JHE

JOURNAL OF HOME ECONOMICS, MENOUFIA UNIVERSITY

Website: https://mkas.journals.ekb.eg

Print ISSN 2735-5934 **Online ISSN** 2735-590X

Nutrition and Food Sciences
Article Type: Original article

Received: 06 Feb 2025
Accepted: 16 Mar 2025
Published: 1 Apr 2025

Potential Effect of Some Commercial Beverages on Nano-Iron Absorption and Related Hematological Parameters in Rats

Amira Darweesh, Rania Eid, Asmaa Gamal Noureldin

Department of Nutrition and Food Sciences, Faculty of Home Economics, Menoufia University, Shibin El Kom, Egypt

*Corresponding author: Amira Darweesh, e-mail: amira_hamdy75@yahoo.com

ABSTRACT:

Commercial beverages, specifically coffee and tea, contain polyphenolic compounds, including caffeine, catechins, and chlorogenic acids. These compounds can form complexes with iron, enhance gastric acid production, and inhibit iron absorption within the gastrointestinal tract, particularly non-heme iron. This study aims to investigate the effects of selected beverages on the absorption of nano-iron and various hematological parameters in male rats. Thirty male rats were provided with a basal diet enriched with nano-iron at a concentration of 35 µg Fe/kg body weight, with the dietary iron being replaced accordingly. The rats were divided into five distinct groups. The first group was the positive control group, which received only the nano-iron diet. The remaining groups were administered the nano-iron diet with 2.5 mL of tea, coffee, cocoa, or Nescafe three times a day over four weeks. Several parameters were assessed, including CBC, serum iron (SI), serum ferritin (SF), and liver enzyme levels. Iron intake, fecal iron content, and absorption were also meticulously examined. The findings indicated that tea significantly reduced iron absorption efficiency, recorded at 40.18%. In contrast, coffee and cocoa demonstrated moderate iron absorption rates of 45.33% and 42.26%, respectively, while Nescafe exhibited the lowest absorption rate at 32.24%. Furthermore, regular consumption of these beverages appeared to influence hematological parameters, with Nescafe having the most substantial effect, followed by tea and coffee. In conclusion, this study demonstrates that tea and Nescafe are significant inhibitors of iron absorption. This characteristic should be considered when developing dietary recommendations for iron nutrition.

Keywords: Serum Iron, Caffeine, Tea, Coffee, Nescafe, Serum Ferritin

Cite as: Darweesh et al., 2025, Potential Effect of Some Commercial Beverages on Nano-Iron Absorption and Related Hematological Parameters in Rats. JHE, 35 (2), 1-13. DOI:10.21608/mkas.2025.358663.1369

1. INTRODUCTION

Iron deficiency is the most common micronutrient deficiency in the world and has a major negative influence on development and health, especially in women and children. Reduced erythropoiesis and compromised cellular metabolism are the outcomes of iron deficiency anemia (IDA), which is caused by inadequate iron intake, excessive loss, or poor absorption[1]. Many researchers have showen that nano iron is absorbed via the typical non-

heme pathways without abnormal accumulation in tissues, indicating its safety for nutritional applications[2,3] . Since many plant meals contain strong absorption inhibitors such as phytic acid or polyphenol compounds, poor absorption of non-heme iron is a common cause of iron insufficiency[4]. In the human diet, polyphenols such as flavones, flavanones, anthocyanidins, isoflavones, and isoflavanones are found in a variety of foods, including fruits, vegetables, spices, legumes, and cereals. They are particularly abundant in tea, coffee, chocolate, and various herbal teas[5] . It is estimated that 1 g of polyphenols is consumed daily in the USA, whereas up to 0.5 g are consumed daily in the UK from tea alone. When food or drink is digested, phenolic compounds are generated, and they can combine with iron in the human gut to prevent absorption[6].Coffee has been demonstrated to have an inhibiting effect on iron absorption from composite meals that is around half that of black tea. Many vegetables with a high polyphenol content and other drinks, such as cocoa, have also been shown to prevent the absorption of iron [7]. The high plants in phenolics reduced Fe absorption from a composite meal of rice, fish, and vegetables by almost 90% [4]. Therefore, this study aimed to evaluate the effect of consuming polyphenol and caffiene containing beverages on nano-iron absorption.

2.MATERIAL AND METHODS

2.1.Materials:

2.1.1 Tea, coffee, cocoa, and Nescafe

Tea, coffee, cocoa, and Nescafe were bought in an adjacent market in Shebin El Kom, Menoufia Governorate, Egypt, and identified by the botanist of the Botanical Taxonomy Department, Agriculture Faculty, Menoufia University.

2.1.2 Chemicals and Kits:

The experiment utilized analytical-grade chemicals. The kits used to measure the various parameters quantitatively were bought from Biodiagnostic Co. in Dokki, Giza, Egypt. Casein, vitamins, minerals, cellulose, and D-L methionine were obtained from Morgan Chemical Co., Cairo, Egypt.Corn oil was purchased from the local marketplace . Nano-iron and other chemicals of analytical grade were purchased from El-Ghomhorya Company for Trading in Drugs, Chemicals, and Medical Instruments, Cairo, Egypt.

2.1.3 Rats:

Thirty adult male albino rats of the Sprague strain, weighing about 145±10 g, were received from the animal house at the Elwan farm, Egypt.

2.2.Methods:

2.2.1 Preparation of tea, coffee, cocoa and nescafe beverages

The selected beverages were prepared by boiling 100 ml of water and then, adding 5 g of selected beverages for 3-5 minutes as described by FSSAI [8] .Determination of phytochemicals in selected beverages: total phenol compounds, flavonoids, total polysaccharides, total terpenoids, total triterpenoids, tannins, alkaloids and anthocyanins were determined according to Singleton & Rossi [9], Zhishen *et al*.[10],Vazirian *et al.* [11] , Łukowski *et al*.[12], Schneider *et al*.[13], Van-Burden & Robinson[14], Harbome [15] and Solovchenko *et al.* [16] ,respectively.

2.2.2 Experimental design:

Rats were housed in well-aerated cages under hygienic conditions and fed on a basal diet for one week for adaptation ad libitum in the animal house, Faculty of Home Economics, Menoufia University. The basal diet consists of

cornstarch (69.5%), protein (10%), corn oil (10%), cellulose (5%), mineral mixture (4%), vitamin mixture (1%), methionine (0.3%), and choline chloride (0.2%). Components of vitamin and salt mixtures are created using the same reference [17]. After the period of adaptation, rats were fed a basal diet containing nano-iron at the level of 35 µg Fe/kg bw by replacing the diet's iron; they were divided into five equal groups. The first group was fed on a nano-iron diet only as a positive control group; the others were fed on a nano-iron diet and received orally 2.5 mL of tea, coffee, cocoa, and Nescafe three times daily, respectively for 4 weeks. The average consumption of selected beverages by rats was calculated according to Paget & Barnes [18], who reported that the average human consumption of soft drinks is one bottle per day (200ml per day), animal dose/200gB.w. equals human dose/1000×18.

2.2.3 Biochemical analysis

At the end of the experimental period (4 weeks), rats were fasted overnight, then anesthetized and incised longitudinally, and blood samples were collected from the aorta. Serum was extracted from the centrifuged blood samples to determine certain biochemical parameters including.

Creatinine, urea, and uric acid levels were determined using an enzymatic colorimetric given by [19], [20] and [21], respectively.The colorimetric method was used to determine AST and ALT according to Reitman &Frankel [22], while ALP activity was determined according to the methods of Moss [23]. Malonaldehyde (MDA), glutathione peroxidase (GSH-Px), catalase (CAT) activity and superoxide dismutase (SOD) were measured using the methods of Buege & Aust [24] ,Splittgerber & Tappel [25], Aebi [26] and Mett & Müller [27], respectively. The Dacie and Lewis technique, [28] was used to determine hemoglobin (HB), hematocrit (HT), red blood cells (RBC), SI, and SF. The mean corpuscular volume (MCV) was calculated by dividing the hematocrit value by the RBC count using the following formula [29]:

MCV = HCT/RBC ×10.

Transferrin saturation (%) was computed using the accompanying formula [29]:

Saturation percentage = (concentration of serum iron ÷ TIBC) × 100.

2.2.4 Feces samples

Iron in rat feces and its diet were ascertained by using flame atomic absorption spectrophotometry (Perkin Elmer, Norwalk, CT, Model 5100 PC) according to [30]. Fe Absorption (%) was calculated according to (29) using the following equations:

$$\text{Fe Absorption (\%)} = \frac{\text{Fe intake (mg)} - \text{Fe in feces}}{\text{Fe intake}} \times 100$$

2.2.5 Statistical analysis

The data were displayed as mean ± standard deviation, and statistical significance was evaluated using one-way analysis of variance (ANOVA). Indicative of statistical significance was a p-value of less than 0.05. For data analysis, the SAS user's guide was used [31].

2.2.6 Ethical Considerations

The animals were handled and cared for in accordance with the rules for animal handling during the study. The ethics committee gave its approval to the protocol number (MUFHE/F/NFS/41/24).

3. Results and Discussion

Bioactivity of secondary metabolites of tea, coffee, cacao, and Nescafe beverages was presented in Table 1. It was found that tea had the highest concentration of total phenolics (13742.3 mg GAE/100g), which was significantly higher than coffee, cacao, and Nescafe which were 3315.7, 1470.39 and 2627.7 mg GAE/100g ,respectively.While Nescafe contained the highest flavonoid and polysaccharide contents followed by tea and coffee, whilst, cacao was the least. For terpenoids and triterpenoids, coffee contains the highest lev-

els followed by tea whereas cacao has significantly lower levels than the others. Although, tea exhibits the highest tannin concentration. Nescafe and coffee had nearly anthocyanin content while cacao had the least. The highest amount of caffeine and alkaloids was found in the tea sample and the lowest amount was recorded in cacao. Gallic acid in coffee and tannic acid in tea both decrease iron absorption to the same degree; galloyl groups and chlorogenic acid also contribute to this inhibitory effect, albeit to a smaller degree. Tea polyphenols, such as catechins, and their derivatives have been linked to neurodegenerative diseases in both experimental and animal investigations [32]. Research has indicated that when taken with meals, tea, and coffee, which are high in polyphenols, might considerably reduce the absorption of iron [33]. By binding to iron and decreasing its bioavailability, tannins and polyphenols are known to prevent iron absorption [34]. Therefore, the assessment of antioxidant activity should therefore consider several variables, including experimental setup, sample preparation techniques, and the physiological significance of the assays [35].

Table (1): Bioactivity of secondary metabolites in selected commercial beverages

Assy	Tea Mean±SD	Coffee Mean±SD	Cacao Mean±SD	Nescafe Mean±SD	LSD
Total phenolics (mg GAE/100g, d.b.)	13742.3^{a}±594.9	3315.7^{b}±127.9	1470.39^{d}±120.20	2627.7^{c}±25.9	584.28
Flavonoids (mg CE/100g, d.b.)	400.4^{a}±20.4	392.8^{b}±3.96	175.45^{c}±13.27	585.88^{b}±175.3	166.68
Polysaccharides (mg starch.100 g-1)	276.13^{b}±9.23	392.8^{b}±3.9	98.10^{c}±1.1	586.80^{a}±175.3	165.33
Terpenoids (mg LE/100 g-1 d.b.)	423.61^{b}±23.9	461.0^{a}±2.2	128.49^{c}±3.02	401.90^{b}±3.2	23.03
Triterpenoids (mg UE.100 g-1 d.b.)	284.1^{b}±6.1	300.5^{a}±2.6	39.40^{d}±2.3	251.6^{c}±2.1	6.90
Tannins (mg VE/100g, d.b.)	4015^{a}±28.2	2264.3^{b}±193.7	982.93^{c}±10.5	2178.10^{b}±21.8	185.7
Anthocyanins (µg QE/100g, d.b.)	0.47^{b}±0.04	0.78^{a}±0.03	0.15^{c}±0.02	0.81^{a}±0.02	0.06
Caffeine (mg/100g, d.b.)	2982.2^{a}±16.8	2168.9^{b}±29.2	792.9^{d}±8.85	1189.8^{c}±55.1	61.40
Alkaloids (mg/100g, d.b.)	294.2^{a}±4.06	279.1^{b}±1.8	32.2^{d}±2.2	197.4^{c}±3.3	5.70

Values are expressed as mean ± SD; Values in the same row having different superscripts letters are significantly (P≤0.05) Abbrev. GAE, gallic acid equivalent; CE, catechin equivalent; LE, linalool equivalent; VE, vanellic acid equivalent; UE, ursolic acid equivalent; QE, quercetin equivalent.

The impact of selected commercial beverages on iron intake, iron excretion, and iron absorption in both the control and selected beverage groups is presented in Table 2. The control group had the lowest iron intake (51.3 mg/kg), while groups receiving 2.5ml oral tea and coffee had higher intake (60.85 mg/kg and 60.37 mg/kg, respectively). For iron excretion in feces, the control group had lower fecal iron excretion (25.2 mg/kg), which suggested better absorption efficiency compared to other tested groups. Rats that received 2.5ml oral administration of tea showed the highest value in Fe in feces (36.4 mg/kg), indicating a significant portion of the ingested iron is not absorbed and is instead excreted through feces. Concerning iron absorption percentage, the control group had the highest percentage of iron absorption (50.87%), while the tea group showed a notable decrease in absorption efficiency (40.18%). This is because rats fed a standard diet had low levels of Fe excretion in their feces, and polyphenol compounds had a negative impact on Fe absorption that reflected the importance of dietary composition in managing iron status effectively. This agrees with several authors who reported that polyphenolic compounds found in beverages like tea and coffee are potent inhibitors of iron absorption. Also, tea, has been shown to inhibit iron absorption more than other beverages, such as cocoa and herbal teas [36]. Although, there were no significant differences ($P \leq 0.05$) in Fe intake between both tea and coffee groups, the group that consumed coffee demonstrated the best absorption with reduced iron in feces, indicating a significant improvement in iron metabolism. The higher

amounts of tannins and caffeine (see Table 1) in tea compared to coffee may be a reason for the difference in iron absorption. These results agree with Hurrell *et al.*[37] who indicated that caffeine's known interference with iron absorption, particularly by forming insoluble complexes with iron in the gastrointestinal tract. Also, according toFuzi *et al*.[38] caffeine may slightly decrease iron absorption, although substances taken in conjunction with caffeine appear to have a bigger impact on this process . Iron-binding polyphenols found in tea and coffee create insoluble complexes that prevent iron absorption. Also, iron absorption decreases when tea (62%) or coffee (35%) is served with meals [39]. Cacao exhibited moderate absorption rates (42.26%), while, the lowest Fe absorption was observed in rats fed on 2.5ml oral administration of Nescafe which recorded (32.24%). This may be because Nescafe contains high amounts of total phenols, tannins and caffeine (see table 1), which have a negative effect on iron absorption. This agreement with Li *et al*.[40] who found that caffeine decreases hepcidin expression, which regulates iron absorption in the intestines and release from stores. Moreover, studies showed that beverages with high polyphenol content can reduce iron absorption by 50-90% [36].

Table (2): Fe intake, Fe feces and Fe absorption in rats fed basal diet and selected beverage groups

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
Fe intake (mg/kg)	51.20^{b}±3.20	60.85^{a}±3.65	60.37^{a}±4.13	54.21^{ab}±2.71	54.76^{ab}±2.06	6.27
Fe in feces (mg/kg)	25.20^{c}±1.30	36.40^{a}±2.90	$3300.^{ab}$±0.60	31.30^{b}±1.50	$3700.^{a}$±1.80	3.67
Fe absorption (%)	50.87^{a}±3.63	40.18^{b}±3.32	45.33^{b}±1.07	42.26^{b}±3.24	32.24^{c}±2.04	4.44

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly (P≤0.05).

Effects of selected commercial beverages on hematological indicators in male albino rats are shown in Table 3. The results showed that the control group had the highest hematological indicators except for WBC. While the other groups showed significantly decreasing hematological indicators compared to the control group. While the group reserved Nescafe, it showed a higher (*P≤0.05*) level in WBC counts than the control group and other groups. The rats received a 35 mg/kg nano-iron diet and 2.5 ml oral administration of Nescafe (G5), which had the highest effect on blood components, which may lead to hematological alterations, contributing to conditions like anemia and inflammation. From the obtained results, the reduction in most hematological parameters in groups consuming selected commercial beverages points toward the inhibitory effects of caffeine and polyphenols on iron absorption and hematopoiesis. Many authors reported that polyphenols, particularly tannins, are known to form complexes with iron, making it less bioavailable [37]. Different research indicated that brown drinks could pose a potential risk toward either limiting the incorporation of iron within our body or obstructing the synthesis of hemoglobin within the blood. This was the outcome of studies on caffeine and polyphenol-containing beverages like tea and coffee [41 and 42]. Several attempts have been made to analyze the impact of Nescafé on some of the hematological parameters. The outcomes of the studies differ quite broadly some of them reported important changes, whereas some showed insignificant changes based on the context of drinking Nescafé. Interestingly, in diabetic Wistar rats, the consumption of Nescafé coffee caused important changes in some of the hematological parameters as a function of dose. At the dominant dosages of Nescafe, there was an observed sufficient change, which may be considered negative regarding some aspects of the health of blood [43].

The effect of selected beverages on SI, SF, TIBC and TS in experimental rats is shown in Table

4. The control group had the highest SI, SF, TS which values 133.2 µg/dL, 131,09 µg/dL and 47.85%, respectively. SI, SF and TS were significantly ($P \leq 0.05$) decreased in selected beverage groups (tea, coffee, cacao and Nescafe) compared with the control group while TIBC had the opposite trend. This agrees with [44] who found that tea and coffee beverages significantly decrease serum iron and ferritin levels in rats. Another study found that a decrease in serum ferritin levels was linked to an increase in coffee consumption [45]. Increased coffee consumption is associated with decreased serum ferritin levels in Korean adults, with men drinking ≥3 coffees/day suggesting a possible iron deficit with a geometric mean of 92.2 ng/mL and women 28.9 ng/mL [46]. In contrast, a study by [47] demonstrated that the levels of iron and ferritin in serum of coffee group were less than the tea group and this group was lower compared to the control group.The stronger inhibitory effect of tea observed in this study may be attributed to its high tannin content, which reduces iron absorption. Additionally, preparation methods, frequent intake, and timing relative to meals enhanced this effect.

Table (3): Effects of selected beverages on hematological parameters in rats

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
Hemoglobin(g/dl)	$13.09^{a}\pm0.05$	$10.89^{b}\pm0.79$	$11.32^{b}\pm0.11$	$11.39^{b}\pm0.31$	$10.7^{b}\pm0.47$	0.80
MCV (fl)	$92.50^{a}\pm1.50$	$80.00^{b}\pm4.50$	$83.6^{b}\pm2.5$	$84.0^{b}\pm1.00$	$13.0^{c}\pm2.00$	4.78
MCH (pg/cell)	$30.00^{a}\pm1.00$	$14.00^{d}\pm2.00$	$17.0^{c}\pm2.00$	$21^{b}\pm1.00$	$12.0^{d}\pm1.00$	2.69
MCHC (g/dl)	$32.50^{a}\pm1.50$	$17.00^{c}\pm4.3$	$19.6^{bc}\pm0.57$	$22.3^{b}\pm1.50$	$16.0^{c}\pm2.00$	4.29
Hct (%)	$47.40^{a}\pm0.85$	$31.50^{d}\pm1.3$	$33.3^{cd}\pm1.6$	$38.8^{b}\pm1.7$	$36.5^{bc}\pm5.08$	4.75
RBC ($\times10^{6}$/µl)	$4.89^{a}\pm0.04$	$4.05^{c}\pm0.150$	$4.13^{bc}\pm0.12$	$4.29^{b}\pm0.02$	$4.01^{c}\pm0.09$	0.18
Platelets ($\times10^{3}$/µl)	$229.00^{a}\pm2.00$	$224.30^{ab}\pm1.5$	$216^{b}\pm6.08$	$213.6^{b}\pm8.3$	$198.0^{c}\pm7.00$	10.34
WBC ($\times10^{3}$/µl)	$5.00^{b}\pm0.11$	$5.07^{b}\pm0.09$	$5.25^{b}\pm0.06$	$5.16^{b}\pm0.03$	$6.5^{a}\pm0.60$	0.54

Values are expressed as mean ± SD, Values in the same row having different superscripts letters are significantly (P≤0.05). MCV: Mean Corpuscular Volume, MCH: Mean Corpuscular Hemoglobin, MCHC: Mean Corpuscular Hemoglobin Concentration, Hct: Hematocrit, RBC: Red Blood Cell Count.

Table (4): Effects of selected beverages on serum iron, ferritin, TIBC and TS in rats

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
Serum Iron (µg/dl	$133.20^{a}\pm1.96$	$82.74^{c}\pm7.13$	$90.61^{c}\pm3.70$	$107.07^{b}\pm8.30$	$80.96^{c}\pm1.59$	9.69
Serum Ferritin (µg/L)	$131.09^{a}\pm1.11$	$64.49^{c}\pm7.80$	$78.95^{c}\pm7.60$	$99.19^{b}\pm6.01$	$63.26^{c}\pm8.46$	12.06
Serum TIBC (µg/dl)	$278.30^{c}\pm5.0$	$383.50^{a}\pm10.90$	$369.16^{a}\pm7.30$	$335.97^{b}\pm13.27$	$385.40^{a}\pm1.92$	15.85
TS (%)	$47.85^{a}\pm4.35$	$21.57^{c}\pm1.07$	$24.54^{c}\pm2.04$	$31.87^{b}\pm1.63$	$21.00^{c}\pm2.00$	4.52

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly (P≤0.05). TIBC: Serum Total Iron Binding Capacity, TS: Transferrin saturation.

Table 5 illustrated the effects of selected beverages on oxidative stress parameters and antioxidant biomarkers in male albino rats. Data indicated that control group (G1) had the lowest MDA levels (0.94±0.01) whereas, the other groups showed a significant increase in MDA levels. As regarding to SOD, CAT and GSH, control group showed the highest level while they decreased in the other groups especially group 5 that showed the lowest decreasing in antioxidant parameters. The obtained results are in the same line with Dludla *et al*. [48] who reported that coffee consumption can reduce biomarkers of oxidative stress and inflammation, which can be essential in alleviating cardiovascular disease risk in healthy individuals. Furthermore, by decreasing ROS production, blocking caspase-3 activation, and boosting antioxidant enzymes like glutathione peroxidase, glutathione reductase, and glutathione-S-transferase, other flavanols found in cocoa,

such as epigallocatechin-3-gallate and procyanidin B_2, shield $CaCO_2$ cells from oxidative stress [49].

Table (5): Effects of selected beverages on oxidative stress (MDA) and antioxidant biomarkers (SOD, CAT and GSH) in male albino rats

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
MDA (nmol/ml)	0.94d±0.01	1.26a±0.02	1.30b±0.03	1.15c±0.08	1.41a±0.03	0.08
SOD (Unit/ml)	13.93a±0.04	11.58bc±0.11	11.35c±0.29	11.8b±0.28	10.85d±0.11	0.35
CAT (Unit/ml)	46.21a±0.4	32.55c±1.76	31.69c±1.82	37.19b±2.09	25.6d±2.45	3.34
GSH (ug/ml)	189.35a±1.68	163.53c±5.14	163.38c±4.25	172.87b±2.78	156.1d±2.81	6.45

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly (P≤0.05). MDA: Malondialdehyde, SOD: Superoxide Dismutase, CAT: Catalase, GSH: Glutathione.

The data presented in Table 6 showed the levels of creatinine, urea, and uric acid in different experimental groups received beverages tea, coffee, cacao and Nescafe. The results revealed that control group showed the lowest level of creatinine, urea, and uric acid, indicating no kidney stress. Regardless urea and uric acid in group 2 (given the oral administration of tea) showed non-significant with control group, while group 3 (given the oral administration of coffee) indicated a moderate increase in creatinine, urea and uric acid compared to control group. Data in the same table illustrated that the oral administration of nescafe had the highest significant (*P<0.05*) levels of creatinine, urea and uric acid which were 1.36±0.09, 27.5±1.57 and 3.92±0.25 mg/dl, respectively as compared to the normal control which recorded 0.53±0.01, 17.32±0.63, 2.94±0.09 mg/dl for the same parameters, respectively.it was found that cacao's polyphenols and flavanols are widely recognized for their antioxidant properties, which may mitigate oxidative stress and improve metabolic and renal health in animal models and humans (50). Yuan *et al*.[51] demonstrated that tea decreased uric acid levels by reducing the activity of adenosine deaminase (ADA) and hepatic xanthine oxidase (XOD), which lowers uric acid synthesis, and by increasing uric acid excretion by modifying the expression of renal urate transporter proteins. In contrast Choi & Curhan [52] discovered that drinking tea had no effect on lowering uric acid levels or the prevalence of hyperuricemia. Additionally, a Korean cohort study found no correlation between the incidence of hyperuricemia and higher tea consumption.Mazidi *et al.* [53] detected no significant association between coffee consumption and renal function or risk of chronic kidney disease (CKD).

Table (6): Effects of selected beverages on creatinine, urea and uric acid in male albino rats

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
Creatinine (mg/dl)	0.53d±0.01	0.82c±0.03	1.21b±0.05	0.78c±0.03	1.36a±0.09	0.099
Urea (mg/dl)	17.32c±0.63	19.5c±0.56	23.01b±1.75	17.67bc±1.81	27.5a±1.57	2.40
Uric acid (mg/dl)	2.94c±0.09	3.06bc±0.2	3.28b±0.8	2.96bc±0.05	3.92a±0.25	0.29

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly (P≤0.05).

Effects of selected beverages on liver enzymes ALT, AST and ALP in male albino rats were shown in Table 7. From such data it could be noticed that group 5 who received 2.5 ml oral administration of Nescafe, exhibited significantly (*P≤0.05*) increased levels of AST, ALT and ALP compared to the normal group. As for ALT and AST intervention with 2.5 ml oral administration of selected beverage tea, coffee

and cacao three times per day for 28 days,there are no significant (*P>0.05*) differences as compared to the normal controls. On the other hand, ALP in rats that received 2.5 ml oral administration of tea showed a non-significant difference when compared with the control group.While group 4 (rats that received the 2.5 ml oral administration of cacao showed a moderate level of ALP enzyme. These results match with the results obtained by Abrokwah *et al*.[54], who discovered that no appreciable alterations in the levels of ALT, AST, and ALP were noted during the time that cocoa was administered to the experimental animals. This indicates that the administration of cocoa had no negative impact on the functioning of the implicated organs because the treatment had no influence on these serum enzyme levels. In contrast, Wei *et al.*[55] suggested a beverage such as cacao or coffee the increased metabolic load caused by caffeine and theobromine may result in modest increases in liver enzymes.

Table (7): Effects of selected commercial beverages on ALT, AST, and ALP in male albino rats

Parameters	Control group	Selected beverage groups				LSD
		Tea	Coffee	Cacao	Nescafe	
ALT (U/L)	31.69^{b}±2.10	31.96^{b}±1.30	$35.64a^{b}$±2.50	33.41^{b}±1.70	38.68^{a}±3.20	4.06
AST (U/L)	32.98^{b}±1.11	32.95^{b}±1.82	$36.74a^{b}$±2.94	31.99^{b}±4.07	41.59^{a}±3.92	5.10
ALP(U/L)	89.03^{d}±1.39	91.91^{d}±2.06	122.03^{b}±3.32	108.91^{c}±5.81	130.23^{a}±1.91	6.06

Values are expressed as mean±SD. Values in the same row having different superscripts letters are significantly (P≤0.05). ALT: Alanine Aminotransferase, AST: Aspartate Aminotransferase, ALP: Alkaline Phosphatase.

4.Conclusion

The findings indicate that the regular consumption of certain commercial beverages, including tea, coffee, cocoa, and particularly Nescafe, adversely affects iron absorption and certain hematological parameters in rats on a nano-iron diet. Consequently, the intake of these beverages may contribute to iron deficiency and associated health issues, such as iron deficiency anemia. Therefore, it is recommended to avoid the simultaneous consumption of these beverages in substantial quantities along with iron-rich meals.

Conflict of Interest

The authors declare that there is no conflict of interest.

Funding

No fund has been received.

5. References

1. Krushnali N N, Ravindra L, Bakal P R, Hatwar A Y, Gawai S S D, Iron Deficiency Anemia: Etiology, Pathophysiology, Diagnosis, and Treatment Approaches. J. Drug Delivery Ther. 2024; 14 (11): 185-93.https://orcid.org/0000-0002-4964-4654
2. Iolascon A, Andolfo I, Russo R, Sanchez M, Busti, F, Swinkels D, Aguilar MP, Bou-Fakhredin R, Muckenthaler MU, Unal S, Porto G, Ganz T, Kattamis A, De Franceschi L, Cappellini M D, Munro MG, Taher A, from EHA-SWG Red Cell and Iron. Recommendations For Diagnosis, Treatment, And Prevention of Iron Deficiency and Iron Deficiency Anemia. Hemasphere. 2024; 15: 8(7) doi: 10. 1002/ hem3. 108. https://doi.org/10.1002/hem3.108
3. Zimmermann MB, Hilty FM, Nanocompounds of iron and zinc: their potential in nutrition. Nanoscale. 2011; 3(6): 2390-8. DOI https://doi.org/10.1039/C0NR00858C
4. Umang M, inmoy R, Manmath S, Pintu C, A. recent paradigm on iron absorption,

prevalence, and emerging dietary approaches to eradicate iron deficiency. Food Bioeng. 2023. https://doi.org/10.1002/fbe2.12042

5. Laddomada B, Blanco A, Mita G, D'Amico L, Singh R. P, Ammar K, Crossa J, Guzmán C. Drought and Heat Stress Impacts on Phenolic Acids Accumulation in Durum Wheat Cultivars. Foods. 2021; 10:2142. https://doi.org/10.3390/foods10092142
6. Merve T, Esra C. Iron Absorption: Factors, Limitations, and Improvement Methods Elif Piskin, Danila Cianciosi, Sukru Gulec. ACS Omega. 2022; 7, 20441−20456. https://doi.org/10.1021/acsomega.2c01833
7. Cagri BG. A Mini Review on The Relationship Between Coffee and Tea Consumption and Iron Absorption in The Gut – Iron Deficiency Anemia. Jpn J Clin Med Res. 2023; (3): 145 https://doi.org10.47363/JJCMR/2023(3)145
8. FSSAI (Food Safety and Standards Authority of India). Manual of Methods of Analysis of Foods – Beverages: Tea, Coffee and Chicory. FDA Bhawan, Kotla Road, New Delhi; 17 July 2023. www.fssai.gov.in
9. Singleton V, Rossi J. Colorimetry of total phenolics with phosphomolybdic phosphor-tungstic acid reagents. Am. J. Enol. Vitic. 1965; 16: 144-158. https://www.ajevonline.org/content/16/3/144
10. Zhishen J, Mengcheng T, Jianming W. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. Food chem. 1999; 64 (4), 555-559. https://doi.org/10.1016/S0308-8146(98)00102-2
11. Vazirian M, Dianat S, Manayi A, Ziari R, Mousazadeh A, Emran H, Saeidnia S, Amanzadeh Y. Anti-inflammatory effect, total polysaccharide, total phenolics content and antioxidant activity of the aqueous extract of three basidiomycetes. Res J Pharmacogn, 2014; 1, 13-19. http://rjpharmacognosy.ir/
12. Łukowski A, Jagiełło R, Robakowski P, Adamczyk D, Karolewski P. Adaptation of a simple method to determine the total terpenoid content in needles of coniferous trees. Plant Sci. 2022; 314: 111090. https://doi.org/10.1016/j.plantsci.2021.111090
13. Schneider P, Hosseiny SS, Szczotka M, Jordan V, Schlitter, K. Rapid solubility determination of the triterpenes oleanolic acid and ursolic acid by UV-spectroscopy in different solvents. Phytochem Lett. 2009; 2(2): 85-87. https://doi.org/10.1016/j.phytol.2008.12.004
14. Van-Burden TP, Robinson WC Fonnation of complexes between protein and tannic acid. J Agric Food Chem. 1981; 1, 77. https://www.sciepub.com/reference/438940
15. Harbome JB. Phytochemical Methods. Springer, India, Private Ltd. 1973. ISBN: 9788181283108. https://www.scirp.org/reference/referencespapers?referenceid=1999009
16. Solovchenko AE, Chivkunova OB, Merzlyak MN, Reshetnikova IV. A spectrophotometric analysis of pigments in apples. Russ J Plant Physiol. 2001; 48 (5): 693-700. https://doi.org/10.1023/A:1016780624280
17. Reeves PG, Nielsen FH, Fahey GC Jr. AIN-93 purified diets for laboratory rodents: final report of the American Institute of Nutrition ad hoc writing committee on the reformulation of the AIN-76A rodent diet. J.

Nutr.1993; 123: 19391951.https://doi.org/10.1093/jn/123.11.1939

18. Paget GE, Barnes JM. Toxicity tests in Evaluation of Drug Activities: Pharmacometrics (Laurence, D. R. & Bacharach, A. L., Eds.), Academic Press, London and New York. 1964. https://doi.org/10.1016/B978-1-4832-2845-7.50012-8
19. Fawcett JK, Scott JE. Enzymatic determination of urea. J Clin Pathol. 1960; 13 (2): 156-159. https://doi.org/10.1136/jcp.13.2.156
20. Jelliffe R. Estimation of creatinine clearance in patients with unstable renal function, without a urine specimen. Am J Nephrol. 2002; 22 (4): 320-324. https://doi.org/10.1159/000065221
21. Barham D, Trinder P. An improved color reagent for the determination of blood glucose by the oxidase system. Analyst. 1972; 97 (1151): 142-145. https://doi.org/10.1039/AN9729700142
22. Reitman S, Frankel S. Determination of serum glutamic oxaloacetic transaminase and serum pyruvic transaminase. Am J Clin Pathol. 1957; 28 (1): 56-68. https://doi.org/10.1093/ajcp/28.1.56
23. Moss, D W. "Alkaline phosphatase isoenzymes." Clinical chemistry vol. 28, 10 (1982): 2007-16. https://pubmed.ncbi.nlm.nih.gov/6751596/
24. Buege JA, Aust SD. Microsomal lipid peroxidation. In: Packer L, editor. Methods in Enzymology. New York, NY: Academic Press; 1978. p. 302-310. https://doi.org/10.1016/S0076-6879(78)52032-6
25. Splittgerber AG, Tappel AL. Inhibition of glutathione peroxidase by cadmium and other metal ions. Arch Biochem Biophys. 1979; 197: 534-542. https://doi.org/10.1016/0003-9861(79)90277-7
26. Aebi H. Catalase. In: Bergmeyer HU, editor. Methods of Enzymatic Analysis. New York, London: Academic Press; 1974. p. 673-677. https://doi.org/10.1016/B978-0-12-091302-2.50032-3
27. Mett J, Müller U. The medium-chain fatty acid decanoic acid reduces oxidative stress levels in neuroblastoma cells. Sci Rep. 2021; 11: 6135. https://doi.org/10.1038/s41598-021-85523-9
28. Dacie S, Lewis J. Practical Haematology. New York: Churchill Livingstone; 1998. https://books.google.com.eg/books/about/Dacie_and_Lewis_Practical_Haematology_E.html?id=rEPUDAAAQBAJ&redir_esc=y
29. Lee R, Nieman D. Nutritional Assessment. 2nd ed. Mosby: McGraw-Hill Science/Engineering / Math; 1996. https://www.scirp.org/reference/referencespapers?referenceid=2677534
30. Rodgerson DO, Helfer RE. Determination of iron in serum or plasma by atomic absorption spectrophotometry. Clin Chem. 1966 Jun; 12 (6): 338-49. https://pubmed.ncbi.nlm.nih.gov/5911779
31. Peng CYJ. Data analysis using SAS. Thousand Oaks (CA): Sage Publications; 2008.https://doi.org/10.4135/9781452230146
32. Kumera G, Haile K, Abebe N, Marie T, Eshete T. Anemia and its association with coffee consumption and hookworm infection among pregnant women attending antenatal care at Debre Markos Referral Hospital, Northwest Ethiopia. PLoS ONE. 2018; 13 (11): e0206880. https://doi.org/10.1371/journal.pone.0206880

33. Aedh A, Elfaki NK, Einas MS. Iron deficiency anemia and associated risk factors among teenagers in Najran, Saudi Arabia. Int J Med Res Health Sci. 2019; 8(5):108-114. ndmkaj/ https://www.ijmrhs.com/medical-research/iron-deficiency-anemia-and-associated-risk-factors-among-teenagers-in-najran-saudi-arabia.pdf
34. Correnti M, Gammella E, Cairo G, Recalcati S. Iron Absorption: Molecular and Pathophysiological Aspects. Metabolites. 2024; 14(4): 228. https://doi.org/10.3390/metabo14040228
35. Munteanu IG, Apetrei C. Analytical Methods Used in Determining Antioxidant Activity: A Review. Int J Mol Sci. 2021; 22 (7): 3380. https://doi.org/10.3390/ijms22073380
36. Zijp M, Onno K, Lilian B M, Tijburg. Effect of tea and other dietary factors on iron absorption. Crit. Rev. Food Sci. Nutr., 2000; 40 (5): 371-398. https://doi.org/10.1080/10408690091189194
37. Hurrell RF, Reddy MB, Cook JD. Inhibition of non-haem iron absorption in man by polyphenolic-containing beverages. Br J Nutr. 1999; 81 (4): 289-295. doi:10.1017/S0007114599000537
38. Fuzi SF, Koller D, Bruggraber S, Pereira DIA, Dainty JR, Mushtaq S. A 1-h time interval between a meal containing iron and consumption of tea attenuates the inhibitory effects on iron absorption: A controlled trial in a cohort of healthy UK women using a stable iron isotope. Am J Clin Nutr. 2017; 106 (6): 1413-1421. https://doi.org/10.3945/ajcn.117.161364
39. Chen DD, Dong XX, Yang XJ, Sun HP, Liang G, Chen X. Tea consumption and serum uric acid levels among older adults in three large-scale population-based studies in China. BMC Geriatr. 2021; 21 (1): 267. https://doi.org/10.1186/s12877-021-02216-8
40. Li Z, Geng M, Dou SR, Wang X, Zhang Z, Chang Y. Caffeine decreases hepcidin expression to alleviate aberrant iron metabolism under inflammation by regulating the IL-6/STAT3 pathway. Reprod Dev Biol. 2022; 12 (7): 1025-1025.https://doi.org/10.3390/life12071025
41. Toxqui L, Vaquero MP. Chronic iron deficiency as an emerging risk factor for osteoporosis: A hypothesis. Nutrients. 2015; 7 (5): 2324 - 2344. https://doi.org/10.3390/nu7042324
42. Teymouri F, Mirzababaei A, Moradi S, Tavakoli A, Asgari M, Setayesh L, Mirzaei K. Association between caffeine intake and anemia risk in pregnant women: A systematic review and meta-analysis of observational studies. J Preg Child Health. 2021;8(9):489.https://doi.org/10.4172/2376-127X.1000489
43. Odikpo N, Oguwike FN, Cornelius MN, Onyekachukwu O, Kosisochukwu EI, Henry E, Okechukwu PN. Nescafé coffee caused changes in hematological parameters of alloxan-induced diabetic Wistar rats. World J Adv Res Rev. 2024; 22(3).https://doi.org/10.30574/wjarr.2024.22.3.1794
44. Al-Mansury S, Hadi SJ, Naji HH, Jassim AM, Abbas SM, Hindi NK. A comparative study of the effect of coffee and tea on some parameters in the rats' blood. Med J Babylon. 2024; 21: 627 - 32. DOI: 10.4103/MJBL.MJBL_1002_23
45. Sung ES, Choi CK, Kim NR, Kim SA, Shin MH. Association of Coffee and Tea with Ferritin: Data from the Korean National Health and Nutrition Examination Survey

(IV and V). Chonnam Med J. 2018 Sep; 54 (3): 178-183.https://doi.org/10.4068/cmj.2018.54.3.178

46. Sung ES, Choi CK, Kim NR, Kim SA, Shin MH. Association of coffee and tea with ferritin: Data from the Korean National Health and Nutrition Examination Survey (IV and V). Chonnam Med J. 2018; 54 (3): 178-183. https://doi.org/10.4068/cmj.2018.54.3.178
47. Von Siebenthal HK, Moretti D, Zimmermann MB, Stoffel NU. Effect of dietary factors and time of day on iron absorption from oral iron supplements in iron deficient women. Am J Hematol. 2023 Jun 26; 98 (9): 1321–1329. https://doi.org/10.1002/ajh.26987
48. Dludla PV, Cirilli I, Marcheggiani F, Silvestri S, Orlando P, Muvhulawa N, Moetlediwa MT, Nkambule BB, Mazibuko-Mbeje SE, Hlengwa N, Hanser S, Ndwandwe D, Marnewick JL, Basson AK, Tiano L. Potential benefits of coffee consumption on improving biomarkers of oxidative stress and inflammation in healthy individuals and those at increased risk of cardiovascular disease. Molecules. 2023; 28 (18): 6440. https://doi.org/10.3390/molecules28186440
49. Ramos-Romero S, Pérez-Cano FJ, Ramiro-Puig E, Franch A, Castell M. Cocoa intake attenuates oxidative stress associated with rat adjuvant arthritis. Pharmacol Res. 2012; 66 (3): 207-212. https://doi.org/10.1016/j.phrs.2012.05.009
50. Jaramillo-Flores ME. Cocoa flavanols: natural agents with attenuating effects on metabolic syndrome risk factors. Nutrients. 2019; 11 (4): 751. https://doi.org/10.3390/nu11040751
51. Yuan D, Lin L, Peng Y, Zhou Y, Li L, Xiao W, Gong Z. Effects of black tea and black brick tea with fungal growth on lowering uric acid levels in hyperuricemic mice. J Food Biochem. 2022; 46 (7): e14140.https://doi.org/10.1111/jfbc.14140
52. Choi HK, Curhan G. Coffee, tea, and caffeine consumption and serum uric acid level: the third national health and nutrition examination survey. Arthritis Rheum. 2007; 57 (5): 816-21. https://doi.org/10.1002/art.22762
53. Mazidi M, Mikhailidis DP, Dehghan A, Jóźwiak J, Covic A, Sattar N, Banach M. The association between coffee and caffeine consumption and renal function: insight from individual-level data, Mendelian randomization, and meta-analysis. Arch Med Sci. 2021 Dec 14;18(4):900-911. https://doi.org/10.5114/aoms/144905
54. Abrokwah FK, Asamoah KA, Esubonteng PK. Effects of the intake of natural cocoa powder on some biochemical and haematological indices in the rat. Ghana Med J. 2009 Dec; 43 (4): 164-8. PMCID: PMC2956371
55. Wei D, Wu S, Liu J, Zhang X, Guan X, Gao L, Xu Z. Theobromine ameliorates nonalcoholic fatty liver disease by regulating hepatic lipid metabolism via mTOR signaling pathway in vivo and in vitro. Can J Physiol Pharmacol. 2021 Aug; 99 (8): 775-785. https://doi.org/10.1139/cjpp-2020-0259

مجلة الاقتصاد المنزلي، جامعة المنوفية
https://mkas.journals.ekb.eg
الترقيم الدولي اون لاين 2735-590X
الترقيم الدولي للطباعة 2735-5934

JHE

Received: 30 Sep 2024
Accepted: 22 Oct 2024

نوع المقالة: بحوث أصلية
التغذية وعلوم الأطعمة

تاريخ الاستلام: ٦ فبراير ٢٠٢٥
تاريخ القبول: ١٦ مارس ٢٠٢٥
تاريخ النشر: ١ ابريل ٢٠٢٥

التأثير المحتمل لبعض المشروبات التجارية على امتصاص حديد النانو والمؤشرات الدموية في الفئران

أميرة درويش، رانيا عيد، أسماء جمال الدين
قسم التغذية وعلوم الأطعمة، كلية الاقتصاد المنزلي، جامعة المنوفية، شبين الكوم، مصر.
* المؤلف المسئول: اميرة درويش -البريد الالكتروني: amira_hamdy75@yahoo.com

الملخص العربى:

تحتوى المشروبات التجارية وخاصه الشاي والقهوة على مركبات بوليفينولية مثل الكافيين، والكاتيشينات والأحماض الكلوروجينية. تُكوّن هذه المركبات معقدات مع الحديد، مما يؤدي إلى زيادة طفيفة فى إنتاج الحمض المعدي، كما أنها تُعيق امتصاص الحديد فى الجهاز الهضمى من خلال الارتباط به، خاصةً الحديد غير الهيمى. لذلك كان الهدف من البحث دراسة تأثير المشروبات تحت الدراسة على امتصاص الحديد النانو وبعض المؤشرات الدموية فى ذكور الفئران. تم تغذية ثلاثين فأر من ذكور الفئران بنظام غذائى أساسى يحتوي على الحديد النانوي 35 ملى جرام/ كيلو جرام من وزن الجسم عن طريق استبدال الحديد فى الوجبة الأساسية به وتم تقسيم المجموعات إلى خمس مجموعات، تم تغذية المجموعة الأولى على الوجبة الأساسية المستبدل بها الحديد بالحديد النانو فقط. وتم تغذية المجموعات الأخرى على الوجبة الأساسية المستبدل بها الحديد بالحديد النانو وتلقت عن طريق الفم 2.5 مل من الشاي والقهوة والكاكاو والنسكافيه ثلاث مرات يوميا على التوالى لمدة 28 يوما. تم تقدير صورة الدم ومستوى الحديد والفيرتين فى المصل وإنزيمات الكبد. كما تم تقدير الحديد المتناول والحديد فى البراز و كفاءة امتصاص الحديد. أظهرت النتائج أن الشاي سجل انخفاضا فى كفاءة امتصاص الحديد (40.18%) كما أظهرت القهوة والكاكاو معدلات امتصاص معتدلة للحديد بلغت (45.33% و 42.26%) على التوالى بينما سجل أدنى معدل امتصاص فى مجموعة النسكافيه (32.24%)، وبناء على ما سبق تشير نتائج الدراسة الى أن الاستهلاك المنتظم للمشروبات تحت الدراسة أثر على المؤشرات الدموية خاصة النسكافية ثم الشاي والقهوة وهذا يعنى أنهم من الممكن أن يقللوا امتصاص الحديد لذلك يجب أخذ هذه الخاصية في الاعتبار عند تقديم نصائح غذائية تتعلق بالحديد

الكلمات الكاشفة: الكافيين، الشاي، القهوة، النسكافيه، سيرم الحديد، سيرم الفيرتين

الاستشهاد الي:
Cite as: Darweesh et al., 2025, Potential Effect of Some Commercial Beverages on Nano-Iron Absorption and Related Hematological Parameters in Rats. JHE, 35 (2), 1-13. DOI:10.21608/mkas.2025.358663.1369