Tea and Iron Absorption

Introduction

Iron has several vital functions in the body, it's major role being as an Oxygen carrier in blood haemaglobin and muscle myoglobin. In addition, it is a component of many enzymes and is required for a number of metabolic processes. Deficiency in dietary iron is the most common nutritional deficiency in the world and can ultimately result in anaemia.

Sources of Dietary Iron

Dietary iron is available in two valence states, Fe^{2+} (ferrous) and Fe^{3+} (ferric). The majority of ferrous iron is found in haem iron and the majority of ferric iron is found in non-haem iron.

- Haem iron is present in the haemaglobin and myoglobin of animals and as a result is found in meat, liver, offal and meat products. This form of iron is relatively available and typically 20-30% of haem iron is absorbed from the diet, although this can rise to 40% in situations of iron deficiency.[1] The level of haem iron absorption is relatively unaffected by other dietary factors.
- Non-haem iron is found in plant foods such as cereals, vegetables, pulses, dried fruit, etc and compared to haem iron it is relatively poorly absorbed, typically less than 10% and often under 5%. The absorption of non-haem iron is much more influenced by an individual's iron status and several factors in the diet that can either inhibit or enhance its absorption.

In the average UK diet, iron mainly comes from[2]:-
- Cereal products (42%)
- Meat and meat products (23%)
- Vegetables (15%)

Enhancers of dietary non-haem iron absorption

- Vitamin C found in fruit, fruit juice and vegetables, enhances iron absorption by reducing the ferric iron to the more readily absorbed ferrous form. In addition, it also protects any iron in the ferrous form from being oxidised back to the ferric form.
- Animal products provide an unidentified substance that appears to promote the absorption of non-haem iron.
- Organic acids such as citric acid and lactic acid (found in fermented products such as sauerkraut) have been found in some studies to enhance the absorption of non-haem iron. The nature of this effect has still yet to be established, although the lower pH in the duodenum, caused by these acids, helps to activate phytase (the enzyme responsible for the breakdown of phytate) in these products[3].

Inhibitors of dietary non-haem iron absorption

- Phytate found in the bran of wheat, oats, maize and other cereals strongly inhibit non-haem iron absorption by interacting with it, rendering it less soluble and thus less available for absorption.

- Calcium appears to interfere with the absorption of iron,[4-5] although the mechanism is unknown.
- Phenolic compounds found in tea, coffee, red wine, some leafy vegetables, nuts and legumes are responsible for the inhibition of iron absorption. It appears to be the galloyl group in these compounds that is responsible for the inhibitory effects.[3]

Dietary Requirements and Deficiency

Individual requirements for dietary iron vary according to age, gender and diet. Low iron intakes are common in the UK population, especially females[6]. Other at risk groups include young infants, teenage girls, premenopausal and pregnant women and the elderly. Iron deficiency ultimately results in anaemia, however, functional consequences may occur even in the absence of anaemia[7], including adverse effects on work capacity, intellectual performance, behaviour and immunological responses.

Tea Drinking and Iron Absorption

Tea drinking mainly influences the absorption of non-haem iron as haem iron is relatively unaffected by tea.

The inhibitory effects of tea drinking on iron absorption was first identified in a study that used test meals fed under experimental conditions.[8] A few studies have attempted to quantify the effect of tea on non-haem iron absorption.[9-11] These studies concluded that tea does have an inhibiting effect on iron absorption, however it has been proposed that findings from experiments using human or animal models based on test meals fed under experimental conditions may not reflect the role of tea when consumed as part of a complex, real diet.[12]

Tea Drinking and Iron Status

It would be expected that if tea has a strong inhibitory affect on non-haem iron absorption it would be associated with a poor iron status. A number of population studies have investigated this hypothesis. Studies investigating tea drinking in children show a higher incidence of anaemia amongst tea drinkers compared to non-tea drinkers[13-15]

Results from studies in adults looking at the effects of tea drinking on iron status are conflicting. Mehta et al[16] found a negative association between total cups of coffee and tea consumed and risk of anaemia. In contrast, Razagui, et al[17] found that meal time drinking was strongly negatively associated with serum ferritin levels in a group of long stay mentally handicapped women.

Similar findings have been found in elderly subjects, where a low consumption of total iron, haem and non-haem iron and ascorbic acid, and higher intakes of calcium, dietary fibre and tea and coffee consumption was found in healthy subjects with low iron stores compared to those with good iron status.[18]

These short term studies indicate that there maybe a negative association between tea drinking and iron status in a number of different populations. However, these studies do not necessarily show cause and effect ie that negative iron status is as a result of tea drinking instead it shows that a group who had a low iron status also had a higher intake of tea. Moreover, they have not controlled adequately for other factors

that are likely to affect iron status e.g. genetic factors, other dietary factors and status of an individual's iron stores. For this reason no firm conclusions can be drawn from these results. In an attempt to address these other factors, Dr Michael Nelson from King's College, London investigated the data from the National Diet and Nutrition Survey (NDNS) in a review on tea drinking and iron status[19]. Information from the NDNS is collected by social class thereby showing differences in dietary intakes according to a number of parameters and therefore likely to reveal any effect of diet on iron status. He concluded that there was no clear evidence from this survey that the higher levels of tea consumption found in the manual social class households is specifically associated with poorer iron status. Further studies are required in this area before any firm conclusions can be made. In addition, because the rate of iron absorption is dependent in part on iron status, some authors have concluded that people could adapt to low iron intakes or low iron bioavailability over time and maintain good iron status.[20]

Practical advice for tea drinking in relation to iron status

- There is no evidence to suggest that tea drinking should be restricted in healthy individuals who are not at risk of iron deficiency and are consuming a well balanced, mixed diet.
- People who have a poor iron status should avoid drinking tea with meals and up to at least one hour after the meal. Any adverse effects that tea may have on iron absorption are then likely to be minimised.
- Certain groups are at higher risk of poor iron status, including infants and toddlers, teenage girls, premenopausal women and men aged 75 years and over. Based on the published evidence in the UK, the higher rates of poor iron status amongst these groups cannot be directly linked to tea drinking. However, it would be prudent to recommend that tea is not drunk with meals or up to one hour after the meal.
- Moderate tea drinking (3-4 cups) spread throughout other times of the day is unlikely to have any adverse effect on iron status. The inhibitory effect of tea on iron absorption maybe partially overcome by the simultaneous consumption of animal tissues and Vitamin C. [21]

In Summary…

Tea consumption will not result in iron deficiency for healthy individuals who are consuming a varied and balanced diet.

The absorption of iron from food is generally low and is influenced by a number of factors including the quantity of iron consumed, the chemical form (haem versus non-haem), interaction with other dietary factors and the individual's physiological condition (status of iron stores, period of growth, menstruation or pregnancy).

Haem iron present in good amounts in meat, offal and meat products is readily absorbed and is unaffected by tea drinking. Non-haem iron found in cereals, vegetables, dried fruit, legumes and nuts is less well absorbed and its absorption is influenced by a wide variety of dietary factors which include enhancers e.g Vitamin C (present in fruit and fruit juice) and animal tissue (meat), and inhibitors e.g. phytate (bran) and tea (polyphenols).

Therefore for those who have a poor iron status or are at high risk of iron deficiency it would be prudent to avoid drinking tea with meals.

Otherwise moderate tea drinking (3-4 cups) spread throughout other times of the day is unlikely to have any adverse effect on iron status, and in fact at this level can actually bring about other health benefits thereby helping to promote overall health and well being.

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