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Spectrophotometric Determination of Iron in some Commercial Iron Containing Tablets/Capsule

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Abstract: *A comparative study of the determination of iron composition in some commercial iron tablets/capsule using spectrophotometric method. Spectrophotometric method is based on the formation of complex iron compound- ferrous tris-o-phenanthroline complex by boiling with hydroxylamine hydrochloride and subsequent addition with 1, 10 - phenanthroline at $p^H \sim 3\pm0.2$ and the absorbance of this colored solution is measured with a spectrophotometer at 508nm. A calibration curve was found to be linear up to the concentration range of 0.0004 mg/ml to 0.0040 mg/ml. Total four pharmaceutical samples from different pharmaceutical companies were analyzed and results were compared with WHO iron intake for human consumption requirement. The study showed that the total iron content in pharmaceutical samples were 46.41 mg, 28.93 mg, 18.86 mg and 29.54 per 1g of the samples. These values are in good agreement with WHO standard and pharmaceutical range.*

Keywords: Phenanthroline, Spectrophotometric Method, Iron Tablets, Iron Capsule.

I. INTRODUCTION

Iron is a chemical element with symbol Fe (from Latin: ferrum) and atomic number 26. It is a metal in the first transition series. It is by mass the most common element on Earth, forming much of Earth's outer and inner core. It is the fourth most common element in the Earth's crust. Its abundance in rocky planets like Earth is due to its abundant production by fusion in high-mass stars. Like other group 8 elements, iron exists in a wide range of oxidation states, −2 to +6, although +2 and +3 are the most common. Elemental iron occurs in meteoroids and other low oxygen environments, but is reactive to oxygen and water. Iron, Fe, is a transition element .It is one of the elements known since antiquity, and has long been prized for its strength and ability to form even stronger alloys, such as steel. Iron forms compounds in both ferrous (ii) and ferric(iii) valencies (Beard, 2001),. Iron reacts with air in the presence of water to form iron(iii)oxide (Fe_20_3), commonly known as rust, it will also form mixed valence compounds like magnetite(Fe_30_4),that contains both ferrous and ferric state iron in their structure (Wallander *et al*., 2006) Iron reacts with the halogens to form its halides salt. It will also react with sulfur at elevated temperatures to form iron sulfide (FeS), known in mineral form as pyrite, or fool's gold. Iron crystal structure and specific metals properties are determined by metallic bonding – the force, holding together the atoms of a metal (Beard, 2001). The ability of the valence free electrons to travel throughout the solid explains both the high electrical and thermal Conductivity of metals. Other specific iron features are:, rust, lustre or shining of their surface (when polished), and ductility (ability to be drawn). These properties are also associated with the metallic bonding and presence of free electron in the metal's crystal lattice (Thomas *et al*., 2009). We have some ferrous metals like: Pig iron, Cast iron, White cast iron, Grey cast iron and Wrought iron. Pure Iron is a lustrous, ductile, malleable, silver-gray and easy to work metal. It has a high melting and boiling point, Iron easily rusts in damp air, occurs native meteorites and combined in most igneous rocks. Iron is not found free in nature but is found iron ores such as hematite, magnetite, taconite etc Electron Configuration: $1s^2\ 2s^2 2p^6 3s^2\ 3p^6\ 4s^2\ 3d^6$

Iron rusts in damp air, but not in dry air. It dissolves readily in dilute acids (Lozoff , 2007). Iron is chemically active and forms two major series of chemicals compounds, bivalents iron (11), or ferrous, compounds and the trivalent iron (111), or ferric, compounds. Irons also react with hot water and steam to produce hydrogen gas. Iron is very active metal; it reacts with other elements to form compounds of iron. Iron can occurs in compounds both ferric compounds and in ferrous compounds. Some of the important iron compounds are: Ferric acetate ($Fe(C_2H_3O_2)_3$), used in the dyeing of cloth, Ferric ammonium oxalate ($Fe(NH_4)_3(C_2O_4)_4$, known as blue spirit, Ferric Chloride ($FeCL_3$), used as water purification and sewage treatment system, Ferric Chromate ($Fe_2(CrO_4)_3$, yellow pigment(coloring) for paints and ceramics , Ferric hydroxide ($Fe(OH)_3$, is a brown pigment for coloring rubber; water purification system, Ferric phosphate (FeP04) is a Fertilizer; additive for animal and human foods, Ferrous acetate (Fe(C2H302)2), is used in dyeing of fabrics and leather; wood preservative, Ferrous gluconate, as a dietary supplement in "iron pills", Ferrous oxalate (FeC_2O_4)is a yellow pigment for paints, plastic, glass etc, Ferrous sulfate(FeS04), is a water purification and sewage treatment system.

II. BACKGROUND OF STUDY

Iron play very important role in human body; of the more than 100 chemical elements known to scientists today, only a few are found in the human body. In fact, only 24 different elements are thought to be essential for humans. The largest elemental components of the body, by mass, are oxygen (65%), carbon (18%), hydrogen (10%), and nitrogen (3%). The other elements in the body, such as calcium, phosphorus, iron, and copper, are known to physiologists as mineral elements and trace elements. Although these elements make up a much smaller percentage of the mass of the body, they are vital to the body's proper functioning. They must be present in the body in the proper amounts, and they must also be available to react with other elements to form critical molecules and Participate in important chemical reactions. Although iron comprises only 0.008% of the body's mass (approximately 6 g for a adult male), it is necessary for our survival.

Iron complexes with the protein hemoglobin are necessary for oxygen transport in the blood. Recall that iron is the central atom of the heme group, a metal complex that binds molecular oxygen (O2) in the lungs and carries it to all of the other cells in the body that need oxygen to perform their activities (e.g., muscle cells). In addition to hemoglobin, other important proteins in the body contain heme groups including myoglobin, which takes oxygen from hemoglobin and delivers it to muscle cells, and the cytochromes, which are important for generating energy. Other proteins, such as those needed for DNA synthesis and cell division, also rely on iron. Furthermore, iron is used to help produce the connective tissues in our body, some of the neurotransmitters in our brain, and to maintain the immune system.

Most people are iron deficiency and iron plays such a crucial role in the body, it is important for us to maintain an adequate supply of iron. Our bodies continually lose iron through everyday processes such as urination, defecation, sweating, and sloughing off skin cells. Bleeding contributes to further loss of iron fromthe body. To compensate for these losses and to maintain an adequate supply of iron, we should consume approximately 18 mg of iron daily. Certain conditions, including heavy bleeding and pregnancy further increase the requirement for iron consumption. Good dietary sources of iron include red meat, liver, egg yolk, beans, nuts, and fortified cereals. If the body iron is too low, a condition known as iron deficiency results. People with iron deficiency cannot produce an adequate amount of hemoglobin to meet their body's oxygen-transport needs. When the deficiency becomes severe such that there are too few circulating red blood cells or the hemoglobin content of these cells is very low, the condition is diagnosed as iron-deficiency anemia. The most common symptoms of iron-deficiency anemia are tiredness and weakness due to the inadequate oxygen supply to the body's cells, and paleness in the hands and eyelids due to the decreased levels of oxygenated hemoglobin, which is red-colored. Iron-deficiency anemia can be treated with iron supplements. It is also possible to have too much iron deposited in the body tissues. This condition is known as iron overload. If the iron overload becomes severe (usually when the total amount of iron in the body exceeds 15 g), the condition is diagnosed as hemochromatosis. Hemochromatosis can result in serious damage to the body's tissues, including cirrhosis of the liver, heart failure, diabetes, abdominal pain, and arthritis. A recessive genetic mutation can put some people, particularly those of Irish or Celtic descent, at a higher risk for developing hemochromatosis. Treatment for the condition consists of removing blood from the patient to decrease the amount of iron in the body.

Adequate iron in human is very good to health. Most food we eat did not contain much iron in it (Hallberg and Hulthen, 2000). The food we eat could be assumed did not contain a satisfactory iron from statistics from that over 50,000 people die daily due to iron deficiency diseases and mortality in children less than five years from less iron food (Ionone et al., 2004). The question is not: why to check the quantity of the food we eat, it is: why not check the quality of the water? People have the right to know the quality of food that they perceive to be eating (Stekel et al., 1983). People have switched to eat the food that contains less iron in it. Some food did not even contain iron it at all leading to iron deficiency disease called anemia, which makes one to weak and have less energy. Getting enough iron will help your body to work more efficiently and may speed your recovery following surgery. Supplements are taken as a 'health insurance' to boost energy, slow down the effects of ageing and reduce the risk of chronic disease, iron is a mineral. Most of the iron in the body is found in the hemoglobin of red blood cells and in the myoglobin of muscle cells. Iron is needed for transporting oxygen and carbon dioxide. It also has other important roles in the body (WHO, 2001). People take iron supplements for preventing and treating low levels of iron (iron deficiency) and the resulting iron deficiency anemia. In people with iron deficiency anemia, the red blood cells can't carry enough oxygen to the body because they don't have enough iron. People with this condition often feel very tired. Iron is also used for improving athletic performance and treating attention deficit-hyperactivity disorder (ADHD) and canker sores. Some people also use iron for Crohn's disease, depression, fatigue and the inability to get pregnant. Women sometimes take iron supplements to make up for iron lost in heavy menstrual periods. Iron-rich foods, such as pork, ham, chicken, fish, beans, and especially beef, liver, and lamb are also used. For certain people, particularly the elderly, supplementing the diet with additional vitamins and minerals can have health impacts.A multivitamin is a preparation intended to be a dietary supplement with vitamins, dietary minerals, and other nutritional elements. Such preparations are available in the form of tablets, capsules, pastilles, powders, liquids, and injectable formulations. Other than injectable formulations, which are only available and administered under medical supervision.In particular, pregnant women should generally consult their doctors before taking any multivitamins: for example, either an excess or deficiency of vitamin A can cause birth defects.] Long-term use of beta-carotene, vitamin A, and vitamin E supplements may shorten life with the additional risk. Severe vitamin and mineral deficiencies require medical treatment and can be very difficult to treat with common over-the-counter multivitamins. In such situations, special vitamin or mineral forms with much higher potencies are available, either as individual components or as specialized formulations. Multivitamins in large quantities may pose a risk of an acute overdose due to the toxicity of some component. However, in contrast to iron tablets, which can be lethal to children, toxicity from overdoses of multivitamins is very rare. There appears to be little risk to supplement users of experiencing acute side effects due to excessive intakes of micronutrients. There also are strict limits on the retinol content for vitamin A during pregnancies that are specifically addressed by prenatal formulas. Iron can be found in many things, such as water, tablets, vegetables, animals etc.

III. MATERIALS AND METHODS

3.1. Materials

All the reagents used were of analar grade and were used without any further purification. Stock solution of Fe2+ (nominally 0.04 mg Fe/mL) was Prepared by dissolving 0.145 g of reagent-grade Fe(NH4)2(SO4)2·6H2O in 500ml distilled water volumetric flask containing O.1 mL of 98% weight H2SO4 and diluted to the mark with distilled water . 10g of hydroquinone powder is required in 1litre of distilled water. 1g was dissolved in 1 L of distilled water and stored in amber bottle. 0-Phenanthroline reagent was prepared by dissolving 2.0 g of 1-10 phenanthroline monohydrates (C12H8N2.H2O) in 1 L distilled water. Trisodium citrate solution was prepared by dissolving 2.5g of the citrate salt in 100 ml of distilled water and stored in amber bottle. 6M HCl was prepared using the serial dilution formula. 0.1M H2SO4 was prepared using the serial dilution formula also.

Apparatus: beakers, standard volumetric flasks, pipette and measuring cylinder.

Equipments: Uv-visible spectrophotometer, pH meter, electric heater and filter papers.

Reagents: Hydroquinone, Trisodium, distilled water, 1-10 phenanthroline, conc.HCl, 98% weight H2SO4, iron ammonia sulphate, Fe(NH4)2(SO4)2·6H2O.

3.2. Method

Phenanthroline Method was employed; all the iron was converted into ferrous state by boiling with hydroxylamine hydrochloric.

Sample collection: The samples (iron-containing tablets/capsule) were purchased from pharmaceutical stores in warri, agbarho, unenurhie and evwreni in Delta State, Nigeria.

Preparation of Calibration Curve; 0.04mg of iron is contained in 0.281 mg of the standard Fe(NH4)2(SO4)2.H2O salt crystals. This solution is in 1000 ml solution of the salt. Therefore, 0.04mg of the Fe in standard iron solution was prepared by dissolving 0.145g of the Fe(NH4)2(SO4)2.6H2O crystals on 1 ml 0.1M H2SO4 and the solution was made up to 500cm3 with distilled water, in a standard volumetric flask. Into four 100cm3 beakers, 10.0 ml, 5.0 ml, 2.0 ml, and 0.04 mg of FE in standard iron solution was pipette, using the serial dilution formula.

Procedure for the Digestion, Reduction, Dilution and Determination of Iron in Iron Tablets/capsule: One of the sample tablets of the iron-containing vitamin was pulverised into fine powder and placed in a 100 ml capacity beaker and labeled 'Feromin tablet'., Appropriate amount of powder was taken in a volumetric flask and dissolved in distilled water. Then the volume was made up to the mark with distilled water. About 25 of 6M HCl were added and the mixture was gradually heated to boil for 15 minutes. The solution was cooled to room temperature. After cooling, the solution was filtered into 100 ml capacity volumetric flask. The solution was allowed to cool, after which it was diluted to 100 mL mark with distilled water. Thereafter, 50 mL of the sample solution was taken in conical flask; 1 mL hydroxylamine hydrochloride solution was added. Then the mixture sample was heated for about 30 min with glass beads in it. The sample was allowed to cool and transferred to 100 mL volumetric flask. The conical flask was rinsed 3 times with small portion of distilled water. Then 10 mL ammonium acetate buffer and 2 mL phenanthroline solution were added into it. The volume was made up to the mark and left for at least 15 minute for maximum colour development. The absorbance was then measured using spectrophotometer and the λ max was obtained by recording absorbance at wavelengths at 508 nm. The same procedure was carried out for each of the vitamin supplement tablets labeled ' chemiron', 'fesolate' and multivitamin iron mineral' respectively.

IV. RESULTS AND DISCUSSION

4.1. Results

The Calibration Graph (curve)

The calibration graph/curve obtained for the absorbance of standard iron (111) solution at various concentration of (0.0004, 0.0008……….0.0040 mg/ml) were obtain at 508nm, is shown in table 1.

Table 1: Absorbance and Concentration of Standard $Fe(NH_4)_2.6H_2O$ Solutions(at 508 nm)

Standard Fe(11) Solution (ml)	Conc. of Standard Solution (mg/ml)	Absorbance (at 504 nm)
10	0.0040	1.563
5	0.0020	0.821
2	0.0008	0.321
1	0.0004	0.201
100 distilled H2O	0.0000	0.000

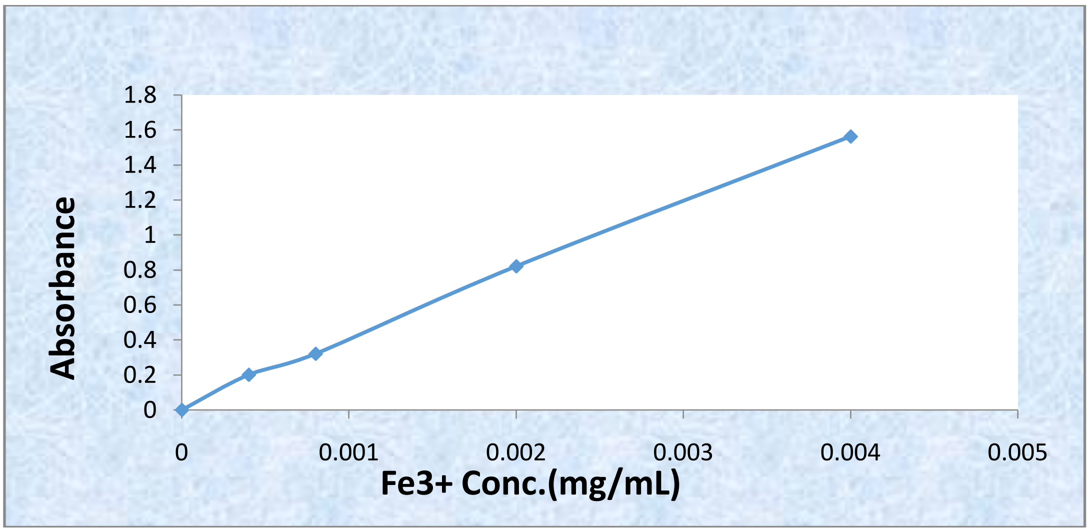

Figure 1: Calibration Curve for the Determination of Iron

The results of the total amount of iron found in each of the iron-containing tablets/capsule were tabulated in table 2.

Table 2: Iron Content found in the various different Iron-Containing Tablets/Capsule

Iron-Containing Samples (Tablet)	Mass of Iron (mg/1g)
Chemiron	46.41
Femiron	28.93
Fesolate	18. 86
MIM capsule	29.54

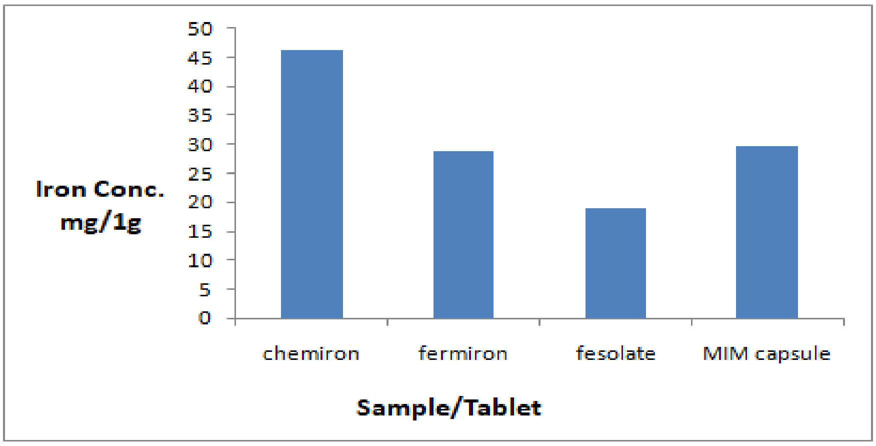

Figure 2: Results obtained from Spectrophotometer

4.2. Discussion

The iron content of the various pharmaceutical vitamin supplement tablets/capsule studied in this research were found to be 46.41, 28.93, 18.46 and 29.54 mg / 60 mg for chemiron, femiron, fesolate and MIM capsule respectively . However, the iron content varied for each of the tablets/capsule and they are all found to be in agreement with pharmaceutical range, and also within the range of W.H.O standard of iron intake for human consumption. These suggest that these vitamins supplements will be effective to different extents when taken for therapeutic use.

V. CONCLUSION

The iron contents in iron tablets were successfully measured by phenanthroline spectrophotometric method. The iron concentrations in iron tablets were found to be 46.41, 28.93, 18.46 and 29.54 mg/60 mg for chemiron, femiron, fesolate and MIM capsule respectively. The results were compared with WHO standard for iron intake in human consumption. It was observed that the amount of iron contained in all the samples lies within the pharmaceutical range and WHO standard. Thus, the iron supplement (samples) names above are recommended for iron deficiency patients.

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