until line sign And shaken until the solution is completely homogeneous.

2.11 Determination Calibration Curve

Standard solutions of Fe 0.05; 0.1; 0.15 and 0.2 mg/L were prepared and put into the autosampler and injected. into the system ICP-MS. Measured For get value absorbance And count equality the linearity line in the equation $y = bx + a$, so that the Fe concentration of the sample solution is obtained.

2.12 Analysis Substance Iron (Fe)

The stages of iron analysis according to Sudrajat *et al.,* (2024) with modifications are:
Sample liquid entered into the volumetric flask measuring 50 mL, then added internal solution standard until reach sign boundary line. The solution is shaken until homogeneous. After that, the prepared sample is placed into a sample tube and injected into the system and ICP-MS through a tube to the plasma and the sample is processed to obtain the concentration results. substance iron in the sample. According to

the National Standardization Agency (BSN) (2004), the Fe content is calculated using the following equation formula:

Analysis Metal (mg/L) = $C \times F_p$

Information :

C : Concentration results measurement (mg/L) F_p : Dilution factor

2.13 Analysis Data

Data analysis in this study used descriptive methods, namely qualitative and quantitative data based on the effect of drying temperature on iron content using the ICP-MS method. Quantitative data were analyzed using the *Kruskall-Wallis statistical test* if the data were not normally distributed and analyzed using the *One Way ANOVA statistical test* , if the data were normally distributed with the aim of determining whether variations in drying temperature provided a significant difference in iron content in the sample.

3 Results And Discussion

Results determination show that The sample used in this study was the Moringa plant (*Moringa oleifera* Lam.) from the Moringaceae family. A total of 3 kg of moringa leaves were collected, Then shared become Three groups of 1 kg each were divided into three groups based on different drying temperatures and wet sorting was carried out, namely separating unwanted plant parts, such as leaf stalks, twigs, and yellow leaves. The moringa leaves were then washed with running water until clean **.** Washing This aim to remove soil and other dirt from the moringa leaves. The first treatment was oven-dried at 45 ºC for 16 hours, the second at 50 C for 13 hours, and the third at 55 ºC. for 9 hours.

Drying of simple ingredients aims to reduce the water content and can inhibit enzymatic reactions in simple ingredients, so that simple ingredients can stored for a long time. The dried simplicia is then dry sorted to separate foreign objects such as unwanted plant parts and other impurities. Still There is And left behind on dry simplicia [16].The dried moringa leaves are then ground using a blender until they obtain powder form, then sieved using a 60 mesh sieve. The purpose of 60 mesh sieving is to reduce the particle size and expand the powder surface. The finely ground Moringa leaf simplicia powder was then weighed and the final weight obtained at a drying temperature of 45 ºC was 151.00 g, at a drying temperature of 50 ºC it was 217.50 g, and at a drying temperature of 55 ºC amounting to 203.91 g.

3.1 Results of Loss Of Drying Moringa Leaf Simplicia

The purpose of determining drying loss is to provide a maximum limit (range) for the amount of compound lost during the drying process. The drying loss parameter is basically is measurement remainder substance after drying on temperature 105 ºC until it reaches a constant weight which is stated as mark percent. In matter special (if the material does not contain volatile/essential oils and volatile organic solvents) is identical to the water content, namely the water content because it is in the atmosphere/open air environment [17]. The average drying shrinkage value of Moringa leaf simplicia can be seen in table 1.

Table 1. Loss Of Drying Leaf Simplicia Moringa

No	Temperature	Average Level ± SD (%)
1	45 º C	8.16% ± 0.1212
2	50 º C	7.73% ± 0.0570
3	55 º C	7.45% ± 0.0888

Based on table 1, it was obtained that the average drying shrinkage of leaf simplicia was moringa on temperature 45 º C as big as 8.16%, temperature 50 º C as big as 7.73%, And temperature 55 º C is

7.45%. The drying shrinkage requirement for simples is ≤10% [18]. The drying shrinkage test results met the established requirements. This test was conducted to determine the maximum amount of compound lost during the drying process.

The results of the statistical analysis of the drying shrinkage of Moringa leaf simplex showed that the data were normally distributed and homogeneous. The ANOVA test gave a significance value of 0.000 (P<0.05), so it was continued with a *Post Hoc Test* to determine the location difference between drying temperature groups. Based on the results of *the Post Hoc Test* conducted, it was found that there was a significant difference between each pair of temperature groups ($p < 0.05$). This indicates a significant difference among the three drying temperatures on the value shrinkage drying simple ingredients leaf Moringa. That is, change temperature drying significantly affects the amount of weight loss of Moringa leaf simplicia after the drying process.

3.2 Total Ash Content Test Results of Moringa Leaf Simplex

Determination of total ash content aims to provide an overview of the internal and external mineral content contained in the simplex originating from the initial process until the formation of the simplex [19] . The results obtained from testing the total ash content of the simplex leaf moringa can seen on Table 2 as follows:

Table 2. Level ash Total Leaf simplicial Moringa

No	Temperature	Average Level ± SD (%)
1	45 º C	10.87 ± 0.7564
2	50 º C	11.91% ± 0.0173
3	55 º C	9.76% ± 0.1802

Based on table 3 above, the results of the total ash content test of moringa leaf simplicia in the treatment temperature drying 45 ºC the average value obtained was 10.87% and a drying temperature of 55 ºC of 9.76%. These results meet the requirements set by Materia Medika Indonesia (MMI). Edition V (1989), namely < 11%. Matter This is in line with research conducted by Tjalo et al ., (2024), which reported that the total ash content value at a drying temperature of 45 ºC was 10.31% And The drying temperature at 55 ºC was 10.26%. Despite the differences in values, both results remain within the range set by the MMI standard. This indicates that drying temperatures below 60 ºC can maintain the natural mineral content without causing significant damage.

Results of total ash content of Moringa leaf simplicia on temperature drying 50 ºC an average value of 11.91% was obtained, which is higher than the drying temperature 45 ºC And 55 ºC. Study conducted by Tafu and Jideani (2022) [25], drying of simple herbs at a temperature of 50 ºC resulted in an ash content of 11.88%. High ash content in simple herbs indicates the presence of excess inorganic substances, both from natural minerals and contamination outside like land dust, And sand [20].Matter This can reduce purity, quality, and potentially affect active compounds due to interactions mineral with metabolit secondary can inhibit absorption.

The Shapiro-Wilk normality test showed that the total ash content data was not normally distributed (sig < 0.05), so the analysis was continued with the Kruskal-Wallis test . This test produced a significance value of 0.046 ($P < 0.05$), which indicates a significant difference in the total ash content of Moringa leaf simplicia at drying temperatures of 45°C, 50°C, and 55°C. With thus, variation temperature drying has a significant effect on the ash content of Moringa leaf simplicia.

3.2 Results Analysis Qualitative Fe

Analysis qualitative Fe aims to identify existence ion iron in the form of ferrous (Fe^{2+}) in a sample through the formation of a characteristic color or precipitate. In this study, the test was carried out using potassium ferricyanide reagent $K_3[Fe(CN)_6]$, potassium ferrocyanide $K_4[Fe(CN)_6]$, and NaOH solutions of various concentrations according to the Svehla method (1985). The difference between the iron ion forms Fe^{2+} and Fe^{3+} is that Fe^{2+} is more easily absorbed by the body through the digestive tract compared to Fe^{3+}. Fe^{3+} must first be reduced to Fe^{2+} by the enzyme ferric reductase on the surface of intestinal cells before it can be absorbed. After absorption, iron in the form of Fe^{2+} is then converted back to Fe^{3+} for storage or transport in the body. The results of the qualitative iron analysis are presented in Table 3.

Based on table 4, the results of the qualitative analysis of Fe show that no distinctive color or precipitate was formed in all treatments, either with the reagent $K_3[Fe(CN)_6]$ 1%, $K_4[Fe(CN)_6]$ 5%,

and 10% NaOH solution. In the 1% $K_3[Fe(CN)_6]$ reagent and the 5% $K_4[Fe(CN)_6]$ reagent showed negative results indicated by the absence of blue precipitate, the results showed a light green and bluish green solution. In the 10% NaOH reagent also showed negative results indicated with No existence sediment blue, results show solution colored yellow.

Table 3. Analysis Qualitative Fe

Reagent	Library Information	Control Positive	Sample	Result
$K_3[Fe(CN)_6]$ 1%	Sediment blue	Sediment blue	Formed solution blue precipitate	(+)
$K_4[Fe(CN)_6]$ 5%	Sediment blue	Sediment blue	Formed solution blue precipitate	(+)
NaOH 10%	Precipitate dirty green If Fe^{2+} and sediment reddish brown Fe^{3+}	Yellow	Yellow	(-)

Information :

(+) : Contain Fe
(-) : No contain Fe

This indicates that the sample did not detect the presence of free Fe ions. in form soluble Fe^{2+} in a way visual. The absence of color or sediment formation can caused by by concentration Fe in simple terms Which very low, so that not enough react For form colored complex. The iron in moringa leaves is generally in the form of organic complexes such as ferritin or bound to proteins and other phenolic compounds which is not easy react with inorganic simple as $K_3[Fe(CN)_6]$ or $K_4[Fe(CN)_6]$ [21]

3.3 Results of Iron (Fe) Analysis Using the ICP-MS Method

Analysis of iron content in Moringa leaf simples study I mi done using the method ICP-MS. ICP-MS is analytical technique that has the ability to measure analytes in multiple elements, high sensitivity, and shorter analysis time fast, amount sample Which less is needed, able to analyze Fe at concentrations Which very low, until ppt level (*parts per trillion*). The working principle of ICP-MS is to change the atoms of the elements in the sample into ion form, then transmitted into *the analyzer* to be separated based on the mass to charge ratio (m/z) and so on [22]. The results obtained in the test level Fe simple ingredients leaf moringa.

Table 4. Results Analysis Iron Using the ICP-MS Method

No	Temperature	Average Level ± SD (mg/L)
1	45 °C	1.2287 ± 0.0081
2	50 °C	1.9613 ± 0.0028
3	55 °C	2.0226 ± 0.0027

In this study, sample preparation was carried out using the wet destruction method. Wet destruction is a separation process. compounds organic in a sample that is added using strong acid. Wet destruction aims to break the chain bonds between metal compounds Which will analyzed with organic compounds. The destruction process is complete if the solution is clear [23]. Wet destruction is carried out using a *microwave digestion device* at a temperature of 220 C for 30 minutes. A sample of Moringa leaf simplicia is weighed at 0.5 g and then added to in each *vessel* and added 5 mL of concentrated HNO_3 in fume hood. HNO_3 is a strong acid solvent which is often used as solvent in process destruction which aims to speed up the destruction process. The addition of acid solvents in the destruction process as an oxidizer because Fe can oxidized with Good by HNO_3 [24].

Next, after the sample preparation process is complete, a concentration series is made. solution Fe Which made from 1000 ppm standard solution then made into a series with a number of concentration that is 0.05; 0.1; 0.15 and 0.2 mg/L. Measurements were taken to obtain a correlation value of 0.9994. Then, analysis was performed. level substance iron with using ICP-MS equipment on sample solutions.

The results of the study showed that the iron content in Moringa leaf simplicia increased with increasing drying temperature. At a drying temperature of 45°C, the iron content was 1.2287 mg/L, increasing at a drying temperature of 50°C to 1.9613 mg/L, and reaching the highest value at a drying temperature of 55°C of 2.0226 mg/L. The high iron content at 55°C is due to the optimal drying process causing a reduction in water content without damaging the structure of Fe-binding compounds, so that Fe is more easily detected after the destruction and analysis process. Research conducted by Amoah et al. (2024) on the analysis of total and extractable iron levels in various green vegetables in Ghana using the SSA method with concentrated HNO_3 and HCl solutions showed that the Fe content of Moringa leaf extract was 133.72 mg/kg. This indicates that the ICP-MS method has higher sensitivity, allowing it to provide more detailed results in determining metal elements such as iron in Moringa leaf simplicia.

The results at a drying temperature of 45°C showed lower Fe levels. This may be due to the slower drying process at lower temperatures, where drying generally takes longer, resulting in water content in Moringa leaves not being reduced optimally. Research by Razzak et al. (2021) supports these findings, reporting that increasing drying temperature can increase mineral content, including iron, because water in plant tissue is lost more quickly and previously bound minerals are released more easily. Thus, drying temperature affects the release and availability of iron in Moringa leaves.

The Kruskal–Wallis test obtained a significance value of 0.027 ($P < 0.05$), indicating a significant difference in the iron content of Moringa leaf simplicia dried at different temperatures. Overall, these results indicate that variations in drying temperature influence the total ash content and iron levels of Moringa leaf simplicia.

4 Conclusion

Based on the results of research conducted on Moringa leaf simplicia, it can be concluded that the proximate analysis showed that the Moringa leaf simplicia at all drying temperature treatments (45°C, 50°C, and 55°C) met the drying loss requirements of <10%. The total ash content was within the limits set by MMI (1989), which was <11%, except at 50°C, which had a total ash content of 11.91% ± 0.0173. This value was higher than the total ash content at 45°C of 10.87% ± 0.7564 and at 55°C of

9.76% ± 0.1802. High ash content may indicate contamination from inorganic materials such as soil, sand, or other minerals. Furthermore, the results of the analysis of iron content using the ICP-MS method showed that a drying temperature of 55°C produced a high iron content, with the highest iron content of 2.0226 mg/L ± 0.0027 compared to temperatures of 45°C and 50°C.

5 Declaration

5.1 Conflict of Interest

The authors declare that there is no conflict of interest regarding the research, authorship, or publication of this article

5.2 Funding Statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. All research expenses were fully borne by the authors.

6 Bibliography

[1] H. Hamzah and N. R. Yusuf, "Analysis of iron (Fe) content in Moringa oleifera leaves grown at different altitudes in Baubau City," J. Chem. Res., vol. 6, no. 2, pp. 88–93, 2019.
[2] B. Y. D. Dani, B. F. Wahidah, and A. Syaifudin, "Ethnobotany of Moringa oleifera in Kedungbulus Gembong Village, Pati," Al-Hayat: J. Biol. Appl. Biol., vol. 2, no. 2, pp. 44–52, 2019.
[3] N. Ahmad and N. Ismawati, Moringa Leaves: Stunting Prevention and Anti-Hyperglycemia. East Kalimantan: Borneo Novelty Publishing, 2021, pp. 14–16.
[4] A. W. Ningsih, M. N. Azizah, and B. Sinaga, "Standardization of Moringa oleifera leaf simplicia using a food dehydrator," J. Pharm. Herb. Med., vol. 5, no. 1, pp. 76–85, 2022.
[5] X. Kou, B. Li, J. B. Olayanju, J. M. Drake, and N. Chen, "Nutraceutical or pharmacological potential of Moringa oleifera," Nutrients, vol. 10, no. 3, p. 343, 2018, doi: 10.3390/nu10030343.
[6] A. Pratiwi, W. N. Nofita, and D. A. Winahyu, "Comparison of iron (Fe) levels in Moringa oleifera leaves from different altitudes using AAS," J. Pharm. Anal., vol. 6, no. 2, pp. 102–108, 2021.
[7] N. R. Putri, I. A. D. Satiti, and N. D. Jayanti, "Effect of Moringa oleifera jelly candy on hemoglobin levels in anemic adolescent girls," J. Kesehat. Tambusai, vol. 5, no. 4, pp. 1075–1084, 2024.
[8] Z. Irwan, "Nutritional composition of Moringa oleifera leaves based on drying methods," J. Kesehat. Manarang, vol. 6, no. 1, pp. 69–77, 2020.
[9] I. D. Putra, A. Dharmayudha, and L. M. Sudimartini, "Identification of chemical compounds in ethanol extract of Moringa oleifera leaves," Indones. J. Vet. Med., vol. 5, no. 5, pp. 464–473, 2016.
[10] D. Handoyo, L. Yunita, and M. E. Pranoto, "Effect of drying temperature on neem (Azadirachta indica) leaf simplicia," J. Farmasi Tinctura, vol. 1, no. 2, pp. 45–54, 2020.
[11] A. Taufan, "Experimental and mathematical modeling of drying Moringa oleifera leaves," J. Ind. Technol. Res., vol. 14, no. 2, pp. 341–352, 2020.
[12] Khairiyanti and H. S. Siregar, "Validation of AAS method for iron (Fe) determination," Student Sci. J., vol. 3, no. 2, pp. 116–124, 2025.
[13] E. C. Mazarakioti et al., "Inductively coupled plasma-mass spectrometry (ICP-MS): A useful tool for food authenticity," Foods, vol. 11, no. 22, p. 3705, 2022, doi: 10.3390/foods11223705.
[14] Ministry of Health of the Republic of Indonesia, General Standard Parameters for Medicinal Plant Extracts. Jakarta, Indonesia, 2000.
[15] S. Kurniawati and D. Sugiarso, "Determination of Fe(II) levels using UV-Vis spectrophotometry with wet and dry destruction methods," ITS J. Sci. Arts, vol. 5, no. 1, pp. C1–C5, 2016.
[16] R. Wahyuni, Guswandi, and H. Rivai, "Effect of drying methods on Andrographis paniculata simplicia quality," J. Farmasi Higea, vol. 6, no. 2, pp. 126–133, 2014.
[17] Ministry of Health of the Republic of Indonesia, General Standard Parameters for Plant Extracts. Jakarta, Indonesia, 2000.
[18] Ministry of Health of the Republic of Indonesia, Indonesian Herbal Pharmacopoeia, 2nd ed. Jakarta, Indonesia, 2017.

Doi:10.30872/jtpc.v10i1.324

[19] M. P. Marpaung and A. Septiyani, "Determination of specific and nonspecific parameters of Fibraurea chloroleuca extract," J. Pharmacopolium, vol. 3, no. 2, pp. 58–67, 2020.
[20] Siswati, "Analysis of moisture and ash content in Curcuma simplicia," Undergraduate thesis, Univ. North Sumatra, 2020.
[21] C. S. Wilschefski and R. M. Baxter, "Inductively coupled plasma mass spectrometry: Analytical aspects," Clin. Biochem. Rev., vol. 40, no. 3, pp. 115–133, 2019.
[22] Z. Irwan, A. Salim, and A. Adam, "Effect of Moringa oleifera on nutritional status in toddlers," Aceh Nutr. J., vol. 5, no. 1, p. 45, 2020, doi: 10.30867/action.v5i1.198.
[23] S. Kristianingrum, "Study of sample destruction methods and their effects," in Proc. Natl. Semin. FMIPA UNY, 2012.
[24] Rusnawati, B. Yusuf, and Alimuddin, "Comparison of wet and dry destruction methods for Pb analysis," in Proc. Natl. Chem. Semin., 2018.
[25] N. Tafu and V. Jideani, "Proximate, elemental, and functional properties of Moringa oleifera leaf powder," Molecules, vol. 27, p. 4935, 2022, doi: 10.3390/molecules27154935.