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The Consumption of some Beverages and their Potential Effects on Renal Functions in rats

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Abstract

This study was conducted to examine the effect of chronic consumption of (Green cola stevia "soda beverage", red bull " energy beverage" , Red tea and Turkish coffee) on kidney functions of female rats . Experimental study was conducted according to the guidelines of Animal Care and Ethics Committee of the NRC as well as the biochemical analysis at the Postgraduate Lab of Home Economics Faculty – Helwan University. Thirty Sprague-Dawley rats (180 ± 5 g) rats were divided into 5 groups as follows

Group (1) was fed on basal diet (as a control negative group). Group (2) was fed on basal diet and given orally (2 ml of Green cola stevia once a day).Group (3) was fed on basal diet and given orally (2 ml of red bull once a day).Group (4) was fed on basal diet and given orally (2 ml of Red tea once a day).Group (5) was fed on basal diet and given orally (2 ml of Turkish coffee once a day).

  Biological evaluation of the diet was performed by determining the feed intake, body weight gain, and feed efficiency. At the end of the experimental period (8 weeks), the rats were slaughtered to obtain blood serum. The serum was used to determine kidney function: urea, uric acid, and creatinine; Serum Vitamin D and calcium . Serum glucose and insulin and liver function (aspartate aminotransferase activity and alanine aminotransferase activity). The results showed a significant decrease in liver function, , significant increases in urea, creatinine, and uric acid in the groups administrated Green cola stevia "soda beverage", red bull " energy beverage" , Red tea and Turkish coffee as compared to the positive control group, while blood proteins (albumin,   total protein, and final body weight) of the group administrated Green cola stevia "soda beverage", red bull " energy beverage" , Red tea and Turkish coffee decreased significantly .Also insulin decreased significantly while glucose increased significantly as compared to the positive control group . the results also cleared that calcium and vitamin D deceased significantly in the group administrated Green cola stevia "soda beverage", red bull " energy beverage" , Red tea and Turkish coffee.

Keywords

Green cola stevia "soda beverage", red bull " energy beverage" , Red tea , Turkish coffee, Renal **.** rats

INTRODUCTION

Kidney diseases are a public health problem all over the world (**Crews et al., 2019**). Chronic renal failure occurs more frequently, has a bad prognosis, and costs a lot to treat. This illness not only seriously affects people's health but also poses a serious financial challenge for the worldwide health care industry (**Tu et al., 2021).** Beverage intake is an important part of dietary intake due to its potential to influence on fluid balance, nutrient intake, and metabolic pathways (**Popkin et al., 2010);** Higher consumption of sugar-sweetened beverages was associated with an elevated risk of subsequent CKD (**Rebholz et al., 2019).** However, the association between beverage consumption and CKD risk is not well established (**Heo et al., 2024).**Soft drinks consumption (SDC) has increased worldwide in the past two-three decades (**Nielsen and Popkin, 2001**). Soft drinks contain predominantly water, phosphoric acid, caffeine, sugar in the form of sucrose and other chemicals in the form of preservatives, colorings and flavors. Numerous various health problems are associated with regular consumption of soft drinks (**Adjene et al., 2010**). Caffeine in carbonated beverages is deliberately added to make individuals addicted, and is readily absorbed rapidly compared with any other drink (**Rapuri et al., 2001**). Additionally, SDC is notably associated with kidney health and a high risk of kidney stone formation (**Ferraro et al., 2013**). SDC causes bone fracture, disruption in bone formation, affects serum or urinary calcium metabolism markers and hypocalcemia, both in clinical and experimental settings (**Teófilo et al., 2010**). Preliminary research has shown that sugar-sweetened (regular) soda as well as artificially sweetened soda could influence kidney disease risk, although the evidence is not consistent (**Karalius and Shoham, 2013**). **Heo et al., (2024)** suggest that lower consumption of sugar-sweetened beverages or artificially sweetened beverages may reduce the risk of developing CKD.

The aim of the study:

The present study will be aimed to examine the effect of chronic consumption of (Green cola stevia "soda beverage", red bull " energy beverage" , Red tea and Turkish coffee) on kidney functions of female rats

Materials and methods:

Beverages : Green cola stevia, red bull, Red tea, Turkish coffee were purchased from the local market.

Chemicals: Casein, vitamins, minerals, and cellulose were purchased from El-Gomhoria Company, Cairo, Egypt.

Kits for blood analysis were e purchased from Alkan Company for Biodiagnostic Reagents, Dokki, Cairo, Egypt.

Animals: Thirty adult female rats (Sprague Dawley strain), (180±5 g.) were obtained from Helwan Farm, Ministry of Health and Population, Cairo, Egypt.

Methods:

Experimental study was conducted according to the guidelines of Animal Care and Ethics Committee of the NRC as well as the biochemical analysis at the Postgraduate Lab of Home Economics Faculty – Helwan University.

The basal diet was formulated according to **Reeves, et al., (1993).** After adaptation period, thirty rats were divided into 5 groups as follows:

Group (1) was fed on basal diet (as a control negative group).

Group (2) was fed on basal diet and given orally (2 ml of Green cola stevia once a day).

Group (3) was fed on basal diet and given orally (2 ml of red bull once a day).

Group (4) was fed on basal diet and given orally (2 ml of Red tea once a day).

Group (5) was fed on basal diet and given orally (2 ml of Turkish coffee once a day).

Nutritional evaluation: The biological evaluation of the diet was carried out by determination of feed intake, body weight gain % and feed efficiency ratio.

At the end of the experimental period (2 months), rats were fasted overnight before sacrificing, dissected under slight anesthesia by ether and the

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blood samples were collected from each rat and centrifuged to obtain serum which stored at -20°C until biochemical analysis.

Biochemical Analysis:

Serum were **used to determine the following parameters :**

Kidney functions: urea , uric acid and creatinine

Liver functions (Aspartate and alanine aminotransferase activities, Total protein and albumin).

Serum Vitamin D , calcium and phosphorus.

Serum glucose and insulin
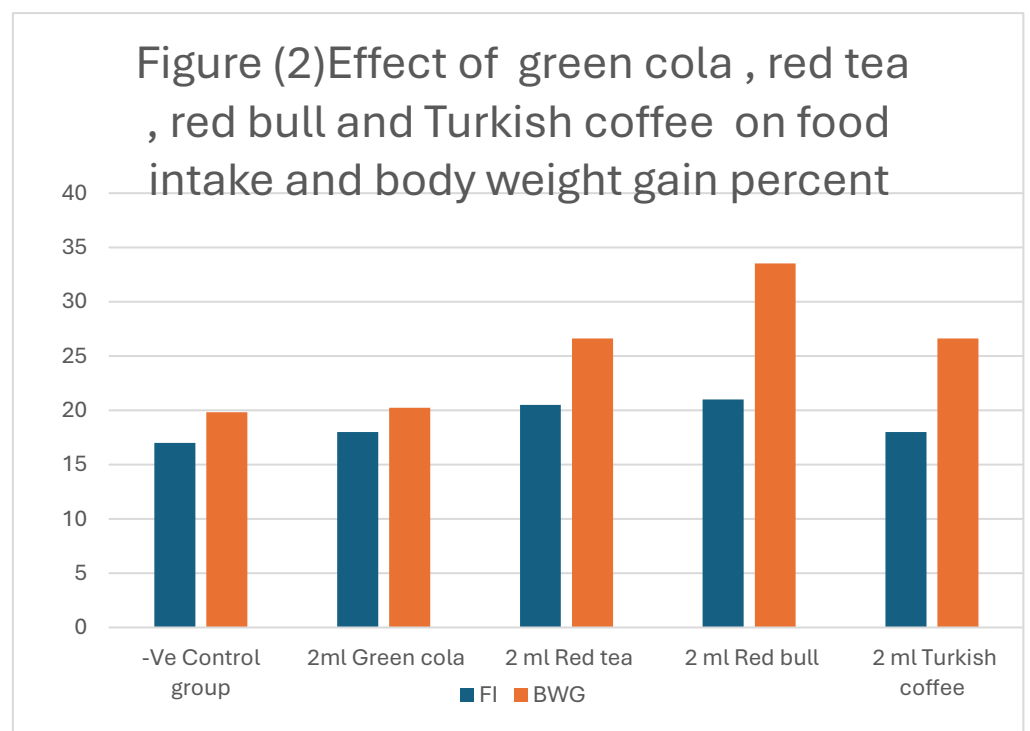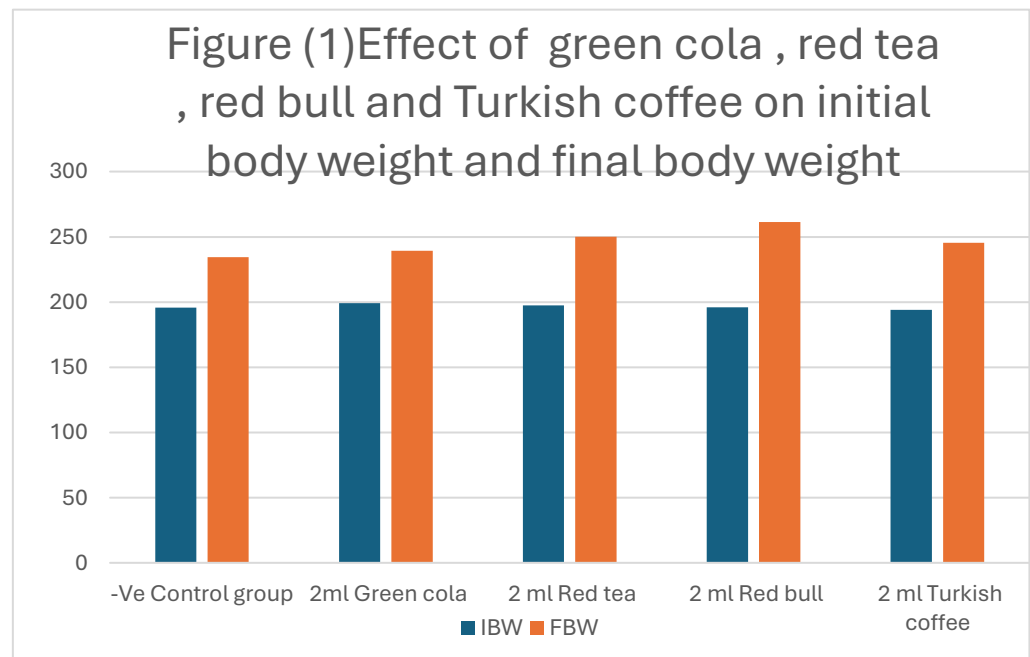
Statistical analysis:

Statistical analysis was performed using SPSS computer program (version 20). One-way analysis of variance (ANOVA) followed Duncan's multiple tests will be done. $P \leq 0.05$ will be significant.
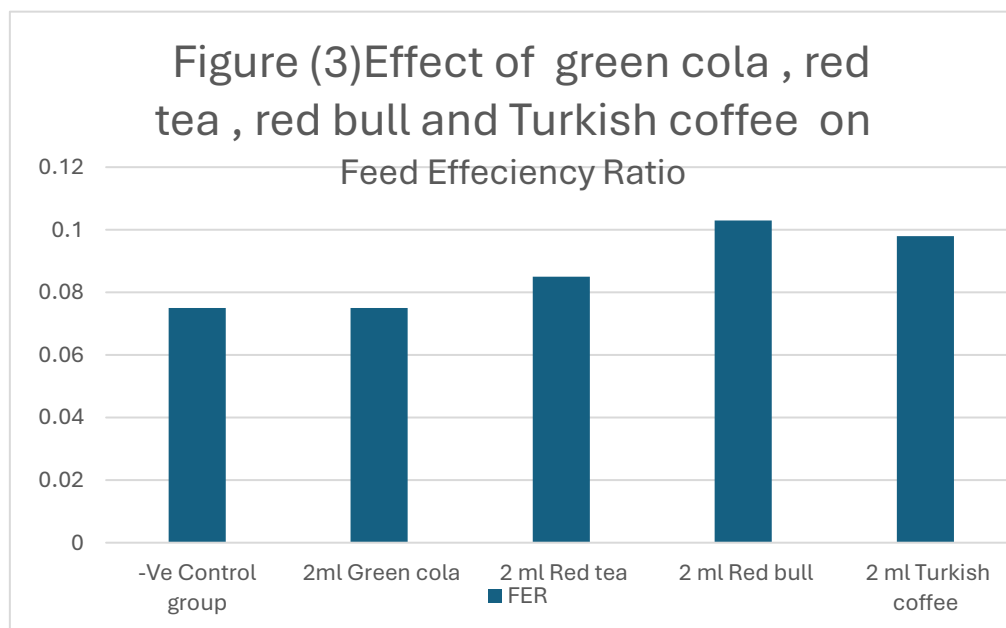
Results and discussion

Table (1) biological effect of green cola , red tea , red bull and Turkish coffee

	IBW (g)	FI (g/d/rat)	FBW (g)	BWG (%)	FER
-Ve Control group	195.87 ± 2.70^a	17.00	234.55 ± 2.10^d	19.81 ± 1.83^c	0.075 ± 0.06^b
2ml Green cola	199.12 ± 0.93^a	18.00	239.40 ± 0.67^{cd}	20.23 ± 0.65^{bc}	0.075 ± 0.02^b
2 ml Red tea	197.60 ± 1.40^a	20.50	250.15 ± 1.51^b	26.60 ± 0.98^b	0.085 ± 0.02^{ab}
2 ml Red bull	196.00 ± 3.10^a	21.00	261.35 ± 3.99^a	33.51 ± 3.90^a	0.103 ± 0.01^a
2 ml Turkish coffee	193.95 ± 2.84^a	18.00	245.47 ± 1.91^{bc}	26.61 ± 1.24^b	0.098 ± 0.03^a

Data are expressed as mean ± SE. Means with different letters in each column are significantly differs at $p<0.05$

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Figure (1)Effect of green cola , red tea , red bull and Turkish coffee on initial body weight and final body weight

Figure (2)Effect of green cola , red tea , red bull and Turkish coffee on food intake and body weight gain percent

Figure (3)Effect of green cola , red tea , red bull and Turkish coffee on Feed Effeciency Ratio

Data in table (1) and figure (1,2 & 3) showed effect of Green cola , Red tea , Red bull and Turkish coffee on body weight and food efficiency ratio in chronic renal failure rats as compared with normal rats (-Ve Control group) data indicated that weight gain increased significantly in groups fed on Red tea , Red bull and Turkish coffee as compared to groups fed on Green cola or(-Ve Control group) .also food efficiency ratio Increased significantly in CRF rats fed on Red bull and Turkish coffee as compared with other groups

The substantial sugar content in these beverages can significantly contribute to excessive caloric intake, further exacerbating glucose metabolism issues and increasing the risk of obesity **(Ariffin et al 2020)** Additionally, the high levels of stimulants such as caffeine, taurine, and guarana found in energy drinks can induce chronic stress, disrupting normal hormonal and metabolic regulation. This combination of factors could accelerate the onset of insulin resistance, obesity, and other metabolic disorders, especially in individuals already consuming poor diets.

The results of Experiment confirmed our previous findings that daily consumption of a solution sweetened with saccharin promoted greater total caloric intake and increased body weight gain relative to consuming a solution sweetened with glucose.. These findings question the longstanding notion that

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substituting high-intensity sweeteners for added sugars in food and beverages is an effective way for humans to improve weight control **(Bellisle & Drewnowski, 2007).** Tea contains a number of polyphenols, such as, for example, tannic acid (**Savolainen, 1992)**, catechins (**Zaveri, 2006**) and quercetin (**Chen et al., 2009),** substances with an antioxidant effect which are capable of chelating metals intake of tea in rats groups had significantly lower body weights **(Winiarska-Mieczan 2015)**

.Table (2)Effect of green cola , red tea , red bull and Turkish coffee on liver function

Parameters Groups	ALT(μ/L)	AST(μ/L)	ALP(μ/L)
-Ve Control group	67.86±2.72[d]	52.48±2.62[b]	150.00±3.22[d]
2ml Green cola	96.53±4.48[b]	57.26±2.12[b]	179.25±3.49[b]
2 ml Red tea	83.20±2.79[c]	55.71±1.94[b]	165.48±2.50[c]
2 ml Red bull	105.69±1.89[ab]	72.39±4.38[a]	193.58±2.63[a]
2 ml Turkish coffee	112.34±4.33[a]	76.82±1.16[a]	200.03±1.74[a]

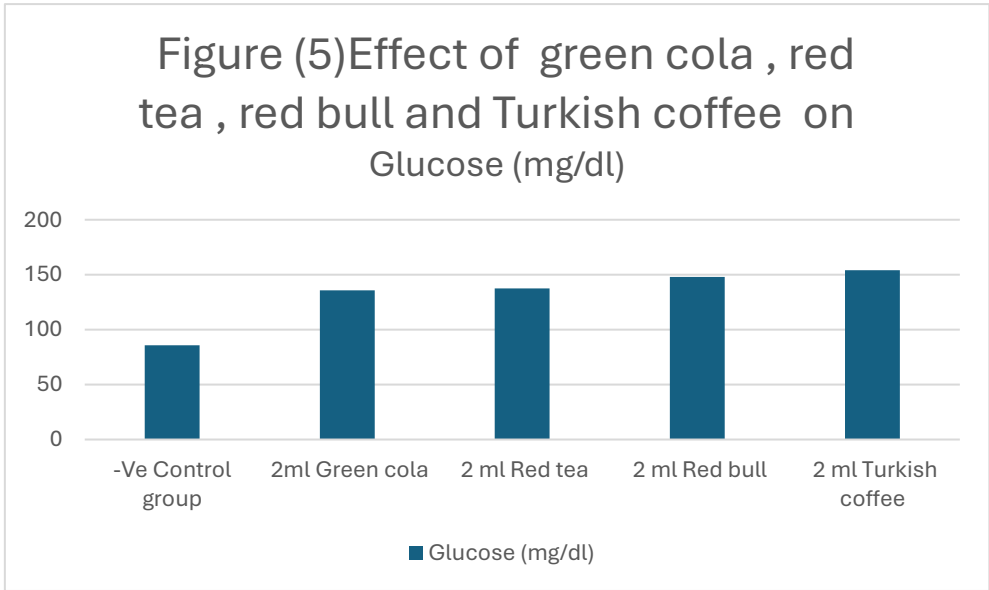Data are expressed as mean ± SE. Means with different letters in each column are significantly differs at $p<0.05$

Figure (4)Effect of green cola , red tea , red bull and Turkish coffee on liver function
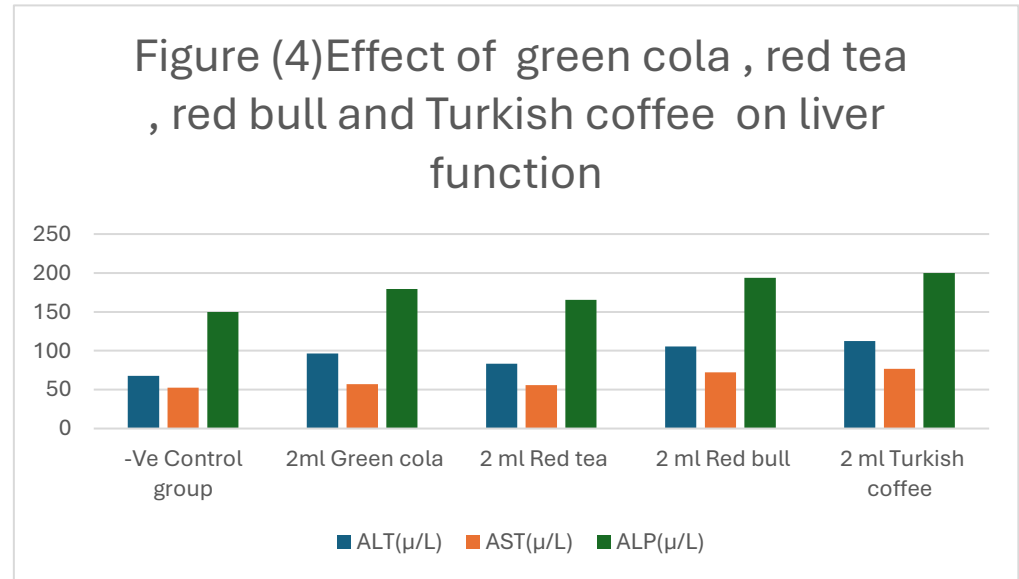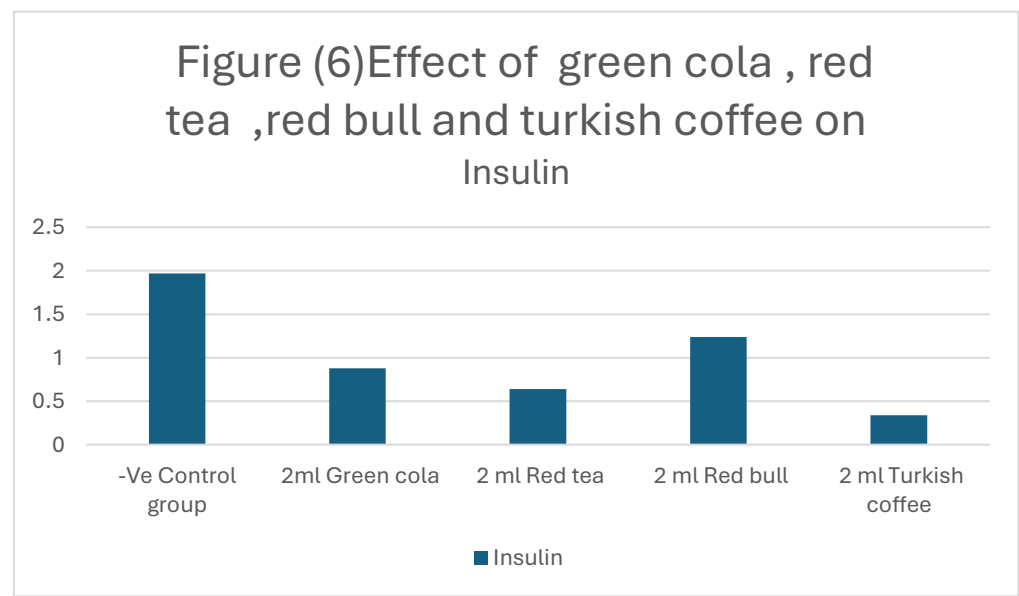
Data in table (2) and figure (4) showed effect of administrated   Green cola , Red tea , Red bull and Turkish coffee on liver function (ALT , AST and ALP) the results indicated that ALT and ALP increased significantly in all groups as compared to normal rats (-Ve Control group) while AST increased in groups administered Red bull and Turkish coffee as compared to other groups. the elevated liver enzymes observed in rats administered energy drink energy suggests adverse effects of the drinks on the liver. Long-term Red Bull usage has been linked to structural damage to the liver and kidneys, renal vascular congestion, tubular damage, and hepatic abnormalities, including changes in enzyme function **(salih et al 2018)**

Table (3)Effect of green cola , red tea , red bull and Turkish coffee on glucose and insulin

Parameters \ Groups	Glucose (mg/dl)	Insulin
-Ve Control group	85.75 ± 1.83^c	1.97 ± 0.13^a
2ml Green cola	135.70 ± 1.91^b	0.880 ± 0.11^c
2 ml Red tea	137.42 ± 2.57^b	0.640 ± 0.02^d
2 ml Red bull	148.00 ± 3.13^a	1.240 ± 0.08^b
2 ml Turkish coffee	154.05 ± 3.27^a	0.340 ± 0.12^e

Figure (5)Effect of green cola , red tea , red bull and Turkish coffee on Glucose (mg/dl)

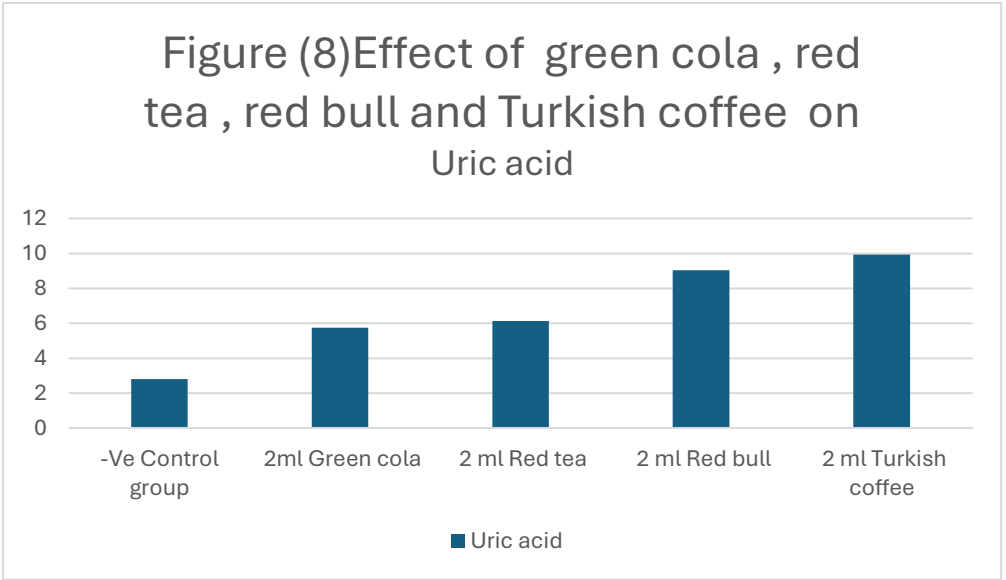Figure (6)Effect of green cola , red tea ,red bull and turkish coffee on Insulin
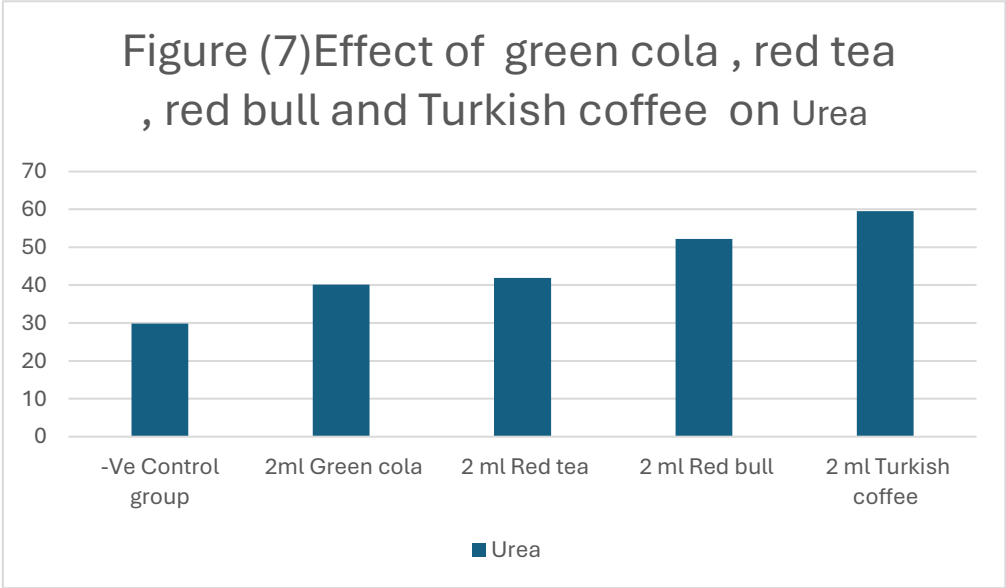
Data in table (3) and figure (5 and 6) showed effect of Green cola , Red tea , Red bull and Turkish coffee on Glucose and Insulin the data indicated that glucose increased significantly in all groups fed on Green cola , Red tea , Red bull and Turkish coffee as compared to normal rats (-Ve Control group) while Insulin decreased significantly in all groups fed on Green cola , Red tea , Red bull and Turkish coffee as compared to normal rats (-Ve Control group) Also consumption of energy drinks containing high and unregulated amount of caffeine has been associated with serious adverse effects, such as seizures, diabetes mellitus, cardiac abnormalities or mood and behavioural disorders, particularly in children, adolescents and young adults and those who take certain medications(seifer et al 2011).

Table (4)Effect of green cola , red tea , red bull and Turkish coffee on renal function

Parameters / Groups	Urea	Creatinine	Uric acid
	mg/dl		
-Ve Control group	29.80 ± 1.28^c	0.392 ± 0.01^d	2.80 ± 0.35^d
2ml Green cola	40.16 ± 1.08^b	0.728 ± 0.03^c	5.75 ± 0.21^c
2 ml Red tea	41.88 ± 2.26^b	0.668 ± 0.02^c	6.13 ± 0.25^c
2 ml Red bull	52.18 ± 3.46^a	0.910 ± 0.01^b	9.05 ± 0.23^b
2 ml Turkish coffee	59.55 ± 3.21^a	1.022 ± 0.02^a	9.93 ± 0.12^a

Data are expressed as mean ± SE. Means with different letters in each column are significantly differs at $p<0.05$

Figure (7)Effect of green cola , red tea , red bull and Turkish coffee on Urea

■ Urea

Figure (8)Effect of green cola , red tea , red bull and Turkish coffee on Uric acid

■ Uric acid

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Figure (9)Effect of green cola , red tea , red bull and Turkish coffee on Creatinine
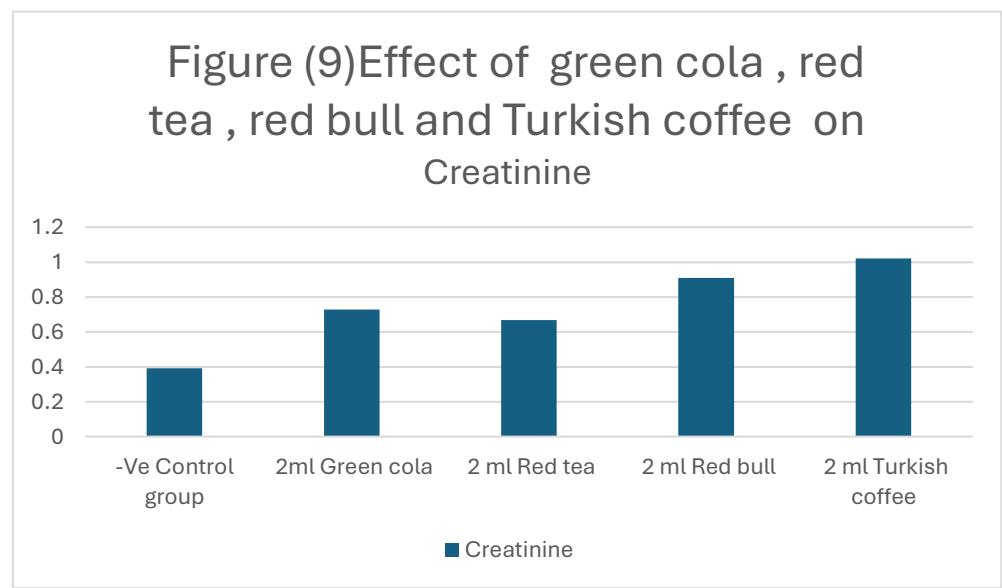
Table (4) and figure (7,8 and 9) showed the effect of Green cola , Red tea , Red bull and Turkish coffee on Urea ,Creatinine and Uric acids it can be noticed that urea , creatinine and uric acids increased significantly in all groups drinking Green cola , Red tea , Red bull and Turkish coffee as compared to normal rats (-Ve Control group).Long-term Red Bull usage has been linked to structural damage to the liver and kidneys, renal vascular congestion, tubular damage, and hepatic abnormalities, including changes in enzyme function(salih et al 2018) According to (Ebuehi et al 2011) consumption of energy drink was associated with higher total protein, triglyceride, HDL and LDL but lower ALT, AST, creatinine, uric acid and albumin, which is in contrast with the present findings of significantly higher urea, uric acid, creatinine and liver enzymes . According to Ebuehi et al, (2011   )consumption of energy drink was associated with higher total protein, triglyceride, HDL and LDL but lower ALT, AST, creatinine, uric acid and albumin, which is in contrast with the present findings of significantly higher urea, uric acid, creatinine and liver enzymes

Table (5)Effect of green cola , red tea red and Turkish coffee on blood protein

Parameters Groups	Total protein	Albumin	Globulin
	mg/dl		
-Ve Control group	10.41 ± 0.21^a	7.19 ± 0.22^a	3.22 ± 0.18^a
2ml Green cola	8.38 ± 0.53^b	6.01 ± 0.36^b	2.37 ± 0.02^b
2 ml Red tea	8.95 ± 0.21^b	6.52 ± 0.20^{ab}	2.43 ± 0.16^b
2 ml Red bull	8.44 ± 0.30^b	5.84 ± 0.20^b	2.60 ± 0.12^b
2 ml Turkish coffee	$6.36\pm0.22c$	4.99 ± 0.09^c	1.36 ± 0.29^a

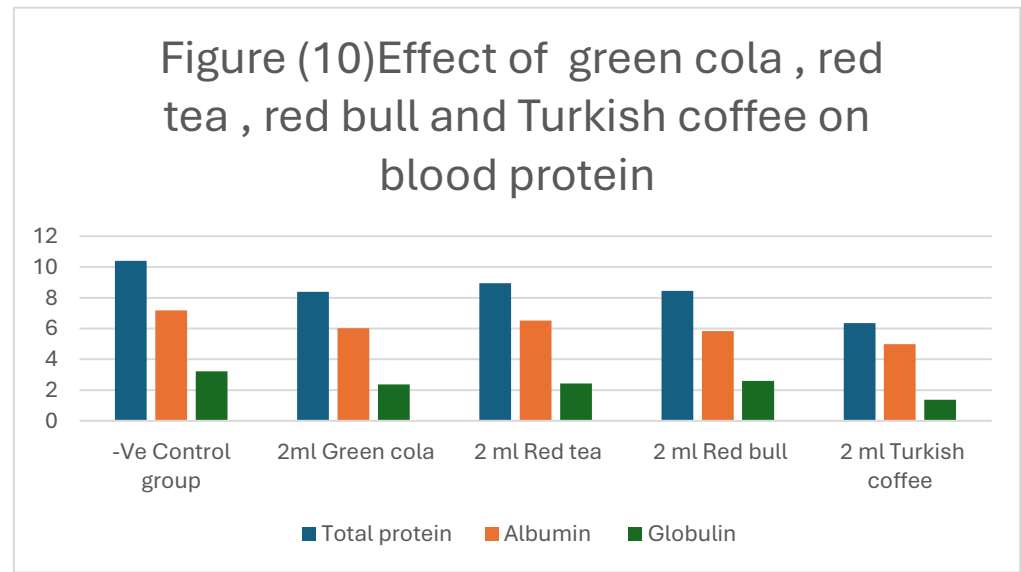Figure (10)Effect of green cola , red tea , red bull and Turkish coffee on blood protein

Table (5)and figure (10) showed the effect of Green cola , Red tea , Red bull and Turkish coffee on total protein , albumin and globulin the data indicated that total protein , albumin and globulin decreased significantly in all groups drinking Green cola , Red tea , Red bull and Turkish coffee as compared to normal rats (-Ve Control group) **Ebuehi et al (2011)**demonstrated that rats administered energy drinks had higher total protein, triglyceride, HDL-, LDL-cholesterol and glucose, but lower ALT, AST, creatinine, uric acid and albumin, without histopathological abnormalities of the brain, heart and liver.

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Table (6)Effect of green cola , red tea , red bull and Turkish coffee on vitamin D and Calcium

Parameters Groups	Vitamin D (nmol/L)	Calcium (mg/dl)
-Ve Control group	57.94±2.12 [a]	13.54±1.33 [a]
2ml Green cola	16.15±1.50 [b]	4.13±1.00 [c]
2 ml Red tea	17.08±1.13 [b]	8.67±2.71 [b]
2 ml Red bull	16.84±1.04 [b]	3.91±1.12 [c]
2 ml Turkish coffee	14.94±0.89 [b]	3.67±1.02 [c]

figure (11)Effect of green cola , red tea , red bull and Turkish coffee on Vitamin D (nmol/L)

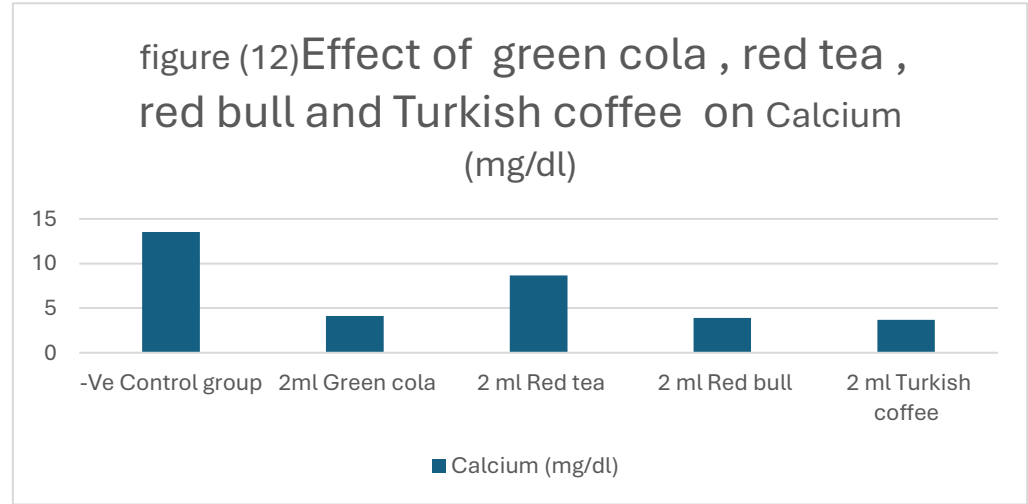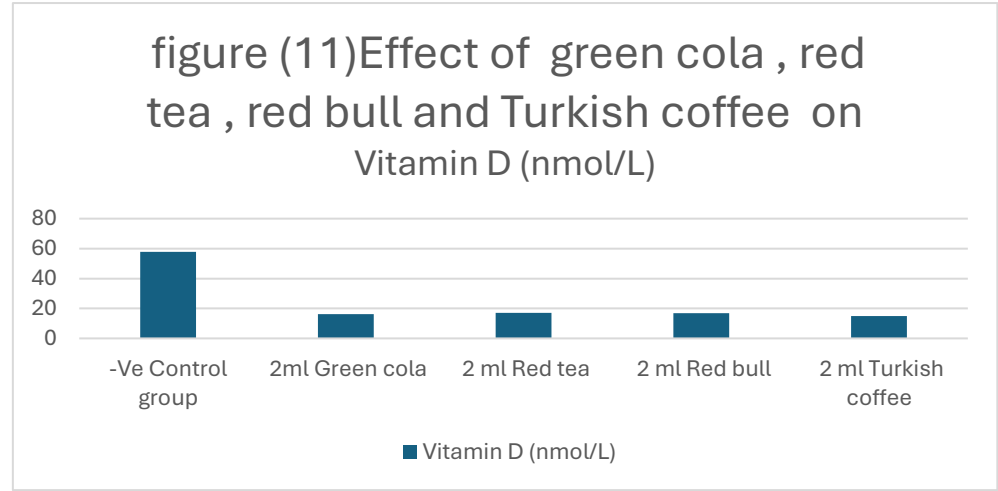figure (12)Effect of green cola , red tea , red bull and Turkish coffee on Calcium (mg/dl)

Table (6)and figures (11 and 12) showed the effect of Green cola , Red tea , Red bull and Turkish coffee on vitamin D and Calcium the data indicated vitamin D and calcium decreased significantly in all groups drinking Green cola , Red tea , Red bull and Turkish coffee as compared to normal rats (-Ve Control group) .High caffeine consumption is cited as a risk factor for osteoporosis because it increases diuresis and urinary calcium loss, reduces intestinal absorption, and inhibits bone mineralization (**Rapuri et al 2001 , Clarke 2010, Altimari et al 2006 and Wetmore et al 2008**) ، **Harris and Dawson-Hughes** **(2010)** reported that adequate calcium intake by postmenopausal women may protect them from the harmful effects of caffeine on bone metabolism. However, because calcium intake generally does not meet the recommended intake **(Velásquez-Meléndez   1997) . Yeh** and **Aloia (1986)** repotted that coffee drinking may lead to a worsening of calcium balance in humans .also Caffeine consumption has been reported to decrease bone mineral density (BMD) , increase the risk of hip fracture and negatively influence calcium retention **Hernandez-Avila *et al.* (1991)**

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الملخص العربي
تناول بعض المشروبات وتأثيراتها المحتملة على وظائف الكلى

أُجريت هذه الدراسة لدراسة تأثير الاستهلاك المزمن لمشروبات (الكولا الخضراء، ستيفيا "مشروب غازي"، ريد بول "مشروب طاقة"، الشاي الأحمر، والقهوة التركية) على وظائف الكلى لدى إناث الفئران. أجريت الدراسة التجريبية وفقًا لإرشادات لجنة رعاية الحيوان والأخلاقيات التابعة للمجلس القومي للبحوث، بالإضافة إلى التحليل الكيميائي الحيوي في مختبر الدراسات العليا بكلية الاقتصاد المنزلي - جامعة حلوان. قُسِّم ثلاثون فأرًا من نوع سبراغ-داولي (١٨٠ ± ٥ جم) إلى خمس مجموعات كما يلي:المجموعة (١) غذت على نظام غذائي أساسي (كمجموعة ضابطة سلبية). تم تغذية المجموعة (٢) على نظام غذائي أساسي وأعطيت عن طريق الفم (٢ مل من ستيفيا الكولا الخضراء مرة واحدة يوميًا). تم تغذية المجموعة (٣) على نظام غذائي أساسي وأعطيت عن طريق الفم (٢ مل من ريد بول مرة واحدة يوميًا). تم تغذية المجموعة (٤) على نظام غذائي أساسي وأعطيت عن طريق الفم (٢ مل من الشاي الأحمر مرة واحدة يوميًا). تم تغذية المجموعة (٥) على نظام غذائي أساسي وأعطيت عن طريق الفم (٢ مل من القهوة التركية مرة واحدة يوميًا). تم إجراء التقييم البيولوجي للنظام الغذائي من خلال تحديد كمية العلف المتناولة وزيادة وزن الجسم وكفاءة التغذية. في نهاية الفترة التجريبية (٨ أسابيع)، تم ذبح الفئران للحصول على مصل الدم. تم استخدام المصل لتحديد وظائف الكلى: اليوريا وحمض البوليك والكرياتينين؛ فيتامين د والكالسيوم في المصل. الجلوكوز والأنسولين في المصل ووظائف الكبد (نشاط ناقلة أمين الأسبارتات ونشاط ناقلة أمين الألانين). أظهرت النتائج انخفاضًا كبيرًا في وظائف الكبد، وزيادة كبيرة في اليوريا والكرياتينين وحمض البوليك في المجموعات التي تناولت مشروب الكولا الأخضر ستيفيا "مشروب الصودا"، ومشروب الطاقة ريد بول، والشاي الأحمر والقهوة التركية مقارنة بالمجموعة الضابطة الإيجابية، بينما انخفضت بروتينات الدم (الألبومين، والبروتين الكلي، ووزن الجسم النهائي) للمجموعة التي تناولت مشروب الكولا الأخضر ستيفيا "مشروب الصودا"، ومشروب الطاقة ريد بول، والشاي الأحمر والقهوة التركية بشكل ملحوظ. كما انخفض الأنسولين بشكل ملحوظ بينما زاد الجلوكوز بشكل ملحوظ مقارنة بالمجموعة الضابطة الإيجابية. كما أوضحت النتائج أن الكالسيوم وفيتامين د انخفضا بشكل ملحوظ في المجموعة التي تناولت مشروب الكولا الأخضر ستيفيا "مشروب الصودا"، ومشروب الطاقة ريد بول، والشاي الأحمر والقهوة التركية

الكلمات المفتاحية

مشروب ستيفيا "الكولا الخضراء"، مشروب الطاقة "ريد بول"، الشاي الأحمر، القهوة التركية، الكلى الفئران