Effect of coffee on some physiological parameters

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Abstract

This present study was undertaken to search out the effect of coffee containing caffeine on some physiological parameters in adult male rabbits. Ten adult male rabbits were randomly divided into two equale groups, control group (C): rabbits of this group were allowed to *ad libitum* supply of drinking water, treated group (T): rabbits of this group were allowed to *ad libitum* supply of drinking water containing 100 mg/kg b.w of coffee, blood samples were collected at 15 and 30 days of the experiment, Blood was drawn by cardiac puncture technique for measuring the following parameters: blood glucose concentration, total cholesterol (TC), blood urea concentration and haemoglobin concentration, section from kidney and liver were taken at the end of the experiment for histological study. The results revealed that coffee consumption at dose 100 mg/kg b.w in drinking water for 30 days cause a significant decrees ($p<0.05$) in blood glucose concentration and a significant increase ($p<0.05$) in total cholesterol and blood urea concentration in addition to non significant reduction ($p>0.05$) in haemoglobin concentration. No histological changes in kidney and liver tissue in the treated group as compared to control group .Results of this study showed that the coffee consumption negatively effected the total cholesterol ,blood urea, and haemoglobin concentration in conclusion the regular consumption of coffee negatively effect on health of both human and animals.

تأثير القهوة في بعض المعايير الفسلجية في ذكور الأرانب البالغة

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الخلاصة

صممت هذه الدراسة لمعرفة تأثير القهوة الحاوية على الكافيين في بعض المعايير الفسلجية في ذكور الأرانب البالغة، استخدمت 10 من ذكور الأرانب البالغة وقسمت عشوائياً إلى مجموعتين متساويتين مجموعة السيطرة (C): أعطيت الماء العادي والعلف ومجموعة المعاملة (T): أعطيت ماء الشرب الحاوي على 100ملغم/ كغم من وزن الجسم من القهوة لمدة 30 يوماً من التجربة، تم جمع عينات الدم في الفترات 15 و30 يوم من التجربة، وتم سحب الدم بطريقة الوخز القلبي لغرض قياس المعايير التالية: قياس تركيز كلوكوز الدم، قياس تركيز الكولستيرول الكلي (TC)، قياس تركيز اليوريا وقياس تركيز الهيموغلوبين بالإضافة إلى اخذ مقاطع نسيجية للكلية والكبد. أظهرت نتائج هذه الدراسة ان تناول القهوة بجرعة 100ملغم/ كغم من وزن الجسم في ما ء الشرب لمدة 30 يوماً تسبب في حدوث انخفاض معنوي ($P<0.05$) في تركيز كلوكوز الدم وارتفاع معنوي ($P<0.05$) في تركيز الكولستيرول الكلي واليوريا بالإضافة إلى انخفاض غيرمعنوي في تركيز الهيموكلوبين ($P>0.05$)، كما أظهرت نتائج المقاطع النسيجية لحيوانات المعاملة ان تناول القهوة لم يسبب أي أذى ملحوظ في نسيج الكلية والكبد. نتائج هذه الدراسة تشير إلى ان القهوة أثرت سلباً في تركيز كل من الكولستيرول واليوريا وهيموكلوبين الدم وبالتالي فأن تناول القهوة بصورة مستمرة يؤثر سلباً في صحة الإنسان والحيوان.

Introduction

Coffee is one of the most consumed beverages in the world (1) prepared from the rosted seeds of the coffee plants .coffee played a crucial role in many societies the energizing effect of the coffee bean plant is thought to have been discovered in the northeast region of Ethiopia and the cultivation of coffee first expanded in the world, from the muslim world coffee spread to Italy then to the rest of Europe to Indonesia, and to America (2). Coffee berries, which contain the coffee seeds or (beans) are produced by several species of small ever greenbush of the genus *Coffea* the most commonly grown arethe highly regarded *Coffea arabica*, and the robusta from of the hardier *Coffea Canephora* (3). Coffee is a chemical mixture reported to contain more than a thousand different molecular substances, including carbohydrates, lipids, nitrogenous, and polyphenol, four major classes were identified: flavan-3-ols (monomers and procyanidins) hydroxycinnamic acid, flavonols, and anthocyanidins, it also contain vitamins, minerals, and alkaloids. Caffeine, cafestol, kahweol, and chlorogenic acids are related to lipid metabolism (4). The stimulant effect of coffee is due to its caffeine content, it has been associated with its ability to act as an antidepressant. There is a link between a decrease in suicide rates and coffee consumption, due to the action of caffeine in blocking the inhibitory effects of adenosine on dopamine nerves in the brain reduced feelings of depression (5). High long – term consumption of caffeine is associated with a lower risk of cardiovascular disease and diabetes (6). Caffeine may minimizes the cognitive decline associated with aging (7), caffeine increases levels of neurotransmitters such as noradrenalin, acetylcholine, and dopamine (8), low doses of caffeine show increased alertness and decreased fatigue, it may reduce the risk of developing cancer and produce adelay in the average onset of cancer, and it may be associated with a reduced risk of parkinsons disease (9), it has been shown to increase the metabolic rate (10,11,12), caffeine may reduce certain kind of hepatic cancer (13), caffeine can also increase vasoconstriction and blood pressure (14) ,it may reduce control of fine movements (e.g. producing shaky hands), and it can stimulat urination (15).

Materials and Methods

A total number of ten adult male rabbits (100-1500 g) were used in this experiment .Animals in all stages of the experiment were housed in iron cages in a conditioned room (22-25º) in the animal house of the department of physiology and pharmacology at college of veterinary medicine-university of Baghdad. The animals were left for ten days for acclimatization with the experimental conditions, Animals had free access to water and standard pellet diet along the experimental period. The animals were randomly divided into two equal groups (5 rabbits/ group) and were treated daily for 30 days as follows: 1-Control group (C): rabbits of this group were allowed to *ad libitum* supply of drinking water, 2-Treated group (T): rabbits of this group were allowed to *ad libitum* supply of drinking water containing 100 mg /kg b.w. of caffeinated coffee (16). Blood samples were collected at 15 and 30 days of the experiment, blood was drawn by cardiac puncture technique, blood samples were kept in tubes and centrifuged at 2500 rpm for 15 minutes, and then serum samples were aliquoted and frozen at -20cº until analysis, serum samples were used for measurement of blood glucose concentration, total cholesterol (TC), and blood urea concentration by using specialized kits from LINEAR company, and haemoglobin concentration by using drab kin method, for histological studies, rabbits were anaesthetized, sacrificed by withdrawal of blood from heart, immediately after scarification, kidney and liver were excised blotted, opened longitudinally and preserved in

10% neutral formalin buffer solution till the preparation of histological sections (17). Statistical analysis of data was performed on the basis of two– way analysis of variance (ANOVA) using a significant level of ($p<0.05$), specific group differences were determined using least significant differences (LSD) (18).

Results and Discussion

There is a significant decrease ($p <0.05$) in blood glucose level in treated group as compared to the control group along the experimental period (Table 1).

Table (1) Effect of oral administration of coffee on blood glucose concentration (g/dl) of adult male rabbits

Groups / Days	Control group	Treated group
15	89±3.1 A a	75±2.9 B a
30	85±2.7 A a	74.6±1.6 B a

Values are expressed as mean ±SE, n= 5 each group
Capital letters denote differences between groups, p<0.05.
Small letters denote differences within group.

This decrease may be due to the active substance (caffeine) present in coffee which enhance insulin sensitivity and decreasing glucose absorption from intestine (8), Magnesium is one of the non caffeinated compounds in coffee which caused increasing or stimulation of beta cells to produce insulin hormone (20). A significant elevation ($p<0.05$) in serum total cholesterol concentration was observed after 15 and 30 days of coffee consumption as compared to control group at both 15 and 30 days of experiment (Table 2).

Table (2) Effect of oral administration of coffee on blood total cholesterol (mg/dl) of adult male rabbits

Groups / Days	Control group	Treated group
15	89±3.3 A a	96±3.5 B a
30	88±3.9 A a	100±5.5 B a

Values are expressed as mean ±SE, n= 5 each group
Capital letters denote differences between groups, p<0.05.
Small letters denote differences within group.

This elevation in cholesterol concentration may be due to the diterpenes (cafestol and kahweol) present in coffee, have acholesterol raising effect because of their action as ligands for farnesoid X and pregnane X receptors in the liver, cafestol and kahweol also lower the synthesis of na^{+}- taurocholate co-transporting polypeptide, essential in the excretion of bile acids into the biliary tract and they increase the synthesis of intestinal bil acid-binding protein (21) responsible for transcellular transport between the apical and basolateral surface of enterocytes (22), they lower the synthesis of cholesterol 7α-and 12α-hydroxylase, which are key enzymes in the biosynthesis of bile acids, being the main path for cholesterol excretion (23). Depending on the results clarified in (Table 3), there were a significant increase ($p<0.05$) in blood urea concentration along the experiment period as compared to control group.

Table (3) Effect of oral administration of coffee on blood urea concentration (mg/dl) of adult male rabbits

Groups / Days	Control group	Treated group
15	15.6±1.2 A a	22.8±2.6 B a
30	17.9±0.9 A a	30 ± 0.7 B a

Values are expressed as mean ±SE, n= 5 each group
Capital letters denote differences between groups, p<0.05.
Small letters denote differences within group.

This increasing may be due to the present of caffeine which is non –selectively block both adenosine receptors and competitively inhibits the action of adenosine. One of the important role of adenosine is dilate the blood vessels the adenosine inhibits the release of neurotransmitters (chemicals that carry messages from one nerve to another) by binding to specific receptors on cells surface. The structure of caffeine and its by-products is chemically similar to that of adenosine, which allows caffeine to bind to the same receptor sites, blocking adenosine and preventing from taking effect (24). Blood samples were collected from rabbits after 15 and 30 days of experiment revealed non significant differences ($p>0.05$) in haemoglobin concentration between the control group and treated group along the experimental period (Table 4).

Table (4) Effect of oral administration of coffee on haemoglobin concentration (g/dl) of adult male rabbits

Groups / Days	Control group	Treated group
15	9.6±0.7 A a	9±0.3 A a
30	10.2±0.6 A a	10±0.5 A a

Values are expressed as mean ±SE, n= 5 each group
Capital letters denote differences between groups, p<0.05.
Small letters denote differences within group.

Coffee may interferes with the absorption of supplemental iron this is due to the polyphenols (tannins) present in coffee which bind to iron in the intestinal lumen ,forming an insoluble complex and thereby inhibition iron absorption (25) other components of coffee such as chlorogenic acid are also thought to interfere with iron absorption (26) there for coffee consumption may lead to iron deficiency anemia in mothers and infant (27). A microscopic examination of kidney in animals treated with coffee showed athicking in artery wall with cuffing of lymphocyts and congestion in blood vessels also there is aheamolysis in RBCs inside it. The glumular was atrophied in some area associated with infiltration of inflammatory cells in pernchyma (Fig 2). Histological section in the liver post 30 days of coffee consumption showed enlargement of hepatocytes lead to disappeared of sinusoid and dilatation of central vein and congestion, infiltration with inflammatory cell inside and around hepatocytes with granulation and increasing of coffer cells, also there is accumulation of inflammatory cells around portal area (Fig 4).

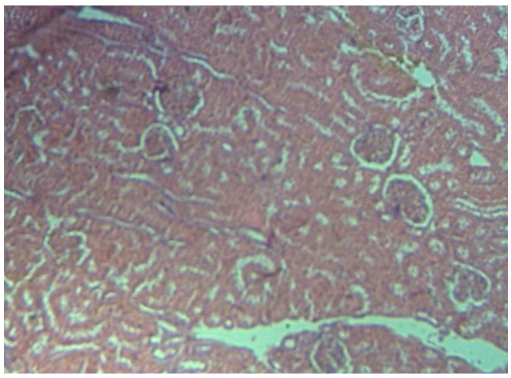

Fig. (1) Histological section in the kidney of rabbit from control group. (H and E 40 X)

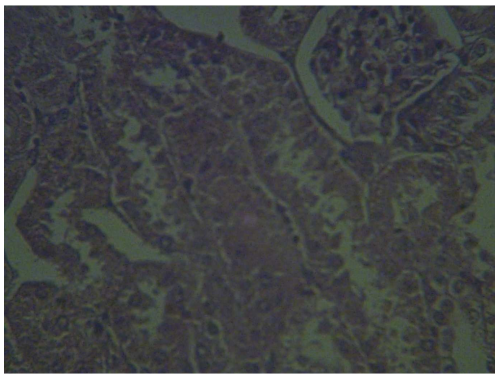

Fig. (2) Histological section in the kidney of rabbit treated with 100 mg/kg of coffee for 30 days, showed thinking in artery wall with cuffing of lymphocyte and congestion of blood vessels. (H and E 40 X)

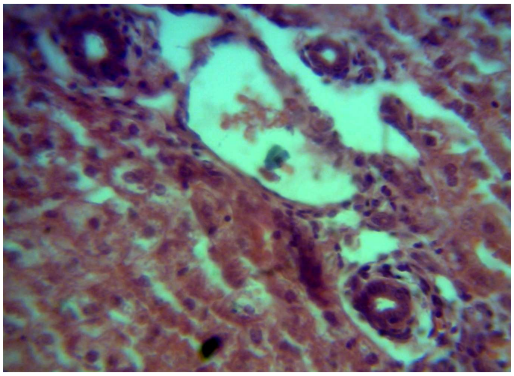

Fig. (3) Histological section in the liver of rabbits from control group. (H and E 40 X)

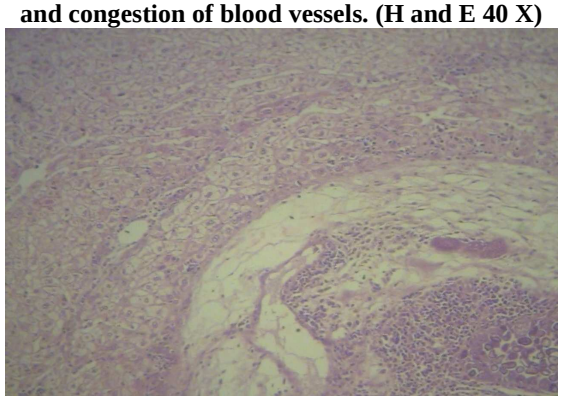

Fig. (4) Histological section in the liver of treated rabbits with 100mg/kg of coffee for 30 days, showed enlargement of hepatocytes lead to disappeared of sinusoid and dilitation. (H and E 40 X)

References

1. Villanueva, C. M.; Cantor, K. P.; King, C. F.; Porru, S. & Kogevinas, M. (2006). Total and specific fluid consumption as determinants of bladder cancer risk. Int. J. of Cancer., 118(8): 2040-2047.
2. Meyers, H. (2005). Suave molecules of mocha-coffee, chemistry, and civilization. New partisan.
3. Levy, J. (2002). The origins of every day things. Firefly Books. P.1948.
4. Ukers, W. H. (2010). All about coffee. (2nd ed). Gale research. P.725.
5. Smith, A. (2002). Effect of caffeine on human behaviour. Food and Chemical Toxicol., 40(9):1245-1249.
6. Thompson, R. & Keene, K. (2004). The pros and cons. Of caffeine. The psychologist (the British psychological society), 17(12): 698-701.
7. Johnson, K. M.; Kritz-Silverstein; Barrett-Connor, E. & Morton, D. (2002). Coffee consumption and cognitive function among older adults. American J. of Epidemiol.,156 (9):842-850.
8. Melicke, A. & Albuquerque, E. X. (2000). Allosteric modulation of nicotinic acetylcholine receptors as a treatment strategy for Alzheimers disease. European J. of Pharmacol., 393(1-3):165-170.
9. Chen; Xu, K.; Petzer, J. P.; Staal, R.; Xu, Y. H.; Beilstein, M.; Sonsalla, P. K. & Castagnoli, K. (2001). Neuroprotective by caffeine and A2A adenosine receptor inactivation in amodle of Parkinsons disease. The J. Neuroscience, 21(Re143): 1-6.

10. Acheson, K. J.; Zahorska-Markiewic, Z. B.; Pitter, P.; Anana Tharaman, K. & Jequier, E. (1980). Caffeine and coffee: their influence on metabolic rate and substrate utilization in normal and obese individuals. Am. J. Clin. Nut., 33(5): 989-997.
11. Dulloo, A. G.; Geissler, C. A.; Horton, T.; Collin, S. A. & Miller, D. S. (1989). Normal caffeine consumption: influence on thermogenesis and daily energy expenditure in lean and postobese human volunteers. Am. J. Clin. Nut., 49(1):44-50.
12. Koot, P. & Deurenberg, P. (1995). Comparison of changes in energy expenditure and body temperatures after caffeine consumption. Ann. Nut.Metab.,39(3):135-142.
13. Sugi, Y., Yasuhiro, N. O. D. A. & Puming, H. E. (2001). Suppressive effect of caffeine on hepatitis and apoptosis induced by tumor necrosis factor-α, but not by the anti-fast antibody,in mice.Bioscience,Biotechnol. and Biochem.,65(3):674-677.
14. Noordizij, M.; Uiterwaal, C. S.; Arends, L. R.; Kok, F. J.; Grobbee, D. E. & Geleijnse, J. M. (2005). Blood pressure response to chronic intake of coffee and caffeine: ameta-analysis of randomized controlled trials. J. Hypertens., 23: 921-928.
15. Rieg, T.; Steigele, H.; Schnerman, J.; Richter, K.; Osswald, H. & Vallon, V. (2004). Requirement of intact adenosine A1 receptors for the diuretic and natriuretic action of the Mythelxanthines Theophyline and coffee. J. of pharmacol. and experimental therapeutics, 313(1): 403-409.
16. Munoz, L.; Keen, C. L.; Lonnerdal, B. & Dewey, K. G. (1986). Coffee intake during pregnancy and lactation in rats: maternal and pup haematological parameters and liver iron, zinc and copper concentration. J. NUT., 116: 1326-1333.
17. Lee, G. & Luna, L.G. (1968). Manual of histological staining methods of armed forces institutes of pathology. 3rd ed. MC Grow-Hill book company. New York. PP. 12-31.
18. Snedeor, G. W. & Cochran, W. G. (1973). Statistical methods. 6th the Iowa state university press, PP. 238-248.
19. Park, S. J.; Jang, J. S. & Hong, S. M. (2007). Long term consumption of caffeine improve glucose hemostasis by enhancing insulinotropic action through islet insulin/insulin like growth factor 1 sigialing in diabetic rats. Metabolism Clinical and Experimental., 56: 599-607.
20. Inoue, H. K.; Kabayashi-Hattori, K. & Horiuchi, Y. (2006). Regulation of the body fat percentage in development- stagerats by Methylxanthin derivatives in high fat diet. Bioscience. 70(5): 1134-1139.
21. Ricketts, M. L.; Boekchoten, M. V. & Kreeft, A. J. (2007). The cholesterol- raising factor from coffee beans, cafestol, as an agonist ligands for the farnesoid and pregnane X receptor. MOL Endocrinol., 21: 1603-1616.
22. Alrefai, W. A. & Gill, R. K. (2007). Bile acid transports: Structure, function, regulation and pathophysiological implications. Pharm. Res., 24: 1803-1823.
23. Vandervelde, A. E.; Vrins, C. L. & Vanden Oever, K. (2008). Regulation of direct transintestinal cholesterol excretion in mice. Am. J. Physiol. Gastrointest liver Physiol., 295: G203-208.
24. Benowitz, N. L. (1990). Clinical pharmacology of caffeine. Annual Review of Medicine, 41(1): 277-288.
25. Morck, T. A.; Lynch, S. R. & Cook, J. D. (1983). Inhibition of food iron absorption by coffee. Am. J. Clin. Nut., 37: 416-420.
26. Gutnisky, A.; Rizzo, N.; Castro, M. E. & Garbossa, G. (1992). The inhibitory action of chlorogenic acid on the intestinal iron absorption in rats. Actaphysiol Pharmacol Therlatinoam., 42:139-146.
27. Munoz, L. M.; Lonnerdal, B. O.; Keen, C. L. & Dewey, K. G. (2010). Coffee consumption as a factor in iron deficiency Anemia among pregnant women and their infants in Costarica. Am. J. of Clin. Nut., 48(3): 645-651.