ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2020; 6(9): 300-304
www.allresearchjournal.com
Received: 01-07-2020
Accepted: 05-08-2020

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Iron deficiency anaemia: Daily iron on dinner plate

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Abstract
Iron deficiency is a concern in both developing and developed countries; Children, adolescent and pregnant, womans are particularly vulnerable. Dietary factors play a role in the development of iron deficiency and subsequent development of iron deficiency anemia. Dietary factors including ascorbic acid and an elusive factor in animal protein foods (meat; fish and poultry) enhance iron absorption; while phytic acid; soya protein; calcium and polyphenols inhibit iron absorption [1]. The aim of this review to discuss the various iron rich foods available with their iron value and bio availability of iron and how to improve the bioavailability of iron in plant foods.

Keywords: Iron, deficiency, dinner plate, WHO

1. Introduction
Anaemia can be defined by a condition in which the total haemoglobin (Hb) level or number of red blood cells (RBCs) is poorly lowered. The World Health Organisation (WHO) defines anaemia as Hb<130 g/L in men older than 15 years, 110 g/L in pregnant women, and <120 g/L in non-pregnant women older than age 15 years. Table 1 shows the definition of anaemia as defined by the World Health Organization (WHO) Iron deficiency anaemia (IDA) is a certain anaemic condition arising due to the inadequate iron to form normal RBCs. IDA is usually caused by insufficient iron intake, chronic blood loss, and increased iron demand [2]. The prevalence of IDA varies across the world. Recognizing the original aetiology and the relevant diagnostic and therapeutic issues are primary keys in the management and assessment of this disorder [2].
Iron is an important dietary mineral associated with many body functions like oxygen transport in the blood. Iron deficiency anaemia is characterized by incomplete haemoglobin synthesis that results in microcytic and hypochromic red blood cells. Due to inadequate haemoglobin, the ability of blood to deliver oxygen to the other body cells and tissues is reduced [3].

Table 1: World health organization definition of anaemia [2].

Population	Hb Diagnostic of Anaemia (g/dL)
Children aged 6 months to 6 years old	<11.0
Children aged 6-14 years old	<12.0
Adult men	<13.0
Adult non-pregnant women	<12.0
Adult pregnant women	<11.0

Iron deficiency anaemia has detrimental effects on the health of children, adolescent girls, women of reproductive age, and pregnant women. In children it can result in impaired cognitive performance, behavioral and loco-motor development, coordination, language development, and scholastic achievement, thereby severely implicating human development, besides increasing morbidity from infectious diseases.
An adolescent girl who enters the reproductive age with low iron stores and becomes pregnant during adolescence or later is at greater risk of giving birth to a low birth weight and preterm baby. The baby is also born with low iron stores and due to poor infant feeding practices is more likely than ever to enter adolescence with low iron stores in the body. Thus this vicious cycle of iron deficiency anemia continues. Women in general are more prone to anaemia than men because of smaller stores of iron and the onset of menstruation imposes

additional requirement of Iron to compensate for menstrual blood loss. In Indian girls, the highest prevalence of anaemia is reported between the ages of 12-13 years which also coincides with the average age of menarche. In girls, the lower total food intake or energy intake by compared to boys, combined with menstrual losses cause adolescent girls to be at greater risk of Iron deficiency and IDA [4].

Risk Factors of Iron Deficiency Anaemia

- Poor Dietary intake of iron resulting in deficiency of iron in the body and thus Iron deficiency anaemia
- Poor consumption of iron absorption enhancers such as vitamin C
- Dietary deficiency of vitamins such as Folic Acid, Vitamin C, Vitamin B12
- Blood loss
- Excessive demands for RBC production as a result of hemolysis

Causes

- Increased demand due to
- Menarche.
- Decreased intake of iron due to
- Inadequate diet
- Loss of Appetite
- Poor socio economic status
- Decreased absorption in gastro intestinal tract due to
- Decreased gastric acidity
- Dietary Imbalance
- Intestinal infestation [5].

Signs and symptoms of Anaemia

Definitive diagnosis of anaemia can only be made by a blood test that measures Haemoglobin (Hb) levels in the blood. However there are some signs that may assist in identifying anaemia. They include:

- Whiteness or pallor in the inner rims of the eyelid, tongue, overall skin, nails, palms of the hand.
- Soreness of the mouth, with cracks at the corners.
- Dizziness, tiredness, fatigue and low energy
- Unusually rapid heartbeat, particularly with exercise
- Shortness of breath and frequent headaches, particularly with exercise
- Lack of interest in play and studies
- Difficulty/ inability to concentrate
- Leg cramps
- Lowered resistance to infections

Iron deficiency anemia develops after normal stores of iron have been depleted in the body. Thus the signs of anemia may not be clinically visible until the anemia is severe (Hb less than 7-8 gms/dl). However, adverse impact on health occurs even before this stage is reached [5].

Dietary Involvement in Prevention of Anaemia

Primary prevention of anaemia is achieved through well-balanced diet rich in iron and other vitamins and minerals involved in iron absorption or in the production of RBCs/ Haemoglobin

Mahanta Goswami Tulika *et al*. 2015, has conducted a study on Effect of Dietary diversity and other intervention in prevalence and determinants of anaemia amongst tea tribe adolescent girls. Interventions given were dietary diversification, health promotion by monthly NHED, cooking demonstration, cooking competition and kitchen garden promotion and counselling to improve IFA compliance and remove barriers and directly observed weekly IFA supplementation. The result of the study shows that Enrolments were 802, with mean age, 14.8 years. Anaemia prevalence was 96.3% with median serum ferritin, 22.9 ng/ml. Following intervention mean haemoglobin difference was 1.48 gm/dl with 13.5% difference in prevalence. Significant association found with worm infestation, lower serum ferritin, insanitary water-sanitation facility and extra salt use, indicating infection, infestation and iron deficiency as major cause of anaemia. Dietary diversification found effective [6].

Jaber *et al*. conducted a study to determine the effect of nutritional education and supplemental iron administration on the prevalence of IDA in Arab infants. A total of 310 infants were randomized into two groups. Mothers in the control group received standard information on prevention of IDA and mothers in intervention group received extensive information on the importance of an iron rich diet and were encouraged to give their children an iron polymaltose complex (IPC) preparation starting from age 4 months to 1 year. Anaemia was recorded in 28% in intervention and 34% in control groups. Frequency of anaemia was lower in infants who received iron medication ≥ 6 months and in infants breastfed for ≥ 6 months. After this study various questions were raised regarding the strategies of preventing iron deficiency anaemia in infancy [7].

What should we eat?

1. Eat often and eat small meals that help in better absorption and digestion.

2. Include protein-rich foods

Sources of protein for vegetarians are

- Milk,
- Curds (yoghurt),
- Cheese,
- Soya nuggets,
- Tofu and
- Paneer.

In addition to above, sources of protein for non-vegetarians are

- Eggs,
- Meats
- Fish and chicken.

3. Should eat Vitamin / Mineral-rich foods / Iron-rich Foods in daily diets:

Cereals and millets: Bajra, ragi, whole wheat flour, puffed rice and rice flakes.

Legumes: Horse gram, moth beans, lentils, bengal gram dal, rajmah, peas dry, cow peas.

Non vegetarian: Chicken liver, egg yolk, mutton, chicken.

Dark green and leafy vegetables like curry leaves, mint chutney, methi, Fern leaves amaranth, drumstick leaves, Spinach, onion stalks, Banana Flower etc. daily.

Nuts and oil seeds: Til, chia seeds, groundnuts, flax seeds, almonds and pista, melon seeds, coconut dry.

Dry fruits: Raisins, black dates, apricot.

Grains: wheat, jowar, bajra, sprouted pulses, ground nut, sesame, jaggery, dried fruits

Vitamin C: Rich foods help in absorption of iron. Citrus fruits (oranges, lemon), Indian gooseberry (Amla), apple, pear are rich in vitamin C

4. Should Eat Dietary sources of folic acid

- Green leafy vegetables – Amaranth, ambat chukka, spinach, mint.
- Oil seeds like gingelly (til) and soya bean
- Orange juice
- Chickpeas
- Other legumes like green gram and red gram Black-eyed beans, cluster beans.

5. Should eat Dietary sources of B 12: Shellfish, liver, fish, lamb, egg and low fat dairy products

6. Fluids: minimum intake of 2½ -3 litres / day

What need to avoid

- Should not drink tea or coffee with the meals. Should take it an hour before or after the meal.
- Should not combine an iron-rich meal with too many calcium-rich foods like milk, cheese, paneer etc.
- Too much fiber in the diet also affects the iron absorption.
- Avoid refined and processed foods – Limit intake of pasta, noodles, polished rice, ready-to-eat foods, etc.
- Avoid pickles [8].

Plant Food Rich in Iron

Table 2: Source: (Foundation of foods and nutrition and diet therapy)

Food Group	Name	Iron, mg/100 g Contained in Raw Edible Portion
Cereals and millets	Bajra (Indian millet, *Pennisetum typhoideum*)	8
	Samai (little millet, *Panicum miliare*)	.3
	Rice bran	35.0
	Wheat germ	6.0
	Rice Flakes	20.0
	Puffed Rice	6.6 mg
Pulses and legumes	Soya bean	15.7 mg
	Chickpea(Kabuli chana)	6.2mg
	Cowpea	2.2mg
	Black lentils	9.1mg
	Green lentils (moong)	8.5mg
	Red lentils	6.6mg
	Bengal gram Dal	9.1 mg
	Peas, dry	7.1
Green leafy vegetables	Mastered leaves	1.6 mg
	Spinach	10.9mg
	Malabar Spinach	1.2mg
	Beet root	0.8mg
	Drumstick leaves	7mg
	Fenugreek leaves	16.5 mg
	Coriander leaves (5gm)	18.5mg
	Fern leaves	1.3mg
	Onoin spring	1.48 mg
	Spiny amaranth	13 mg
	Colocasia (green leaves)	10.0 mg
	Parsely	6.2mg
	Sessile joyweed	17mg
	Cabage	0.8mg
	Bathua Leaves	4.2mg
	(rosella	1.4mg
	Radis leaves	3.6 mg
	Curry leaf	3.1mg
	Amaranth tender	25.5 mg
	Mint	5.2mg
Other Vegetables	Banana Flower	56.4mg
	Drumstick	5mg
	Beans	4.5mg
	Lotus stem, dry	60.6
	Brinjal	0.2mg
	Bitter Guard	1.8mg
	Peas	1.5mg
Nuts and oil-seed	Til	10.5mg
	Watermelon seeds	7.4mg
	Garden cress seeds	100.0mg
	Almond	4.5mg
	Cashew	5.0mg
	Mustard seeds	7.9 mg

Factors Influencing Dietary Iron Absorption

The bioavailability of dietary iron is the proportion of iron that is actually available for absorption and utilization by the body. The bioavailability of food and dietary iron is influenced by certain factors, some of which are briefly described below.

Haem and non-haem iron: Food iron is classified as either haem iron (the iron from meat, poultry and fish), or non haem iron (from cereals, pulses, legumes, fruits and vegetables). In humans, haem iron is well absorbed and its absorption varies little with the composition of the meal. Absorption is inversely related to the quantity of iron stores in the body, i.e. absorption ranges from 15 to 25 percent. The absorption of non-haem iron ranges from 2 to 20 percent. The specific rate of absorption of non-haem iron from plant foods is highly dependent on the effect of concomitantly ingested dietary components (reducing substances such as ascorbic acid keep iron in the reduced ferrous form) and the amount of body iron stores. Severely iron-deficient individuals absorb non-haem iron at higher rates than those with normal iron.[8]

Phytates and polyphenols.

The iron in Indian diets is mainly non-haem, the absorption of which is inhibited by food components, primarily phytates in grains, legumes, nuts, vegetables, roots and fruits, and polyphenols (tannates) in tea, coffee, vegetables, herbs and spices. Phytates can decrease non-haem iron absorption by 51–82 percent, and are found in higher concentrations in unrefined, non- or under-milled cereals than in refined, milled cereals. Fermentation can degrade the phytate and increase the bioavailability of iron in bread made from whole wheat flour (Brune *et al*., 1992).

Calcium

Calcium from dairy products interferes significantly with iron absorption of both haem and non-haem iron. Studies showed that about 30–50 percent more iron was absorbed when no milk or cheese was served with the main meal, which provided most of the dietary iron. The first 40 mg of calcium in a meal showed no inhibiting effect, whereas 300–600 mg of calcium inhibited iron absorption by 60 percent, which is the maximum inhibition of iron (Hallberg *et al*., 1991; Hallberg, 1998).

However, in an Indian study, the absorption of iron from cereal-based milk diets was shown to be better than that of meat or fish diets (Narasinga Rao *et al*., 1983). The high iron availability of breast milk, which averages 50 percent (compared to 10–20 percent in cow's milk), is reduced when breast milk is taken together with cow's milk or weaning foods. Weaning foods should there for be given separately from the breast milk (Chaudhary and Vir,1994). Because calcium is also an important nutrient, it should be included in the diet for optimum health. Practical solutions for the competition of calcium with iron is to increase iron intake, increase its bioavailability or avoid taking calcium and iron-rich foods at the same time.

Soybean: Soy protein in a meal reduces the amount of iron absorbed (Hallberg and Rossander, 1982). It has been found that the iron availability of an Indian meal is lowered more by adding soy milk than soy meal (Christian and Seshadri, 1989), but the effect of soybean on non-haem absorption has been controversial (Hallberg and Rossander, 1982). Some fermented soy sauces have, however, been found to enhance iron absorption (Baynes *et al.*, 1990).

Ascorbic acid

Ascorbic acid (vitamin C) is the most potent enhancer of non-haem iron absorption even in the presence of inhibitors such as phytates, tannates and calcium. It can reduce food ferric iron to the better absorbed ferrous iron by 75–98 percent.

In Indian studies, the addition of ascorbic acid to cereals and pulses enhanced the available iron (NIN, 1992). In cereal-based diets, absorption was the best for rice and vegetable combinations, which may result from ascorbic acid present in the vegetables (Narasinga Rao *et al.*, 1983). Daily intake of guava fruit with the two major meals by young anaemic women resulted in a significant increase in iron. In a community-level study, anaemic preschool children were given supplements of 100 mg synthetic ascorbic acid at each of their two daily meals for a period of two months; this improved their iron levels significantly and the prevalence of anaemia was reduced from 96 to 26 percent (Seshadri *et al*., 1985).

In regional meals, the addition of citrus fruit juices or a portion of potato, cauliflower or cabbage increased iron availability markedly (Seshadri, 1993; Chaudhary and Vir, 1994). The addition of 25 mg of ascorbic acid as lemonade consumed at two meals a day doubled the absorption of iron from a meal and improved the iron status of the participating women (García *et al*., 1998).

The comprehensive review has shown that a food source containing 50 mg of ascorbic acid consumed with the main meal (Cook and Monsen, 1977) providing most of the daily intake of iron enhances iron bioavailability significantly. Ascorbic acid also improves the availability of iron from fortified foods. The enhancing effect of ascorbic acid is dose-dependent, but little extra benefit is derived by increasing the intake of ascorbic acid beyond 100 mg in a meal. The influence of ascorbic acid is greatest on meals with low iron bioavailability, such as vegetarian meals.

Diaz Margarita (2003) *et al.* conducted a study in rural Mexico on sustainable approach to improving iron status at the community level to encourage the consumption of local ascorbic acid–rich foods, in conjunction with meals high in non heme iron. Fifteen non pregnant, non lactating, iron-deficient (ferritin < 12 μg/L) women ($\bar{x}$ ± SD age: 28.3 ± 7.7 y) fasted overnight and were brought to a community clinic. After an initial blood sample, subjects consumed 0.25 mg Fe with both breakfast and lunch for 14 d. On day 29, another blood sample was taken, and a reference dose of 2.7 mg Fe with 25 mg ascorbic acid was given. For the following 15 d, participants consumed 0.25 mg Fe added to both breakfast and lunch with 25 mg ascorbic acid added to each meal as limeade. A final blood sample was taken on day 59.

The results shows when 25 mg ascorbic acid as limeade was added to test meals twice a day for 2 wk, iron absorption increased significantly (P< 0.001) in every subject: the mean absorption rose from 6.6 ± 3.0% to 22.9 ± 12.6% [4].

Table 3: Shows locally available Common fruit rich in Vit C

Fruits Name	Vitamin C/100gm
Amla 	600 mg of vitamin C
Gauva 	222.8mg
Lime 	29.1mg
Lemon, sweet (Mitha)	53mg
Pineapple 	47.8mg
Orange 	53.2 mg
Tomato, ripe	23 mg
Melon 	8.1mg

Conclusion

The review concluded that Nutrition education programmes is very much importantn to addressing the issue of iron deficiency within different population groups with varying dietary habits, socio-economic situations and nutritional and health status. Provision of Nutrition education and iron rich food based diet plan will be improve the dietary pattern of anemic adolescent, children and pregnant women.

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