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Determination of Iron in Some Selected Iron Containing Tablets Using Redox Titration

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Abstract: Iron is an essential trace element, required for haemoglobin formation and the oxidative process of living tissues. A comparative study of the determination of iron in iron tablets was carried out using Redox titration on five samples of capsule containing iron. The capsules were analyzed using Redox titration on five of the samples containing iron content inform of ferrous fumarate. The weight of ferrous fumarate Fe ($C_4H_2O_4$) as well as elemental Fe^{2+} in milligram per gram for each capsule containing ferrous fumarate was determined. The titration was carried out using potassium permanganate (vii) ($KMNO_4$) which is the oxidation agent. The results obtained indicated Chemiron contained 144±4.61 (mg/g) while the label contained 150mg/g, Astyfer contained 74.6±5.69 (mg/g) while the label contained 80mg/g, Ferrobin plus contained 246±2.36 (mg/g) while the label contain 300mg/g, Emivite super contain 102±3.64 (mg/g) while the label contain 100mg/g, and Maxiron 265±1.73 (mg/g) while the label contain 250mg/g. Base on the results for the analysis of all the sample it can be concluded that Maxiron have the highest percentage of iron which is best supplements for adult lacking high percentage of iron. However, Astyfer has the lowest amount of iron which is the best supplement for infants who require very low amount of iron supplements.

Keywords: Iron, Tablet, Redox, Supplement

1. Introduction

Iron is the most abundant metal found in the earth crust, water as well as in different food stuffs naturally. Iron is also found in human body. [1] About 70% of iron in the average adult is found in the red blood cells of the blood called hemoglobin, which plays a vital role in transportation of oxygen from the lungs to various tissues in the body while the remaining 30% is present as storage iron in the kidney, liver, spleen and bone marrow. Myoglobin, in the muscles cells accepts, stores, transports and releases oxygen. Iron is an essential element which is vital and required for various biological functions. [1]

The average daily nutritional requirement of iron is 8-11mg/d for males and 16-27mg/d for adult female due to the iron losses through their regular menstrual blood flow. [2]

Iron is essential to virtually all living organisms and is integral to multiple metabolic functions, [3] It is an essential trace element, required for haemoglobin formation and the oxidative process of living tissues. [4-5] Iron is required for many vital functions such as reproduction, healing of wounds, cellular growth, oxidative metabolism, muscles activity and execution of various metabolic processes. The main role of iron is to carry oxygen to the tissues where it is needed, although use for DNA synthesis and also in the protection against microbes and free radicals produced in the body promote the development of heart diseases and damage the level of cholesterol in the blood. [6]

Nutritional deficiency of folate is commonly associated with people consuming inadequate diet. Pregnant women are at high risk of folate deficiency because pregnancy significantly increases folate requirement, especially during periods of rapid fetal growth. [7-8] Low iron intake can lead to iron deficiency which leads to various disorders such as anemia, cheilosis, dyspnea, irritability, impaired memory and increased in susceptibility to infection. [9-11] Anaemia is a major public health problem worldwide with prevalence of 43% in developing countries and 9% in developed nations.

[12-13] Iron deficiency anaemia in young children is the most prevalent form of micronutrient deficiency worldwide. [14] For such conditions, some iron supplement is needed along with foodstuffs such as egg yolk, fish kidney, wheat, maize, spinach, pheasant, meat etc. Iron supplementation can be administered in form of tablets capsule or injection from which iron content in iron containing tablets or capsule may vary from one pharmaceutical formulation to another. However, the pharmacopeia range of iron in tablet has been allocated from 48-54mg, as iron overdose leads to cases such as convulsion, multisystem organ failure, coma, and even death. [15]

Medicinally, iron is required as a dietary supplement in conditions of iron deficiency associated with secondary anaemia. A satisfactory intake of iron can be ensured by eating a suitable diet, because certain foods such as liver, kidney, egg yolk, and spinach are rich in iron. Nevertheless, it is sometimes necessary to supplement the iron taken in natural diet with iron tablets. Since iron is the key component of haemoglobin, therefore taking appropriate amount of iron drug supplement can help build red blood cells and reverse anaemia caused by too little iron in the body. [16-17] Most of the iron tablets bought at the pharmacies usually contain Iron (ii) sulphate (ferrous fumarate) examples of these tablets with their trade names are Astyfer, Chemiron, Fesolate, etc [18].

The principle that governed the identification of iron (Fe^{2+}) in iron containing drugs, is the ability of iron (Fe^{2+}) to reduce strong oxidizing agents such as potassium permanganate (vii) $KMnO_4$ to Mn^{2+}, for which the iron itself is oxidized from Fe^{2+} to Fe^{3+} and the end point of the reaction is associated to the formation of a persistent pale pink colour solution. [19]

The aim of this study is to determine the quantity of iron in selected iron containing drugs using Redox titration. Then compare the label amount of iron in the iron containing drugs and the quantity determined experimentally.

2. Materials and Methods

2.1. Materials

The samples were iron containing tablets obtained from Passmac Gold Pharmacy, No. 5 kilgori Road, Besides Intercity Bank, Sokoto State, Nigeria. The samples were labelled 1, 2, 3, 4, 5. All chemicals were used of analytical grade.

2.2. Method

2.2.1. Redox Titration

The principle that governed the identification of iron (Fe^{2+}) in iron containing drugs, is the ability of iron (Fe^{2+}) to reduce strong oxidizing agents such as potassium permanganate (vii) [$KMnO_4$] to Mn^{2+}, for which the iron itself is oxidized from Fe^{2+} to Fe^{3+} and the end point of the reaction is associated to the formation of a persistent pale pink colour solution. [19]

2.2.2. Standardization of 0.02m $KMnO_4$ Solution Using 0.1m (NH_4) Fe $(SO_4)_2$ $6H_2O$

9.8g of solid (NH_4) Fe $(SO_4)_2$ $6H_2O$ reagent was dissolved in 25cm^3 of 1.5 M H_2SO_4 in a conical flask. The burette was then filled with the prepared 0.02m K MnO_4 solution and titrated against the pipette solution of (NH_4) Fe $(SO_4)_2$ $6H_2O$ until a persisting pale pink colour was observe which indicates the end point of the reaction. The corresponding titre value was recorded and the procedure was repeated for two more times, each time noting the corresponding titre value.

2.2.3. Determination of the Amount of Iron in the Iron Containing Medications

Five (5) iron capsules were weighed and transferred in to 250cm^3 volumetric flask, distilled water was added up to the mark to dissolve into solution.

A pipette was used to measure 20cm^3 of the solution into a conical flask, and was titrated against the standardized 0.02m $KMnO_4$ until a persisting pate pink colour was observed, which indicate the end point of the reaction. The corresponding titre value was carefully recorded. The procedure was repeated for each of the samples. The titre value obtained was used to calculate the amount of iron in the samples.

Chemical reaction

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

3. Results and Discussion

Table 1. *The result of the Redox analysis of the samples.*

S/N	Sample	Iron (Fe) mg/g	Label/standard mg/g	Difference
1	Chemiron	144±4.61	150	6
2	Astyfer	74.6+5.69	80	5.4
3	Ferrobin plus	246±2.36	300	54
4	Emivite super	102±3.64	100	2
5	Maxiron	265±1.73	250	15

The results obtained for the analysis were summarized in table 1. Although the capsule was produced by different manufacturers, samples 1, 2, 3, 4 and 5 have the same iron formulation which is iron fumarate. Also it can be seen from the table the difference of some of the capsule is quite comparable with the label/standard concentration of (Fe) in the Redox titration. And might be due to the in complete transfer or dissolution of the sample solution may interfere with the observation of the endpoint.

Moreover, in the accuracy of measurement faculty

weighing apparatus, improper through mixing of component or splashes of the samples may also result in such variations. However, if at all none of the above has happened, the differences may only be a marketing promotion strategy from manufacturers.

4. Conclusion

Based on the result for the analysis of all the samples 1-5 it can be concluded that Maxiron (265mg/g) have the highest amount of iron. Hence Maxiron capsules can be regarded as the most suitable for those groups lacking iron supplement (e.g. menstruating and pregnant women and those who suffer blood loss due to accidents). However, Astyfer which has the lowest amount of iron is the best supplement for infants who require very low amount of iron supplements.

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