

Introduction

Contrary to what we are told in the expensive advertising campaigns by the meat industry, an appropriately planned, well-balanced vegetarian diet is compatible with an adequate iron status. Although the iron stores of vegetarians may be reduced, the incidence of iron-deficiency anaemia in vegetarians is not significantly different from that in the general population. Restrictive vegetarian diets (including macrobiotic), however, can be associated with iron-deficiency anaemia. Adequate iron nutrition depends on both the amount of dietary iron consumed and the amount absorbed. Western vegetarians who consume a variety of foods have a better iron status than do those in developing countries who consume a limited diet based on unleavened, unrefined cereals. Western vegetarians generally also consume greater amounts of vitamin C, an important enhancer of non-haem iron absorption.

Functions of Iron

The primary function of iron in the body is to transport oxygen. About 67% of body iron is present as haemoglobin and myoglobin. Haemoglobin, which is present in red blood cells, is essential for transferring oxygen from the lungs, via the blood, to the tissues; myoglobin is present in muscle cells and accepts, stores, transports and releases oxygen in the muscles. About 6% of body iron is used as a component of certain proteins (it forms part of the cytochromes, which are essential for respiration and energy metabolism), and as a component of certain enzymes it is involved in the synthesis of collagen and various neurotransmitters. In addition, iron is needed for proper immune function.

About 25% of the iron in the body is stored as ferritin, which is found in cells and circulates in the blood. The average adult male has about 1,000 mg of stored iron (enough for about 3 years), whereas women on average have only about 300 mg (enough for about 6 months). When iron intake is chronically low, stores can eventually become depleted, decreasing haemoglobin levels.

Types of Dietary Iron

Iron in food occurs in two forms, haem iron and non-haem iron. Approximately 40% of the iron in meat products is haem iron; 60% of the iron in meat and all the iron in plant foods is non-haem iron. The absorption by the body of the two types of iron differs, with about 2% to 20% of non-haem iron, and about 20% of haem iron, being absorbed.

Iron Absorption

The body uses several mechanisms to regulate iron absorption. Controlling absorption is important because the body cannot easily excrete excess iron once absorbed. The extent of iron absorption depends on a variety of factors, the most important of which is the size of current iron stores in the body. If stores are depleted there is a marked increase in the capacity of the body to absorb iron in order to try and correct the depletion. Conversely, if iron stores are increased then the absorption of dietary iron is reduced to try and prevent iron overload from occurring.

Enhancers and Inhibitors of Iron Absorption

The degree of absorption of iron can vary dramatically depending on a variety of dietary factors. Non-haem iron is much more sensitive to these factors than haem iron, and depending on the composition of a meal, absorption can vary 20-fold.

Vitamin C, which is abundant in vegetarian diets, significantly enhances the absorption of non-haem iron. To enhance absorption, the vitamin C source and iron must be consumed at the same meal. In addition to vitamin C, fruits and vegetables contain small amounts of other organic acids (e.g. citric acid and malic acid) that can also enhance non-haem iron absorption.

Tannic acid (e.g. in tea) can reduce non-haem iron absorption by as much as half; calcium can also inhibit iron absorption considerably. In addition, phytates (found in whole grains and legumes) also reduce iron absorption.

Studies have shown that when iron intake from plant foods is relatively high and a variety of foods is consumed, inhibitors and enhancers of iron absorption can offset each other and iron balance is not adversely affected.

Factors enhancing non-haem iron absorption:

- Low body stores
- Hydrochloric acid in the stomach
- Vitamin C
- Sugars
- Haem iron

Factors hindering non-haem iron absorption

- Full body stores
- Reduction in stomach acid
- Tannins (e.g. in tea)
- Oxalic acid (e.g. in spinach)
- Phytic acid (in dietary fibre)
- Calcium and phosphorus in milk

Iron Loss

As mentioned above, iron in the body is regulated mainly by the degree of absorption. The body cannot easily excrete excess iron once absorbed, so if iron stores are high then the absorption of iron is reduced. Small amounts of iron, however, are lost through the normal sloughing off of intestinal cells, and some is lost via sweat and blood loss. Pre-menopausal women lose about 50% more iron than men because of menstruation. On average, men lose about 1.0 mg of iron per day and women lose about 1.5 mg (although, because of great variation in menstrual blood loss among women, some lose much more than this).

Dietary Sources of Iron

Iron is widely distributed in foods (refer to Table 1 below). Of the plant foods, good sources include tofu, legumes, whole grains (including wholemeal bread), wheat germ, oatmeal, green leafy vegetables, peas, broccoli, potatoes, nuts, seeds, peaches and dried fruit. The use of iron cooking utensils and saucepans also contributes to dietary intake.

Recommended Dietary Intakes (RDIs)

Recommended Dietary Intakes for iron in Australia:

- Men - 7 mg/day
- Pre-menopausal women - 12-16 mg/day
- Post-menopausal women - 5-7 mg/day
- The RDI for women when pregnant increases by 10-20 mg/day

Low Iron Stores: Not Necessarily Unhealthy

It is important to distinguish between low iron stores and iron deficiency anaemia. Iron stores are represented by serum ferritin levels and although generally lower in vegetarians, they are just as likely to be adequate. As long as stores are adequate and within the normal range, low iron stores are not necessarily of major concern. There is, however, a level at which someone is considered iron "depleted" (even without the symptoms of anaemia being present), when serum ferritin has fallen below a certain level. If iron depleted, steps should be taken to increase iron intake and absorption. If you are concerned about your haemoglobin and ferritin iron levels, these can be easily measured via a blood test at your local medical centre.

Iron Deficiency

A low iron intake is partly compensated for by increased absorption rates, but when needs are not met iron stores begin to decrease. Once stores are depleted, the level of iron in the blood will begin to decrease, and haemoglobin production will be suppressed. It can take a long time for iron-deficiency anaemia to develop, but eventually haemoglobin production can decrease to a point where anaemia does occur. The number of red blood cells falls so low that there is decreased oxygen-carrying capacity of the blood. Absorption of iron at this stage may be as high as 50%. Note here that iron deficiency (i.e. depleted body iron stores) can occur with or without the prevalence of anaemia.

Many adults with mild iron deficiency experience no obvious problems, other than vague symptoms of tiredness, headache, irritability, or depression, and do not show obvious signs or symptoms of anaemia.

Signs and symptoms of iron deficiency anaemia include pale skin, brittle fingernails, tiredness, weakness, apathy, breathlessness especially on physical exertion, giddiness, palpitations, reduced immune function, inadequate temperature regulation, loss of appetite, headache, behavioural disturbances and reduced intellectual performance. The fatigue is caused by insufficient synthesis of red blood cells and cytochromes. These symptoms are similar to those of other health problems and diseases, making it very difficult to self-diagnose anaemia. If you are concerned about your iron level a simple blood test at your local medical centre will give an accurate indication of your current iron status. Iron deficiency anaemia will be signaled by the presence of microcytic (abnormally small) blood cells and very low haemoglobin levels in the blood.

Iron deficiency is one of the most common nutrient deficiencies in Western countries. There is a higher risk of iron deficiency during four periods of life: 6 months to 4 years, adolescence, during the female reproductive period, and during pregnancy. During infancy, iron-deficiency anaemia can permanently affect brain development, and in early childhood, iron deficiency interferes with growth, weight gain and behavioural development.

Iron Overload

Although not as common as iron deficiency, iron overload can also be serious. Haemochromatosis, a genetic disorder where individuals absorb more iron than normal, can lead to iron stores in the body eventually building up to such high levels that organs are damaged trying to store the extra iron. Haem iron poses the greatest risk for people with this disorder.

Even in individuals without haemochromatosis, excess iron stores do not provide any particular advantage and may even have adverse effects. For example, iron is a pro-oxidant - it promotes the oxidative damage that is linked to many chronic diseases. In some studies, excess iron stores (and intakes) have been linked to increased risk of heart disease and certain forms of cancer, particularly colorectal cancer. Other studies have shown that lower iron stores may reduce the risk for diabetes through enhancing insulin sensitivity.

Since absorption control is the main mechanism the body uses to protect against excess iron, and with non-haem iron being more sensitive to the factors that control absorption, diets that contain only non-haem iron, i.e. vegetarian diets, are more likely to protect against excess iron storage.

Iron status of Vegetarians and Vegans

On the whole, research indicates that the dietary intake of iron by vegetarians, particularly in the case of vegans, meets or exceeds the RDI. The key question, however, is not how much iron is consumed, but how much is actually absorbed, and, consequently, whether the iron status of vegetarians and vegans is adequate.

Even taking into consideration factors like vitamin C intake and use of leavened bread, vegetarians absorb less iron from their diets than non-vegetarians. Some research has suggested that some vegetarians may absorb only about 10 percent of the iron in their diet while omnivores absorb about 18 percent.

It is likely that some adaptation to lower iron intakes takes place. One study has found that vegetarians lost far less iron from their intestines, compared to omnivores. And in men consuming a diet with low iron bio-availability, iron absorption increased over time. Therefore, it is possible that a diet with low iron bio-availability can lead to increased absorption and decreased excretion of iron.

Typically, due to the reduced absorption of non-haem iron in comparison to haem iron, the amount of stored iron of vegetarians and vegans is substantially lower than that of non-vegetarians, but their stores are just as likely to be adequate. And despite these lower stores, most studies have shown that the incidence of iron-deficiency anaemia in vegetarians is not significantly different from that in the general population.

It is important to note here that with iron deficiency anaemia being relatively common among omnivore women, the fact that vegetarian women are no more likely to be deficient in iron is not a reason for them to be complacent about this mineral.

Summary

Although the incidence of iron-deficiency anaemia in vegetarians is not significantly different from that in non-vegetarians, this doesn't mean that vegetarians should be complacent about iron. And despite the fact that adaptation may take place, it is important for vegetarians to eat a diet that emphasises iron-rich foods and enhances iron absorption. Iron deserves attention in the diets of everyone.

For people concerned about their iron level a simple blood test at a local medical centre will give an indication of their current iron status. For people concerned that their dietary intake of iron may not be adequate, we recommended that they see an Accredited Practising Dietitian who specialises in vegetarian nutrition (refer to the Dietitians page on our website).

Table 1: Some dietary sources of iron

Food	Serving	Iron content (mg)
Apricots (dried)	1/4 cup	1.5
Avocado	100 g	0.6
Baked beans (cooked)	1/2 cup	0.7
Barley, whole (cooked)	1/2 cup	1.6
Bread, whole wheat	1 slice	0.9
Broccoli (cooked)	1/2 cup	1
Brussels sprouts (cooked)	1/2 cup	0.9
Cashew nuts	2 tbsp	1
Garbanzo beans (cooked)	1/2 cup	3.4
Kelp (cooked)	1/2 cup	42
Kidney beans (cooked)	1/2 cup	1.5
Lentils (cooked)	1/2 cup	3.2
Licorice	50 g	4.4
Lima beans (cooked)	1/2 cup	2.2
Marmite (fortified)	5 g	1.8
Molasses	1 tbsp	3.3
Navy beans (cooked)	1/2 cup	2.5
Nori (cooked)	1/2 cup	20.9
Parsley (raw)	50 g	4.7
Peas (cooked)	1/2 cup	1.2
Pinto beans (cooked)	1/2 cup	2.2
Potato, with skin (cooked)	1 medium	2.7
Prunes	1/4 cup	0.9
Pumpkin seeds	2 tbsp	2.5
Raisins	1/4 cup	1.1
Rice, brown (cooked)	1/2 cup	0.5
Some breakfast cereals (fortified)	100 g	10 (approx)
Soybeans (cooked)	1/2 cup	4.4
Spinach (cooked)	1/2 cup	1.5
Split peas (cooked)	1/2 cup	1.7
Sunflower seeds	2 tbsp	1.1
Tahini/Sesame seeds	2 tbsp	1.2
Tempeh (cooked)	1/2 cup	1.8
Textured Vegetable Protein (TVP) (cooked)	1/2 cup	2
Tofu	1/2 cup	6.2
Wheat germ	2 tbsp	1.2