

# Spectrophotometric Determination Of Iron In Vitamin Tablets Calculations

## Spectrophotometric Determination of Iron in Vitamin Tablets

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**Abstract** - Iron was determined in a commercially available vitamin supplement using a spectrophotometric technique in this experiment. 1,10-phenanthroline was reacted with a vitamin tablet digested in hydrochloric acid. A reducing agent, called hydroquinone, was added to the solution to oxidize the  $\text{Fe}^{3+}$  to  $\text{Fe}^{2+}$  to form the colored complex successfully. An absorbance band was produced with an absorbance maximum of 508nm. Using the Fe standard curve equation produced from this experiment, the amount of iron was measured to be 8.364 mg. The commercial iron supplement sample we analyzed contained 10 mg of elemental iron, folic acid, and vitamin B-complex, which can address iron deficiency and anemia. Consequently, the results showed a 16.36% error.

**Keywords:** Analytical chemistry; Quantitative Analysis; Iron Content; Pharmaceutical analysis; Spectrophotometry.

### I. Introduction

The average adult human body contains 4-6 grams of iron, most of which is found in the hemoglobin, a blood protein. Hemoglobin is responsible for transporting oxygen from the lungs to the various tissues in the body to produce energy. This metabolic mechanism produces carbon dioxide transported back to the lungs by hemoglobin [7].

Sources of iron can be from foods such as meat and leafy, green vegetables. Dietary supplements of iron in vitamin

tablets can be taken when the dietary intake is deficient in iron. Iron supplements contain iron in various compounds: ferrous fumarate, ferrous sulfate, and ferrous gluconate [7].

To create a solution that absorbs radiation in the visible region, the iron must first be converted into a form that absorbs radiation in the visible region by reacting it with an organic compound called 1,10-phenanthroline [1,3]. This molecule reacts with  $\text{Fe}^{2+}$  to form a complex that contains one iron ion and three 1,10-phenanthroline molecules. The color of this compound in solution is bright red-orange, and it absorbs light very strongly in the visible region at a wavelength of 508 nm [1,3]. To produce the colored complex, the iron ions must be in the  $\text{Fe}^{2+}$  oxidation state. Since  $\text{Fe}^{3+}$  is easily oxidized to  $\text{Fe}^{2+}$  in acid and water, a reducing agent called hydroquinone is added to the solution. In addition, it is important that the solution's acidity is carefully controlled, or the Fe-1,10phenanthroline complex will not form. Adding sodium citrate to the solution will neutralize some of the acid and maintain the proper pH [1].

To determine the concentration of iron in a sample solution, the resulting solution will be diluted to an appropriate concentration, and its absorbance measured. A standard curve will be constructed using data collected from a series of solutions of known concentration. The concentration of iron in the sample solution, and thus the amount of iron in the vitamin tablet, can subsequently be calculated [1].

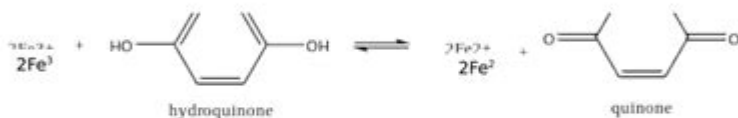


Figure 1. Reaction of iron with hydroquinone.

Spectrophotometric determination of iron in vitamin tablets calculations is a vital analytical technique used to quantify the concentration of iron in dietary supplements and multivitamins. Iron is an essential trace element vital for various physiological functions, including oxygen transport, energy production, and immune system support. Given the importance of iron, ensuring that vitamin tablets contain accurate amounts is crucial for consumer safety and health. This article will delve into the principles of spectrophotometry, the methodology for determining iron concentration in vitamin tablets, and the calculations involved in the process.

# Understanding Spectrophotometry

Spectrophotometry is an analytical method that measures the amount of light absorbed by a sample at specific wavelengths. The fundamental principle is based on the Beer-Lambert Law, which states that the absorbance (A) of a solution is directly proportional to the concentration (C) of the absorbing species and the path length (l) of light through the solution:

- $A = \epsilon \times C \times l$

Where:

- A = absorbance (no units)
- $\epsilon$  = molar absorptivity ( $\text{L} \cdot \text{mol}^{-1} \cdot \text{cm}^{-1}$ )
- C = concentration of the analyte ( $\text{mol} \cdot \text{L}^{-1}$ )
- l = path length of the cuvette (cm)

In the context of determining iron in vitamin tablets, a specific wavelength is chosen where iron compounds exhibit maximum absorbance.

## Importance of Iron Supplementation

Iron supplementation through vitamin tablets is vital for various populations, particularly:

- Pregnant women
- Individuals with iron-deficiency anemia

- Vegetarians and vegans who may lack sufficient iron
- Athletes, who may have increased iron needs

Understanding the concentration of iron in these supplements is crucial to prevent both deficiencies and potential toxicity from excessive iron intake.

## Methodology for Spectrophotometric Determination of Iron

The spectrophotometric determination of iron involves several steps:

### 1. Sample Preparation

To prepare the vitamin tablet sample for analysis, follow these steps:

1. Weigh a specific amount of the vitamin tablet (usually around 1 g).
2. Crush the tablet into a fine powder.
3. Dissolve the powder in a suitable solvent, typically a dilute acid like hydrochloric acid (HCl).
4. Filter the solution to remove any insoluble materials.

## 2. Formation of Iron Complex

Iron must be converted into a form that can be easily detected. This is often done by forming a colored complex with a reagent. Common reagents for iron analysis include:

- 1,10-phenanthroline
- Dipyridyl
- Ferrozine

For example, the reaction of iron(II) with 1,10-phenanthroline leads to a colored complex, which can be measured spectrophotometrically.

## 3. Calibration Curve Preparation

To quantify the iron concentration in the sample, a calibration curve must be established:

1. Prepare a series of standard solutions of known iron concentration.
2. Measure the absorbance of each standard solution at the selected wavelength.
3. Plot the absorbance against concentration to create a calibration curve.

This curve will be used to determine the concentration of iron in the tablet sample based on its

absorbance.

## 4. Measurement of Sample Absorbance

Once the sample is prepared and the iron complex is formed, measure the absorbance of the sample solution using a spectrophotometer. Ensure that the path length is consistent with that used for the calibration curve.

## Calculations for Iron Concentration

After obtaining the absorbance of the sample, the next step is to calculate the concentration of iron.

### 1. Use the Beer-Lambert Law

From the calibration curve, you can find the molar absorptivity ( $\epsilon$ ) and use it in the Beer-Lambert Law equation to find the concentration (C) of iron in the sample:

1. Rearrange the Beer-Lambert Law to solve for C:

2. 
$$C = A / (\epsilon \times l)$$

Where:

- A is the absorbance you measured for your sample.
- $\epsilon$  is the molar absorptivity from your calibration curve.
- l is the path length of the cuvette, typically 1 cm.

## 2. Convert Concentration to Total Iron Content

Once the concentration (C) is determined, convert it to total iron content in the original vitamin tablet sample:

1. Calculate the total amount of iron in the sample using the formula:
2.  $\text{Total Iron (mg)} = C \text{ (mol/L)} \times \text{Volume of solution (L)} \times \text{Molar Mass of Iron (g/mol)} \times 1000 \text{ (mg/g)}$

For example, if the concentration of iron is found to be 0.001 mol/L in a 50 mL solution, the calculation would be:

$$\text{Total Iron (mg)} = 0.001 \text{ mol/L} \times 0.050 \text{ L} \times 55.85 \text{ g/mol} \times 1000 = 2.7925 \text{ mg}$$

## Conclusion

The spectrophotometric determination of iron in vitamin tablets calculations is a crucial analytical process that ensures the quality and safety of dietary supplements. By understanding the methodology and calculations involved, laboratories and manufacturers can accurately assess the iron content in their products, thereby maintaining consumer trust and adhering to regulatory standards. This technique not only highlights the importance of iron in human health but also underscores the responsibility of producers to deliver accurate and effective supplements.

## **Frequently Asked Questions**

### **What is spectrophotometry and how is it used to determine iron in vitamin tablets?**

Spectrophotometry is an analytical method that measures the intensity of light absorbed by a sample at specific wavelengths. In the determination of iron in vitamin tablets, a specific wavelength is chosen based on the absorbance characteristics of iron complexes formed during the analysis.

### **What is the principle behind the spectrophotometric determination of iron?**

The principle is based on Beer-Lambert law, which states that the absorbance of a solution is directly proportional to the concentration of the absorbing species and the path length of the light. By measuring the absorbance of iron at a specific wavelength, the concentration can be calculated.

### **What reagents are commonly used in the spectrophotometric determination of iron?**

Common reagents include phenanthroline or 1,10-phenanthroline, which forms a colored complex with iron(II) ions, allowing for quantification through absorbance measurements.

### **How do you prepare a standard curve for iron determination in vitamin tablets?**

To prepare a standard curve, known concentrations of iron solutions are prepared, their absorbances are measured using a spectrophotometer, and a plot of absorbance versus concentration is constructed. This curve is then used to determine unknown concentrations in the sample.

### **What calculations are involved in determining the concentration of iron**

## **from absorbance data?**

Calculations involve using the standard curve equation ( $y = mx + b$ ), where 'y' is the measured absorbance, 'm' is the slope, 'x' is the concentration of iron, and 'b' is the y-intercept. Rearranging the equation allows for the calculation of the concentration of iron in the sample.

## **What is the significance of the wavelength selection in spectrophotometric analysis?**

Wavelength selection is crucial because it must correspond to the maximum absorbance of the iron complex. This ensures maximum sensitivity and accuracy in quantifying the concentration of iron present in the sample.

## **What are potential sources of error in spectrophotometric determination of iron?**

Potential sources of error include improper calibration of the spectrophotometer, interference from other substances in the vitamin tablet, variations in sample preparation, and deviations from the Beer-Lambert law under high concentrations.

## **How can interference from other vitamins or minerals be minimized during the analysis?**

Interference can be minimized by using selective reagents that form specific complexes with iron, optimizing pH conditions, and performing appropriate dilution of the sample to reduce the impact of other components.

## **What are the advantages of using spectrophotometry for iron analysis in vitamins?**

Spectrophotometry is advantageous due to its simplicity, rapid analysis, high sensitivity, and the ability to analyze multiple samples simultaneously without extensive sample preparation.



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