Guide to iron and nutrition

Smart nutrition – optimally supplied

Iron - a vital trace element

Iron belongs to the nutrient group of essential trace elements. Since our body cannot produce iron itself, this vital element must be ingested daily in sufficient quantities through food. The recommended daily requirement appears to be comparatively low at an average of 15 mg/day. Nevertheless, the importance of sufficient coverage of requirements should not be underestimated, because iron plays a decisive role in some vital metabolic processes in our body.

The German Federal Institute for Risk Assessment (BfR) classifies the iron supply of the German population as satisfactory. Children and adolescents, senior citizens, women athletes, vegetarians and vegans are among the groups of people for whom the status of their iron supply should be kept in view.

In this brochure, you will learn how our body absorbs iron from food and how it uses it, what important functions iron assumes in the human body, which reference values apply for the individual groups of people and how you can optimally cover your daily iron requirements through a clever combination of foods.

We wish you much pleasure in reading this brochure!

Yours sincerely, Haus Rabenhorst

Overview

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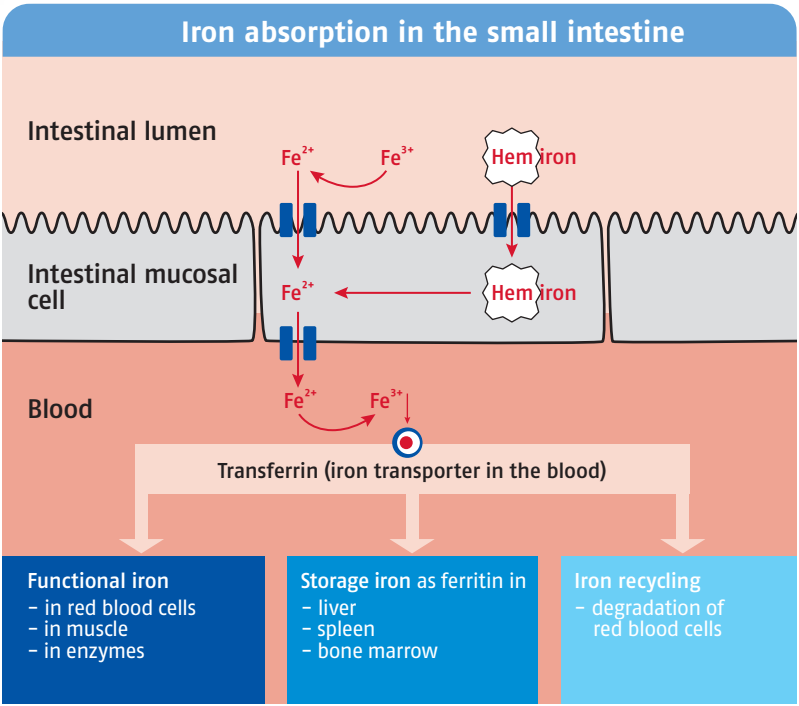
Iron absorption from food

Iron absorption takes place in the small intestine. After the absorption of iron from food, the trace element is either stored as storage iron or released into the blood as functional iron.

The decisive factor for the absorption of iron is the food source. Depending on whether it is of animal or plant origin, the uptake follows different mechanisms. The absorption of animal heme iron is relatively uncomplicated. It is absorbed into the intestinal mucosa cells by means of a transport protein. The non-heme iron from plant food sources, on the other hand, cannot be absorbed directly. It lies weakly bound in the form of trivalent iron ions (Fe^{3+}). Since the uptake of iron into the cells of the intestinal mucosa is only possible in its dissolved form as divalent iron ion (Fe^{2+}), the non-heme iron must first be reduced to Fe^{2+} by means of an enzyme and can then be absorbed. Within the cells, the iron is stored or released back into the blood, depending on the body's iron levels. If the iron is to be stored, it is bound to the protein „ferritin" and deposited in this form. If iron is needed, it is bound in the blood to a transport protein called „transferrin". This transports the trace element to various organs and tissues.

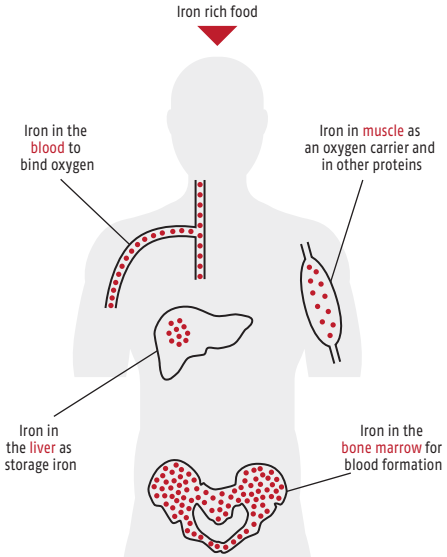


Source: „Vitamins, trace elements and minerals“, 2nd updated and expanded edition 2019, Thieme Verlag

Central element for many metabolic functions

Iron takes on a variety of tasks in very different metabolic processes in our body.

It is a component of the red blood pigment hemoglobin and supports the normal formation of red blood cells in the bone marrow. Since iron can bind oxygen, it is responsible for the storage and transport of oxygen in the blood. This applies equally to the muscles: As the central atom in myoglobin, it also supplies the muscle with a large amount of oxygen. It also plays an important role in cellular energy supply, DNA synthesis and contributes to the normal function of the immune system.



The iron requirement – reference values and focus groups

The daily requirement of iron is individual and depends on age, gender and phase of life.

The iron requirement results from the daily iron losses via stool, urine and sweat and amounts to about 1 mg per day. Women have additional losses due to menstruation. However, it is not sufficient to take in the required amount of about 1 mg of iron per day with food. When our body absorbs iron from food, only a portion enters the blood via the intestinal cells. The remaining iron is excreted via the intestine. Only about 10–15 % of the iron in food is actually available to our body. The German Society for Nutrition (DGE) has taken this into account in its recommendations for iron intake. To cover the daily iron requirement of about 1 mg, adults are recommended to take in between 10 and 15 mg of iron in their diet.

Recommended iron intake* mg/day

Age	**	
Adults 19 to under 25 years	15	10
Adults 25 to under 51 years	15	10
Adults 51 to under 65 years	10	10
Adults > 65 years	10	10

*D-A-CH (Germany, Austria, Switzerland) reference values for nutrient intake, 2nd edition 2018.

** non-menstruating women who are not pregnant or not breastfeeding: 10 mg/day

Continuation next page

Recommended iron intake*	mg/day	
Focus group	♀ **	♂
Babies until 4 months	0.5	0.5
Babies 4 to under 12 months	8	8
Children 1 to under 4 years	8	8
Children 4 to under 7 years	8	8
Children 7 to under 10 years	10	10
Children 10 to under 13 years	15	12
Children 13 to under 15 years	15	12
Youth 15 to under 19 years	15	12

Focus group	♀
Pregnant women	30
Breastfeeding mothers	20

* D-A-CH reference values for nutrient intake, 2nd edition 2018

** non-menstruating women who are not pregnant or not breastfeeding: 10 mg/day

Additional demand in growth periods

Iron requirements are particularly high in children and adolescents during the growth phases. In the first 12 months of life, birth weight triples and body height doubles by the beginning of the second year of life. The brain also grows enormously during this time and in the first years of life. For this amazing development and the many growth spurts thereafter, children need all their strength and also iron. In girls, iron levels may be impaired when they get their period and also in boys due to the considerable increase in muscle mass during puberty.

Additional needs in maternity

During the nine months of pregnancy, the iron requirement doubles from 15mg/day to 30mg/day. The developing baby or the additional hematopoiesis for blood flow to the uterus requires about 1,000mg of iron over and above the normal iron requirement throughout pregnancy, which must be provided by the mother. Even during the breastfeeding period, the requirement is increased by one third (20mg). This requirement also applies to non-breastfeeding women in order to compensate for blood loss during and after childbirth.

Iron and nutrition – it depends on the source

A replenished iron store can be well maintained by a balanced diet. In addition, the body adapts within certain limits to the current iron requirement: If the iron stores are empty, it can obtain significantly more iron from food. The amount of iron absorbed varies depending on the food. Humans can utilize iron from animal foods, so-called heme iron, better than non-heme iron from plant sources, such as fruits, vegetables or grains. This is because plant iron is predominantly solid-bound and in the trivalent form (Fe^{3+}). In order for the body to absorb it, it must first convert it into a soluble form and reduce it to divalent iron (Fe^{2+}). Heme iron in red meat, poultry and fish is already dissolved as Fe^{2+} and is absorbed to more than 20%. The absorption rate from plant foods is about 5%. The rest is excreted. According to WHO data, the absorption of iron from a mixed diet is between 10–15%.

Iron content of selected foods

(Iron in mg / 100 g food)

Meat, fish, seafood

Pork, lean	1.5
Beef, lean	2.1
Turkey, breast	1.0
Lamb, leg	2.5
Beef/pork mince	2.4
Liver, pork	17.0
Anchovy	4.9
Tuna	1.0
Pollock	1.0
Mussel, triggered	4.2

Vegetables, pulses

Spinach	3.4
Chard	2.7
Broccoli	0.8
Courgette	1.0
Tomatoes	0.5
Carrots	0.4
Lamb's lettuce	2.0
Peas, frozen	1.5
Beans, white, canned	6.5
Lentils	8.0

Cereals, cereal products

Bulgur	4.5
Quinoa	8.0
Rice, brown rice, cooked	1.2
Wholemeal pasta, with egg, cooked	0.5
Wholemeal wheat flour	5.0
Wholemeal rye flour	3.7
Oatmeal	5.5
Cornflakes	2.0
Muesli, with nuts	4.4

Fruit, nuts, oilseed

Apricot, dried	4.4
Fig, dried	3.3
Raspberry	1.0
Kiwi	0.8
Sesame seeds	10.0
Pistachio kernel, without shell	7.3
Pine nut	9.2
Linseed	8.2
Pumpkin seed	4.9
Almond, sweet	4.1

Source: Heseker H. and Heseker B., Die Nährwerttabelle, 6th updated edition (2019/2020), Umschau Zeitschriften Verlag

Inhibitory factors in iron absorption

The absorption of iron is inhibited by various substances such as lignin, oxalic acid, phosphate and above all phytates, which are found in cereals, wholemeal rice, maize, legumes and soy products. Yet it is precisely these plant foods that are very rich in iron. Phytates are found in many plants and serve to store phosphate and minerals such as calcium and iron. Just as in plants, phytates can also bind iron in the intestine so that it is no longer available to the body. By grinding, heating, soaking, sprouting or fermenting foods such as grains and legumes, the phytate content can be significantly reduced.

Therefore, wholemeal breads baked with yeast and sourdough, for example, are a better source of iron than breads made with mineral leavening agents. Tannins have a similar effect to phytates, which are found in tea, coffee, wine, as well as other polyphenols in pulses or various vegetables, fruits and grains. They can also bind iron and make it inaccessible to the body.

Inhibitors of iron availability

Nutritional factor	Examples / Explanations
Phytate	in cereal products, corn, rice, whole grain products, soy products and pulses
Lignin	in linseed and wholemeal cereals
Oxalic acid	in chard, rhubarb, spinach and beetroot
Polyphenols e.g. tannins	in all plants; red wine, coffee (also without caffeine and also in cereal coffee) and tea (especially black and green tea), millet, spinach
Vegetable proteins	in all plants, especially legumes and wholemeal products
Calcium salts	in milk and cheese

Food cleverly combined

In addition to the varying availability of iron from foods iron absorption also depends on the composition of the whole diet, as different foods influence each other. By cleverly combining foods with poor iron availability with products that favour iron absorption, the iron intake of the diet can be increased 10-fold. This means that the combination of foods is more important than the level of iron content of individual foods. Thus, fruit acids of all kinds favour the absorption of vegetarian non-haem iron. Eating meat also has a positive effect. The following table gives an overview of all nutritional factors that favour iron availability:

Iron availability promoter	
Nutritional factor	**Examples/Explanations**
Vitamin C (ascorbic acid)	in all fruits, in particular citrus fruits (e.g. lemons, oranges) and their direct juices and vegetables
Fruit acids	in all fruits and fruit juices
Haem iron	in beef, roast beef, smoked pork, anchovies; Haem iron is a component of the red blood pigment haemoglobin as well as of the myoglobin of the muscle
Meat in general	improves the absorption of iron from other food components
Sulphurous amino acids	cysteine in beef and pork, oats, egg white, soybeans, poultry and salmon
Low pH level	acidic foods generally promote the absorption of iron

Iron and vitamin C – the perfect liason

The most important iron absorption promoter is vitamin C (ascorbic acid). With its help, trivalent non-haem iron can be reduced to bivalent iron and can be better absorbed into the intestinal cells. Even small amounts of vitamin C or even other organic acids, such as fruit acids in fruit and vegetables or lactic acid in sauerkraut, can increase iron absorption by a factor of two to three. Vitamin C can also counteract the inhibiting effect of phytates due to its absorption-promoting properties. A vitamin C-rich direct juice with muesli, sauerkraut with Sunday roast or a colourful fruit salad with kiwi, sea buckthorn and sesame for dessert are therefore ideal when it comes to optimising iron absorption.

Vitamin C content of selected foods

(Vitamin C in mg/100 g)

Fruits and fruit juices

Sea buckthorn berry juice	265
Acerola fruit nectar	230
Lemon	50
Orange or orange juice	45
Kiwi	45
Clementine	30

Vegetables and herbs

Parsley	160
Wild garlic	150
Sweet pepper, red	140
Brussels sprouts	110
Broccoli	95
Kohlrabi	65

Source: Heseker H. and Heseker B., Die Nährwerttabelle, 6th updated edition (2019/2020), Umschau Zeitschriften Verlag

Helpful tips and tricks for an optimal iron supply:

- ✓ A replenished iron store can be well maintained by a balanced diet.
- ✓ Within certain limits, the body adapts to the current iron requirement. If the iron stores are empty, it can obtain significantly more iron from food.
- ✓ Animal haem iron can be absorbed by the body more quickly and in greater quantities than non-haem iron from plants.
- ✓ A balanced, mixed diet is important for optimal iron absorption: even small amounts of meat or fish promote the availability of plant-based iron.
- ✓ The availability of plant-based non-haem iron from food can be improved by cleverly combining foods, e.g. by adding a glass of orange juice to muesli with oatmeal or potatoes and peppers to lentil stew.
- ✓ Vitamin C has a positive effect on iron absorption. Therefore, a vitamin C-rich juice, for example, is recommended as a drink with an iron-rich meal.
- ✓ Foods rich in oxalic acid, such as rhubarb, beetroot, chard and spinach should be eaten in moderation. By combining them with dairy products, e.g. milk, cream, curd cheese, some of the oxalic acid can be bound. Calcium and oxalic acid react to form insoluble calcium oxalate which is excreted.
- ✓ Whole grain products such as whole grain oatmeal, whole grain bread, whole grain pasta, whole grain rice are to be preferred and should be combined with vitamin C-rich fruit and vegetables: e.g. a muesli made from wholemeal oat flakes soak overnight in milk or yoghurt and mix with fresh fruit in the morning.
- ✓ Breads made using traditional sourdough are the better choice.
- ✓ Tea, coffee and red wine should be enjoyed in moderation because of the tannins they contain, and preferably only one hour after an iron-rich meal.

A few extra tips for vegetarians and vegans

✓ It is true that although vegetable food is considered a less good source of iron, vegetarians are not supplied with less iron than meat eaters.

✓ When choosing vegetables, always pay attention to the iron content. Green vegetables contain more iron than others. To increase the intake of iron from plant sources, iron-rich foods should be eaten together with foods containing vitamin C and / or organic acids, e.g. combine lamb's lettuce with peppers or oranges.

✓ Good plant sources of iron are pumpkin seeds, amaranth, flax seeds, quinoa, dried lentils, pistachios, pine nuts, oatmeal, dried apricots and spinach.

✓ Fermenting, heating, soaking or sprouting – with the right preparation, the phytate content of plant foods can be reduced and thus the iron absorption increased.

Haus Rabenhorst O. Lauffs GmbH & Co. KG
Rabenhorststr. 1 · 53572 Unkel/Rhine, Germany
www.rabenhorst-juice.com
www.rotbaeckchen.com

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