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The effect of some beverage extracts on intestinal iron absorption

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Summary: The effect of some beverage extracts namely anise, mint, caraway, cumin, tilia, liquorice, karkade and tea, on the absorption of iron was tested in tied-off intestinal segments of rats. The rate of intestinal iron absorption was calculated in terms of an absorption index. The tannin, phytic acid and ascorbic acid contents of these beverages were analysed.

The results show that anise, mint, caraway, cumin, tilia, liquorice, arranged in decreasing order of their effect, promoted the absorption of iron. Karkade did not exert an appreciable effect while tea inhibited absorption. The results are discussed in relation to the content of these beverages of tannins, phytic or ascorbic acids. It is recommended to offer these beverages to children and also to adults as a preventive agent to iron deficiency anemia. Also can be used for the preparation of bioavailable medicinal iron.

Zusammenfassung: Es wurde der Einfluß von einigen Getränkeauszügen wie Anis, Minze, Kümmel, Cumin, Tilia, Süßholz, Karkade und Tee auf die Eisenresorption im Darm von Ratten untersucht. Die Eisenresorptionsrate wurde im Verhältnis zum Resorptionsindex berechnet. Der Tanningehalt sowie der Gehalt an Phytin- und Ascorbinsäure dieser Getränke wurde ermittelt.

Die Untersuchungsergebnisse zeigen, daß Anis, Minze, Kümmel, Cumin, Tilia und Süßholz in der Reihenfolge ihrer Erwähnung eine abnehmende Wirkung auf die Zunahme der Eisenresorption haben. Karkade hat keinen Einfluß auf die Eisenresorption, während Tee sie verhindert. Die Ergebnisse werden in bezug zum Tanningehalt und zum Phytin- oder Ascorbinsäuregehalt dieser Getränke diskutiert. Es wird empfohlen, diese Getränke Kindern und Erwachsenen als vorbeugendes Mittel bei Eisenmangelanämie zu geben.

Key words: iron, absorption, beverages, anemia, anise, mint, caraway, cumin, tilia, liquorice, karkade, tea

Schlüsselwörter: Eisenresorption, Getränke, Anämie, Anis, Minze, Kümmel, Cumin, Tilia, Süßholz, Karkade, Tee

I Introduction

In most cases the iron deficiency anemia is due to the poor bioavailability of the ingested iron. This is particularly true in countries where the diet is predominantly composed of cereal or legumes. Iron present in such food, although appears to satisfy the nutritional requirements, yet, its bioavailability is poor (1, 2).

A highly bioavailable iron salt is essential for successful combating of anemia, that spread among different sectors of the population not only in developing countries but also in developed ones (3).

Beverages, such as anise, caraway, cumin, karkade, liquorice, mint, tilia and tea are given to children in our country some times as worm drinks between meals, and also as a remedy from diseases such as diarrhea or common cold. Little informations are available concerning the influence of these beverages on the bioavailability of iron.

The aim of the present study is to show how these beverages affect intestinal absorption of iron, and whether they are useful as promotors to iron absorption.

Material and methods

The experiments were done on Spraque-Dawley albino rats of body weight ranging from 95–140 g and comprising both sexes. The groups of rats comprised from 6–7 litters.

The solution of beverages were prepared as usually done at homes. Table 1 shows the method of preparation and quantity of ingredient used. The iron test solution was ($FeCl_3 \cdot 6\ H_2O$) dissolved in 0.01 N HCl saline.

The phytate content in the beverage extract was determined by the method of Haug and Lantzsch (4). Tannin content was estimated by the method of Hagerman and Butler (5). Ascorbic acid was measured by the method of Association of Vitamin Chemists (6). The blood hemoglobin concentration was determined by the method of Betke and Savelsberg (7).

The dose given was formed by adding 1 ml from beverage extract to 1 ml of iron solution. This dose contains 500 n mol Fe, and was labelled with active iron (^{59}Fe) obtained from (Institute National des Radioéléments, B-6220 Fleurus, Belgium).

Table 1. Method of preparation of beverage extract.

No.	Beverage	Means of preparation	g/100 ml
1	Anise	Seeds boiled with distilled water for 5 min	2.5 g/100 ml
2	Caraway	Seeds boiled with distilled water for 5 min	2.5 g/100 ml
3	Cumin	Seeds boiled with distilled water for 5 min	2.5 g/100 ml
4	Karkade	Seeds boiled with distilled water for 5 min	5 g/100 ml
5	Liquorice	Powder infused in distilled water for 3 h	5 g/100 ml
6	Mint	Dried leaves boiled with distilled water for 5 min	1.5 g/100 ml
7	Tea	Black tea added to boiling distilled water for 1 min	1.5 g/100 ml
8	Tilia	Dry leaves boiled with distilled water for 5 min	1.5 g/100 ml

Each dose contains an activity that measured about 100,000 cpm in the Gamma Scintillation Counter (Nuclear Interprise Scaler Ratemeter SR5). The pH of the dose was measured before injection.

The absorption experiments were done in tied off segments of the intestine in vivo (8). The segment measured 20 cm and comprised both the duodenum and the front part of the jejunum. After an overnight fast, the iron dose was injected into the tied-off segment during ether anaesthesia. One hour after dosing, blood was withdrawn by open-heart puncture. The intestinal segment was removed, washed three times, each with 20 ml of physiological saline. The liver was separated. The rest of the body was placed in a polyethylene bag.

The ^{59}Fe activity in each of blood, liver, intestinal segment and the rest of the body was measured in the Gamma Counter. The measurements were corrected for the background and decay rate of the isotope.

The absorption index was calculated according to the following equation:

$$\text{Absorption index} = \frac{^{59}\text{Fe activity in blood + liver + rest of the body}}{^{59}\text{Fe activity of the given dose}} \times 100$$

Results

The results of analysis of the beverages are shown in Table 2. The blood hemoglobin concentration of rats used in these studies ranged from 11.3–12.4 g/100 ml.

Absorption of iron

The measured activity of ^{59}Fe in the rest of the body, blood, liver, and intestine of rats given the iron dose with beverages from the family umbelliferae is shown in Table 3.

Compared to rats given iron alone the addition of each anise, caraway or cumin to the dose caused a significant increase in the ^{59}Fe content of the measured organs. The intestinal segment contained significantly lower content of ^{59}Fe due to addition of each of anise or cumin. The absorption index amounted to 14.1, 33.7, 30.0 and 30.9 % for each of iron alone, with anise, caraway or cumin respectively.

The ^{59}Fe activity measured in the body of rats given other beverages with the iron is shown in Table 4.

Table 2. Ascorbic acid, tannin, phytic acid and iron contents of ingredients used in this study (mg/100 g dry weight).

No.	Beverage	Ascorbic acid	Tannin	Phytic acid	Iron
1	Anise	14.4	trace	trace	37.7
2	Caraway	7.2	trace	10.0	15.1
3	Cumin	7.2	trace	10.0	31.3
4	Karkade	36.0	trace	trace	128.5
5	Liquorice	10.8	trace	10.0	118.2
6	Mint	trace	133.0	trace	156.6
7	Tea	24.0	1733.0	28.0	31.2
8	Tilia	12.0	trace	8.0	24.7

Table 3. Mean values ± S.E. of ^{59}Fe activity in rest of the body, blood, liver and intestinal segment, 1 hour after injection of the labeled iron dose alone or with the added beverage solution in tied-off segments of normal rats.

Given dose (1 ml)		^{59}Fe Activity (cpm) in			
		Rest of the body	Blood	Liver	Intestine
$FeCl_3 \cdot 6H_2O$	Mean	10470	2424	1161	77378
	± S.E.	1565	434	146	6129
$FeCl_3 \cdot 6H_2O$	Mean	27030	4653	2038	52049
+	± S.E.	5976	518	434	7771
Anise pH 2.3	P <	0.025	0.01	S.S.	0.05
$FeCl_3 \cdot 6H_2O$	Mean	22804	5242	1970	70869
+	± S.E.	3752	840	285	6666
Caraway pH 2.2	P <	0.025	0.025	0.05	N.S.
$FeCl_3 \cdot 6H_2O$	Mean	24309	3770	2802	26338
+	± S.E.	1040	342	177	1990
Cumin pH 2.4	P <	0.001	0.05	0.001	0.001

Anise, caraway, and cumin belong to the family umbelliferae.

Table 4. Mean values ± S.E. of ^{59}Fe activity in rest of the body, blood, liver and intestinal segment, 1 hour after injection of the labeled iron dose alone or with the added beverage solution in tied-off segments of normal rats.

Given dose (1 ml)		^{59}Fe Activity (cpm) in			
		Rest of the body	Blood	Liver	Intestine
$FeCl_3 \cdot 6H_2O$	Mean	10470	2424	1161	77378
pH 2.1	± S.E.	1565	434	146	6129
$FeCl_3 \cdot 6H_2O$	Mean	12347	2011	837	46409
+	± S.E.	2009	143	94	6362
Karkade pH 2.6	P <	N.S.	N.S.	N.S.	0.01
$FeCl_3 \cdot 6H_2O$	Mean	24333	6190	3051	55862
+	± S.E.	3342	900	1173	6630
Mint pH 3.0	P <	0.005	0.005	N. S.	0.05
$FeCl_3 \cdot 6H_2O$	Mean	2428	441	461	83247
+	± S.E.	776	173	116	2966
Tea pH 2.6	P <	0.001	0.005	0.005	N.S.
$FeCl_3 \cdot 6H_2O$	Mean	17340	2183	1865	51635
+	± S.E.	1104	247	164	9863
Tilia pH 2.4	P <	0.01	N.S.	0.01	0.05
$FeCl_3 \cdot 6H_2O$	Mean	15989	2531	1731	23762
+	± S.E.	898	223	175	4522
Liquorice pH 3.1	P <	0.025	N.S.	0.05	0.001

The results show that mint and tilia enhanced absorption of iron with an absorption index of 33.6 % and 21.4 %. Karkade caused a non significant increase in the ^{59}Fe content in the rest of the body (absorption index 15.2 %). Liquorice slightly enhanced the absorption of iron. The absorption index was 20.3 %. Tea markedly diminished absorption of iron (absorption index 3.3 %). The intestinal segment contained significantly lower content of ^{59}Fe in case of karkade, mint, tilia and liquorice, but higher value in case of tea. However, such higher value is not significantly different from control.

Discussion

In general, beverages that promoted the absorption of iron were anise, mint, caraway, cumin, tilia, liquorice, and karkade, while tea hindered iron absorption. Evaluation of the action of these beverages was based on the absorption index of each. The enhancement of iron absorption due to addition of each of these beverages to the iron dose depends on the net interaction of promotors or inhibitors of iron absorption present in the beverage. Anise extract is free of tannin and phytic acid. It also contains relatively higher content of ascorbic acid relative to caraway, cumin, and tilia. Tannin and some forms of phytic acid are known to diminish the absorption of iron (9, 10). The tannin content of tea is more than 20 times that present in some of these beverages. This may explain the inhibitory action of tea on iron absorption. In addition, it was found that phytic acid content of tea is the highest among other beverages analysed.

Although, caraway, cumin and liquorice contain relatively higher content of phytic acid yet, caraway and liquorice considerably enhanced iron absorption. It seems that this form of phytate is the monoferric phytate that was reported to exert no hindrance effect on iron absorption (11).

These three beverages do not contain tannins which may also contribute to their enhancing action on iron absorption.

Although the absorption index of iron in rats given caraway with the iron dose is less than that in case of anise, yet the ^{59}Fe content of blood of rats given karaway with the iron dose is higher. This indicates that more iron is incorporated into red blood cells in rats given caraway, i.e. better utilization.

The other beverages namely mint, tilia, karkade and liquorice promoted the absorption of iron to varying degrees. A remarkable effect of mint is manifested in the marked increase of ^{59}Fe content in blood and liver. This shows that in addition to the enhancing action of mint to iron absorption, it also enhances utilization and storage.

An important observation is that the intestinal ^{59}Fe content is higher in case of beverages that hindered iron absorption, while it is lower in beverages that enhanced absorption. The accumulation of iron in the intestinal mucosa may be the cause of hindrance to iron absorption (8).

The promoting action of such beverages to iron absorption makes us recommend mothers to offer such drinks to their children from time to time or between meals. This will help to improve the bioavailability of iron in the gut. It is also possible to make use of such beverages for the preparation of medicinal iron.

References

1. Martinez-Torres C, Layrisse M (1974) Interest for study of dietary absorption and iron fortification. World Rev Nutr Diet 19:51
2. El-Shobaki FA, Saleh N (1986) The effect of food stuffs commonly consumed in Egypt on iron absorption and utilization. J Sci Food Agric 37:64
3. WHO, Tech Report Series (1968) No 405, pp 1–37
4. Haug W, Lantzsch HJ (1983) Sensitive method for the rapid determination of phytate in cereal products. J Sci Food Agric 34:1423
5. Hagerman AF, Butler TC (1978) Protein precipitation method for the quantitative determination of tannins. J Agric Food Chem 26:809
6. Association of vitamin chemists (1951) Methods of Vitamin Assay. Interscience Publishers, Inc, New York
7. Betke K, Savelsberg W (1950) Stufenphotometrische Hämoglobinbestimmung mittels Cyanhämoglobin. Z Biochem 320:431
8. El-Shobaki FA, Rummel W (1977) Mucosal transferrin and ferritin factors in the regulation of iron absorption. Res Exp Med 171:243
9. Roy SN, Mukherjee S (1979) Influence of food tannins on certain aspects of iron metabolism: Part 1. Absorption and excretion in normal and anemic rats. Indian J Biochem Biophys 16:93
10. Gillooly M, Bothwell TH, Charlton RW, Torrance JD, Bezwoda WR, MacPhail AP, Derman DP (1984) Factors affecting the absorption of iron from cereals. Br J Nutr 51:37
11. Morris ER, Ellis R (1976) Isolation of monoferric phytate from wheat bran and its biological value as an iron source to the rat. J Nutr 106:753

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