



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

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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

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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 shown 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 iso-flavanones 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 caffeine 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 De-

partment, 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]:

$$MCV = HCT/RBC \times 10.$$

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

$$\text{Saturation percentage} = (\text{concentration of serum iron} \div \text{TIBC}) \times 100.$$

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 ($P \leq 0.05$) Abbrev. GAE, gallic acid equivalent; CE, catechin equivalent; LE, linalool equivalent; VE, vanillic 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 to Fuzi *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 ($P \leq 0.05$).

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 ($P \leq 0.05$) 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 ±0.05	10.89 ^b ±0.79	11.32 ^b ±0.11	11.39 ^b ±0.31	10.7 ^b ±0.47	0.80
MCV (fl)	92.50 ^a ±1.50	80.00 ^b ±4.50	83.6 ^b ±2.5	84.0 ^b ±1.00	13.0 ^c ±2.00	4.78
MCH (pg/cell)	30.00 ^a ±1.00	14.00 ^d ±2.00	17.0 ^c ±2.00	21 ^b ±1.00	12.0 ^d ±1.00	2.69
MCHC (g/dl)	32.50 ^a ±1.50	17.00 ^c ±4.3	19.6 ^{bc} ±0.57	22.3 ^b ±1.50	16.0 ^c ±2.00	4.29
Hct (%)	47.40 ^a ±0.85	31.50 ^d ±1.3	33.3 ^{cd} ±1.6	38.8 ^b ±1.7	36.5 ^{bc} ±5.08	4.75
RBC (×10 ⁶ /µl)	4.89 ^a ±0.04	4.05 ^c ±0.150	4.13 ^{bc} ±0.12	4.29 ^b ±0.02	4.01 ^c ±0.09	0.18
Platelets (×10 ³ /µl)	229.00 ^a ±2.00	224.30 ^{ab} ±1.5	216 ^b ±6.08	213.6 ^b ±8.3	198.0 ^c ±7.00	10.34
WBC (×10 ³ /µl)	5.00 ^b ±0.11	5.07 ^b ±0.09	5.25 ^b ±0.06	5.16 ^b ±0.03	6.5 ^a ±0.60	0.54

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly ($P \leq 0.05$). 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 ±1.96	82.74 ^c ±7.13	90.61 ^c ±3.70	107.07 ^b ±8.30	80.96 ^c ±1.59	9.69
Serum Ferritin (µg/L)	131.09 ^a ±1.11	64.49 ^c ±7.80	78.95 ^c ±7.60	99.19 ^b ±6.01	63.26 ^c ±8.46	12.06
Serum TIBC (µg/dl)	278.30 ^c ±5.0	383.50 ^a ±10.90	369.16 ^a ±7.30	335.97 ^b ±13.27	385.40 ^a ±1.92	15.85
TS (%)	47.85 ^a ±4.35	21.57 ^c ±1.07	24.54 ^c ±2.04	31.87 ^b ±1.63	21.00 ^c ±2.00	4.52

Values are expressed as mean ± SD. Values in the same row having different superscripts letters are significantly ($P \leq 0.05$). 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 Dlodla *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 B₂, shield CaCO₂ 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 ($P \leq 0.05$). 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, re-

spectively. 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 ($P \leq 0.05$).

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 ($P \leq 0.05$) 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 Abrokwa *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	35.64 ^a ±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	36.74 ^a ±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 ($P\leq 0.05$). 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.

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نوع المقالة: بحوث أصلية
التغذية وعلوم الأطعمة

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

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الملخص العربي:

تحتوي المشروبات التجارية وخاصة الشاي والقهوة على مركبات بوليفينولية مثل الكافيين، والكاتيشينات والأحماض الكوروجينية. تُكوّن هذه المركبات معقدات مع الحديد، مما يؤدي إلى زيادة طفيفة في إنتاج الحمض المعدي، كما أنها تُعيق امتصاص الحديد في الجهاز الهضمي من خلال الارتباط به، خاصةً الحديد غير الهيمي. لذلك كان الهدف من البحث دراسة تأثير المشروبات تحت الدراسة على امتصاص الحديد النانو وبعض المؤشرات الدموية في ذكور الفئران. تم تغذية ثلاثين فأر من ذكور الفئران بنظام غذائي أساسي يحتوي على الحديد النانوي 35 ملغ/ كجم من وزن الجسم عن طريق استبدال الحديد في 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 والكافيو والنسكافية ثلاث مرات يوميا على التوالي لمدة 28 يوما. تم تقدير صورة الدم ومستوى الحديد والفيريتين في المصل وإنزيمات الكبد. كما تم تقدير الحديد المتناول والحديد في البراز وكفاءة امتصاص الحديد. أظهرت النتائج أن الشاي سجل انخفاضاً في كفاءة امتصاص الحديد (40.18%) كما أظهرت القهوة والكافيو معدلات امتصاص معتدلة للحديد بلغت (45.33% و 42.26%) على التوالي بينما سجل أدنى معدل امتصاص في مجموعة النسكافية (32.24%)، وبناء على ما سبق تشير نتائج الدراسة إلى أن الاستهلاك المنتظم للمشروبات تحت الدراسة أثر على المؤشرات الدموية خاصة النسكافية ثم الشاي والقهوة وهذا يعني 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، النسكافية، سيرم الحديد، سيرم الفيريتين

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