Supplementary Material 8: Extracting Iron Ions From Sesame Powder Using Energy-Saving Methods

Revised by Emma Tsai and Joyce S. Yu

2026.05.23

I. Objective

To extract iron ions from sesame powder using both traditional heating and microwave heating methods, and to compare their heating extraction efficiencies.

II. Technique

The iron content in sesame powder can be quantified using UV-Vis spectrophotometry following microwave-assisted and hot-plate extraction methods.

III. Introduction

Iron is an essential nutrient for both animals and plants. It is the primary component of "hemoglobin," serving as an oxygen carrier in the human body. Generally speaking, the demand for iron ions is greatest during the growth stages of infants and adolescents, during menstruation and pregnancy in women, or for regular blood donors. A lack of iron ions in the human body can lead to anemia and trigger metabolic disorders.

However, since the human body cannot metabolize excess iron, consuming too much iron can create an unnecessary burden on the body, such as causing DNA damage in cells, increasing free radicals, and stimulating tumor cell growth, which in severe cases may lead to cancer or other adverse outcomes. Therefore, properly compensating for regular iron loss by supplementing iron ions through a daily diet is a very important health concept. Accurate and effective nutritional labeling on food has thus become an important indicator for consumers when purchasing food.

Since the iron ion content in most foods is near the detection limit of analytical instruments, the process of quantitative analysis is relatively tedious and complex. Typically, solvents (acids or chelating agents) are first used to extract metal ions before concentration analysis is performed. The purpose of this experiment is to extract iron ions from food using the traditional heating method and the microwave heating method, respectively. The iron ion extract is then reacted with an aqueous solution of potassium thiocyanate (KSCN) to form a blood-red iron thiocyanate complex ion . Utilizing its distinct color, quantitative analysis is performed by measuring the absorbance at 450 nm using a UV-Vis spectrometer, and the extraction efficiencies of the two methods are compared.

$$\underset{\text{(Yellow-brown)}}{Fe^{3+}(aq)} + \underset{\text{(colorless)}}{SCN^{-}(aq)} \rightleftharpoons \underset{\text{(blood-red)}}{[Fe(SCN)]^{2+}(aq)} \qquad (8\text{-}1)$$

IV. Equipment

- 100 mL Volumetric flask, 10 mL Volumetric flask
- Lens cleaning paper, Heating magnetic stirrer
- 100 mL Beaker, Dropper, Filter paper, Plastic wrap
- Cuvette, UV-Vis spectrometer
- Microwave oven (1500W), Electronic thermometer

V. Chemicals

- Black sesame powder
- 10% Nitric acid
- 1% Potassium thiocyanate
- Iron(III) chloride

VI. Procedure

(1) **Preparation of Standard Solutions**

1. **1% KSCN Solution**: Weigh 1.0 g of potassium thiocyanate (KSCN), add it to 100 mL of 10% nitric acid, and dissolve completely to prepare a 1% potassium thiocyanate solution. (Prepared by TAs)

2. **2.5 mg/mL Stock Solution**: Weigh 2.5 g of iron(III) chloride, add it to 100 mL of 1% KSCN, and dissolve completely to prepare a 2.5 mg/mL standard stock solution. (Prepared by TAs)

3. **Diluted Standards**: Prepare a series of diluted standard solutions with concentrations of 1.50, 1.75, 2.00, 2.25, and 2.50 mg/mL from the stock solution by diluting with 1% KSCN.

4. **Calibration Curve**: Measure the absorbance of the five diluted standard solutions using a UV-Vis spectrometer and plot the calibration curve at 450 nm.

(2) **Quantitative Analysis of Iron Ions (Hot Plate Heating)**

1. Weigh 5.0 g of sesame powder and add 25 mL of 10% nitric acid into a beaker . Place the mixture on a hot plate, maintain the temperature at 40°C for 30 minutes, and then perform gravity filtration to collect the orange-red solution.

2. Take 2 mL of the filtered orange-red solution, transfer it into a 10 mL volumetric flask, and dilute to the mark with 1% KSCN.

3. Measure the absorbance of the resulting solution at 450 nm using a UV-Vis

spectrometer . Use 1% KSCN as the blank solution.

(3) **Quantitative Analysis of Iron Ions (Microwave Heating)**

1. Weigh 5.0 g of sesame powder and add 25 mL of 10% nitric acid into a
2. beaker. Transfer the mixture into a microwave oven and heat at 750 W for 25 seconds. Perform gravity filtration to collect the orange-red solution.
3. Take 2 mL of the filtered orange-red solution, transfer it into a 10 mL volumetric flask, and dilute to the mark with 1% KSCN.
4. Pour the solution into a cuvette and measure its absorbance at 450 nm using a UV-Vis spectrometer. Use 1% KSCN as the blank reference solution .

VI. Precautions

1. **Safety**: Standard PPE (lab coat, goggles, and gloves) is mandatory at all times.
2. **Chemical Handling**: Handle all chemicals with care, as they may be toxic or hazardous. Follow all laboratory safety regulations and the instructions of the TAs at all times.
3. **Prohibited Actions**: Removal of any chemicals or laboratory equipment from the lab is strictly prohibited.
4. **Instrument Preheating**: The spectrophotometer must be preheated for 20 minutes before use.
5. **Cuvette Cleaning**: When cleaning the cuvette, clean only the inner walls; do not touch the outer surface.
6. **Optical Surface Care**: When handling the cuvette, avoid touching the optical (clear) surfaces, and wipe them with lens tissue before measurement.
7. **Cuvette Alignment:** During measurement, ensure that the orientation marks on the cuvette and the instrument are aligned.
8. **Microwave Safety**: When operating the microwave oven, do not open the door during heating. Wear heat-resistant gloves when removing samples.
9. **Odor Control**: Odors may be generated during heating. After heating, place the sample in a fume hood until it has cooled completely.
10. **Reagent Preparation**: Each two groups require about 120.0 mL of 1% KSCN solution. First measure approximately 120.0 mL, and take more if necessary.

Lab Report: Extracting Iron Ions from Sesame Powder Using Energy-Saving Methods

Name: _____ Student ID:

Department: _____ Group: _____ Date:

I. Experimental Data and Results

(1) **Characteristic absorption peak wavelength (**λ) _____nm

(2) **Standard iron ion solution concentration:** _____mg/mL

(3) **Calibration Curve:** Plot the calibration curve with Absorbance (A) on the vertical axis (y-axis) and Iron Ion Concentration (mg/mL) on the horizontal axis (x-axis).

Trial	Iron Ion Concentration (mg/mL)	Absorbance (A)
2.50		
2.25		
2.00		
1.75		
1.50		

(1) **Heating Record Table for Microwave and Hot Plate Stirrer**

Parameter	Microwave Heating	Hot Plate Stirrer Heating
Weight of Sesame Powder (g)		
Absorbance of Sesame Iron Ions (A)		
Concentration of Sesame Iron Ions (mg/mL)		
Output Power (W)		
Heating Time (s)		
Output Energy (kJ)		

- Note : Watt = Joule / second (1 W = 1 J/s

II. Questions and Discussion

1. If the inner diameter of the cuvette used in this experiment is 1.0 cm, a sample prepared by taking 2.0 mL of a 0.4 mg/mL standard iron ion solution and diluting it to 10.0 mL yields an absorbance of 0.686. If the cuvette is replaced with one having an inner diameter of 3.0 cm, and the volume of the standard stock solution taken is changed to 0.50 mL (diluted to the same final volume), what will its absorbance be?

2. What is the recommended daily iron intake for a normal adult? List three types of food rich in iron, indicating their iron content per serving/100g and your data sources.

3. What is the heating principle of an electric hot plate? Please explain the fundamental differences between its mechanism and that of microwave heating, and compare the heating and extraction efficiencies of the two methods .

III. References

1. Somenath Mitra; Nicholas P. Tworischuk. *'Green Chemistry in Teaching Laboratory: Microwave Induced Reactions'*, **2010** (p. 4).

2. Strauss, C.; Trainor, R. *Aust. J. Chem.* **1995**, *48*, 1665 (p. 4).

3. Department of Health. *Dietary Reference Intakes and Their Explanations*, 7th Edition, **2011**, 518-573 (p. 4).