How Much Iron?
An Introduction to Iron Toxicology, Part 2

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**How Much Iron is Present in Iron-Fortified Foods?**

In the 2001 issue of *Dietary Reference Intakes* (DRIs) for Iron, the Panel on Micronutrients of the Food and Nutrition Board writes, "The median dietary intake of iron is approximately 16 to 18 mg per day for men and 12 mg/day for women." Let us take a look at these estimates.

Apparently there is a great deal of freedom as to the amount of iron that can be added to food. The 2001 DRIs states, "Some fortified cereals contain as much as 24 mg of iron per 1-cup serving." (Food and Nutrition Board, 2001, p 356). We will use this value to make an estimate as to how much iron some people are actually consuming.

The estimated intakes of iron used by the Panel on Micronutrients were based on the assumption that iron-supplemented food contains the actual amount stated on the label. P. Whittaker and colleagues (2002) from the FDA analyzed twenty-nine cereals for iron content.

"When the labeled value was compared to the assayed value for iron content, 21 of the 29 cereals were 120% or more of the label value and 8 were 150% or more of the label value. This gives us an approximate estimate that fortified cereals contain around 1.3 times as much iron as the label states."

Now let us make an estimate as to how much iron a person might consume from iron-fortified cereal. Whittaker and colleagues have already done this for us, so let us accept their findings in order to come up with some estimate of how much iron we really are consuming.

"Serving size quantities were estimated in 72 adults who regularly ate cereal. The median analyzed serving size was 47 g for females, and 61 g for males with a combined median of 56 g as compared to the label value of 30 g. For adults, the amount of cereal actually consumed was approximately 200% of the labeled serving size."

Since the one-cup serving of cereal cited in the DRIs provides, according to the label, 24 mg of iron, and cereal eaters usually eat around two cups, that cereal has provided 48 mg of iron, assuming the label is accurate.

Now, let us consider that the cereal may actually contain 130% of the label-stated amount, as found by Whittaker. A person eating a couple of cups of cereal could be ingesting as much as 62 mg iron! This is well above the upper level (UL) established by the Food and Nutrition Board. Let us hope that cereal eaters do not also take an iron containing supplement!

**Labels on Iron-Containing Supplements and Cereals are Inappropriate and Misleading**

Labels on iron supplements are, according to guidelines established by the FDA, supposed to be expressed...
as percent Daily Value (%DV).

Unfortunately, labeling as %DV is very misleading in the case of iron. The “Daily Value” for labeling for iron is 18 mg iron, and has nothing to do with the human need for iron. The Recommended Dietary Allowance (RDA) for adult males and postmenopausal women is 8 mg iron. Therefore, a supplement that provides 18 mg iron supplies 225% the RDA for these people. However, the label states that it is only 100% of the DV. Since the amount of iron a person needs does not depend on the caloric intake, labels on iron-containing supplements should state the percent of the RDA or Estimated Average Requirement (EAR), not the %DV.

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<th>EAR</th>
<th>RDA</th>
<th>DV</th>
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<tbody>
<tr>
<td>Men (19 years and older)</td>
<td>6 mg/day</td>
<td>8 mg/day</td>
<td>18 mg/day</td>
</tr>
<tr>
<td>Women (51 years and older)</td>
<td>5 mg/day</td>
<td>8 mg/day</td>
<td>18 mg/day</td>
</tr>
<tr>
<td>Women (19 to 50 years)</td>
<td>8.1 mg/day</td>
<td>18 mg/day</td>
<td>18 mg/day</td>
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</tbody>
</table>

- **EAR** = Estimated Average Requirement
- **RDA** = Recommended Dietary Allowance
- **DV** = Daily Value used for labeling purposes

To confuse things even more, some supplements do not express the iron content, but express, for instance, the iron fumarate content. The labeling on Vitron-C® illustrates this. The label lists the amount of ferrous fumarate (not the amount of iron). According to the label, 200 mg ferrous fumarate provides 325% of the DV for iron. It contains 712% of the RDA for adults other than premenopausal women.

By comparison, the label on Ferro-Sequels® states that the product contains 50 mg of iron (derived from ferrous fumarate). The 50 mg of iron in Ferro-Sequels® is 625% the RDA, and even exceeds the UL, but the label indicates that it contains 277% of the Daily Value.

Conclusion: It is not possible to determine from the label what percentage of the RDA is actually contained in any particular iron supplement. A similar circumstance is found for iron-fortified cereals. Determining the amount of iron in cereals is even more difficult, since the actual weight of iron is not given on the label—only the DV is given. Labels for iron should contain both the actual amount of iron per serving, and the %RDA, or %EAR.

**Choose Your Poison: What Kind of Iron Is Added to Food?**

The chemical nature of the iron is important. Iron must be in the divalent form (Fe²⁺) for efficient absorption, so most of the iron that is used in fortification is Fe²⁺. However, very fine iron powder where iron is in the neutral state (Fe⁰) is apparently also permitted and used. Some of the other forms of iron used for supplementation include iron(II) oxide, iron(II) fumarate, iron(II) sulfate, and carbonyl iron (Fe⁶). The 1993 report on Iron Deficiency Anemia of the Food and Nutrition Board lists 7 different kinds of iron(III) and 7 different kinds of iron(II) compounds that are approved.

An FDA-approved red food coloring is apparently a mixture of iron(II) and iron(III) oxides. The FDA has also approved two iron “flavor enhancers”—iron chloride and iron sulfate. It is certain that no one knows how much of these “flavor enhancers” is being used, nor what foods they are used in.

Some of the newer additions to the list of iron additives are iron(II) EDTA, iron-choline citrate complex, and iron(II) ascorbate.

**What Kind of Iron Is Mutagenic?**

Whittaker and colleagues (2001) from the FDA reported on the genotoxicity of various forms of iron. “We found that elemental and salt forms of Fe, including compounds used in dietary supplements and for food fortification, induced mutagenic responses in L5178Y mouse lymphoma cells. ...exposure of mouse lymphoma cells to Fe⁶, Fe⁵⁺, and Fe⁴⁺ resulted in the induction of mutagenic responses with likely different mechanisms of iron metabolism.”

**Heme Iron and Human Disease**

Heme iron refers to the iron that is found in red meat. Heme iron is much more efficiently absorbed than most other forms of iron. A recent article by A. Tappel (2007) from the University of California, Davis, presents a summary of the role of heme iron in a variety of diseases. “Dietary epidemiological studies indicate correlations between the consumption of red meat and/or processed meat and cancer of the colon, rectum, stomach, pancreas, bladder, endometrium, ovaries, prostate, breast, and lung; heart disease; rheumatoid arthritis; type 2 diabetes; and Alzheimer’s disease. The correlation of all these major diseases with dietary red meat indicates the presence of factors in red meat that damage biological components. This hypothesis will focus on the biochemistry of heme compounds and their oxidative processes.” (Med Hypotheses, 2007, 68:562-4)
IRON, LUNG CANCER, AND VITAMIN C: A NOTE OF CAUTION TO CIGARETTE SMOKERS

When iron(II) is combined with vitamin C, the iron is very efficiently absorbed—perhaps as efficiently as is heme iron. This is the basis for the more recently formulated iron supplements that are currently being sold in North America. As iron(II)-vitamin C, 40 or 50% of the ingested iron may be absorbed, compared to the ordinary 15% or less.

The Iowa Women’s Health Study (Lee and Jacobs, 2005) addressed the question of “Interaction among heme iron, zinc, and supplemental vitamin C intake on the risk of lung cancer.” Increased heme iron intake was associated with increased lung cancer. The higher the vitamin C intake, the greater the association between heme iron and lung cancer. A note of caution to smokers who think vitamin C will act as an antioxidant and protect them. The antioxidant properties of vitamin C are compromised, and it carries a powerful prooxidant into the body!

GENETICALLY MODIFIED IRON-ACCUMULATING GRAINS

In recent years, genetically-modified iron-accumulating strains of rice, wheat, and corn have been developed (Gura, 1999), and are probably being used. Their intended use is in developing countries where iron deficiency is believed to be common. Whenever these “naturally iron-enriched” grains are used, they should be clearly marked. Unfortunately there are currently no labeling regulations for them.

Intervention by genetically-modified iron-rich grains needs to be very carefully evaluated. The Somali nomads are one group that is targeted as needing iron supplementation. They consume a milk-based diet—one that is considered to be severely deficient in iron. The hemoglobin levels of Somali men indicate that—by comparison with medical standards for Caucasian males—the Somalis have “iron-deficiency anemia.” However, even with low hemoglobin levels, they are very vigorous people and do not suffer clinical symptoms of anemia.

“Iron-deficiency” is believed to result in reduced resistance to infection. Higher rates of infection among children have been clearly demonstrated in several populations throughout the world. However, this observation may not apply to all populations. In 1978 a group of researchers reported results of a very interesting experiment on the incidence of infection among “iron-deficient” and iron-supplemented Somali men (Murray et al, 1978).

“The incidence of infection was studied in 137 iron-deficient Somali men, 67 of whom were treated with placebo and 71 with iron. Seven episodes of infection occurred in the placebo group and 36 in the group treated with iron; these 36 episodes included activation of pre-existing malaria, brucellosis, and tuberculosis. This difference suggested that host defence against these infections was better during iron deficiency than during iron repletion.”

At the end of 30 days the men who received the iron tablets showed a 50% increase of blood hemoglobin. “Iron-deficiency” in these Somali men protects them from infection. Since infectious diseases are the primary cause of death among the Somali, dietary intervention must be carefully evaluated.

WOMEN OF CHILDBEARING AGE MAY OCCASIONALLY NEED IRON SUPPLEMENTATION

Women of childbearing age are not as susceptible to iron toxicity as are men and post-menopausal women. In fact these women are the target group for iron deficiency. Iron supplementation may be necessary. The reason should be apparent: Monthly loss of blood protects women from iron accumulation, but makes them susceptible to iron deficiency.

However, even menstruating women should be very cautious in using iron-containing supplements. The vast majority of menstruating women do not develop iron deficiency anemia. They may develop transient anemia but this is quickly reversed since they naturally absorb more iron from the diet. The Food and Nutrition Board (1993) estimated the incidence of “iron deficiency anemia” among women of childbearing age to be 4 to 10 percent. Even this estimate may be too high, since it is based on national surveys that do not take into consideration the occurrence of the symptoms of iron deficiency.

It would be wise for any woman who suspects that she is in need of iron to consult a physician before taking any iron supplement. Diagnosis of iron deficiency anemia should be based on several blood measurements including: hematocrit, hemoglobin content, transferrin binding, and serum ferritin.

If iron addition to food is continued, the foods to which iron is added should be clearly marked to indicate that they are a special food to be used only under advice of a physician so that they won’t be used by those who might be harmed by them.

ACUTE IRON POISONING

According to the FDA, accidental iron over-dose is the most common cause of poisoning deaths in children under 6 years of age in the United States. The FDA has taken steps to prevent accidental iron poisoning of children by requiring warnings on iron supplements (FDA, 1997).

Acute iron poisoning has little to do with the iron excess diseases associated with aging. These diseases result from long-term exposure to low-level, excessive dietary iron.
Men and Post-Menopausal Women Are the Targets for Iron Excess Diseases

Iron is a cumulative poison, and most of its toxic effects are seen as diseases of aging. Francesco S. Facchini, M.D., referred very accurately to iron as "the aging factor." (The Iron Factor of Aging, Fenestra Books, 610 East Delano Street, Suite 104, Tucson, AZ 85705). Iron is a pro-oxidant, and contributes to all aspects of aging.

How Much Dietary Iron Do Adult Males and Post-Menopausal Women Need?

Men: The EAR (Estimated Average Requirement) for all men 19 years and older is 6 mg iron/day, and the RDA is 8 mg iron/day. The median intake is 16-18 mg iron/day.

Post-Menopausal Women: The EAR for iron for women over 51 years is 5 mg/day; the RDA is 8 mg/day. Median iron ingestion for these women is 12 mg/day.

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<th>EAR</th>
<th>RDA</th>
<th>Median Intake</th>
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<tr>
<td>Men</td>
<td>6 mg/day</td>
<td>8 mg/day</td>
<td>16-18 mg/day</td>
</tr>
<tr>
<td>Post-Menopausal Women</td>
<td>5 mg/day</td>
<td>8 mg/day</td>
<td>12 mg/day</td>
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It is clear that a major portion of the U.S. population—those most susceptible to iron storage and toxic effects—are currently consuming much more iron than the amount necessary for healthy iron balance. Since the Panel on Micronutrients estimated that one half of the dietary iron comes from fortified foods, it seems apparent that if foods for adults were not fortified with iron, iron ingestion for the majority of people would be very close to the EAR and RDA.

How Has Sweden Handled the Iron Fortification Problem?

Following the lead of the U.S. and Canada, Sweden joined ranks and initiated an iron-fortification program in the 1950s. People from Sweden and Finland have a high incidence of hereditary hemochromatosis. The National Food Administration of Sweden determined that the evidence that iron fortification of food was harming this target group was significant enough to terminate the program. The iron fortification of food in Sweden was withdrawn on January 1, 1995 (Olsson et al., 1997).

It is interesting that no mention is made of the Swedish experience in the 2001 DRIs. Why? It is very likely that not one of the 14 members of the Panel on Micronutrients was even aware of actions of the Swedish National Food Administration. The U.S. Food Board and Health Canada should carefully follow the results of the Swedish experiment!

References


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