Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Physiological Impact of Formalin on Lipid Profile, and Protective Role of Vitamin C

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Abstract

THIS STUDY was designed to experimentally assess the effect of formalin on lipid profile [cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), very low-density lipoprotein (VLDL) and triglyceride (TG)] and the protective role of vitamin C. Totally, 24 adult male albino rats were purchased, prepared, and divided equally into 4 groups; control (drenched distilled water), EG1 (drenched 200 ppm of formalin, daily), EG2 (drenched 300 ppm of formalin, daily) and EG3 (drenched 300 ppm of formalin and 100 mg/Kg B.W orally of vitamin C, daily). Then, all study animals were subjected to direct collection of blood from the heart, and obtaining of sera. The lipid profile results of the experimentally treated group with formalin showed a significant increase in concentrations of serum cholesterol, LDL, VLDL and TG, but significant decrease was seen in the concentration of HDL. Based on our results, there is a significant association between formalin and lipid profile; therefore, accidental exposure to formalin can cause an alteration in cholesterol, LDL, VLDL, HDL and TG leading to increase the risk of acute or chronic toxicity, and then, occurrence of diseases. Our study showed that the locally and globally formalin-related studies are few and need to be supported to detect pathogenesis and mode of action for formalin toxicity. In addition, there are many materials used in the workplace can be hazardous when they come into contact with or be absorbed into the body. Hence, furthermore local studies are of great importance to provide additional data.

Keywords: Experimental study, Cholesterol, Lipoproteins, Triglyceride, Iraq.

Introduction

Every day, animals and humans are exposed to different chemicals in air, food, and water; with the fact that some individuals appear to be more sensitive to a particular chemical than others [1]. Chemical toxicity is very dangerous to health as it may cause several types of severe diseases after prolonged intake [2].

The risk evaluation is usually need for considering the expected contacts, calculation of risk values and damage severity to understand the actual existence of toxic components with recording responses in a particular tissue to assessment the disease possibility [3, 4].

However, the health dangerous of toxic chemicals depends on several factors such as type and the nature of the chemical, length of exposure, and general state of health [2, 5]. Formalin is an irritant, corrosive, and toxic substance which prepared by mixing 40% of formaldehyde solution in water. Formalin and formaldehyde are used in manufacturer of plastics and resin as well as in processing steps of sugar, food, pharmaceuticals and textile industries [6-8].

Many studies have referred that exposures to formalin occurs by inhalation or by skin/eye contact, and can be detected by smell; however, sensitive individuals may experience different symptoms such as severe pneumonia, pulmonary oedema, bronchitis, dyspnea, rhinitis, lacrimation, burning and mucous

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(Received 20/04/2024, accepted 22/06/2024)
DOI: 10.21608/EJVS.2024.284082.2022

membrane irritation [9-11]. Other studies mentioned that ingestion of formalin can result in corrosive injuries to the mucosa of the gastrointestinal tract, bleeding, nausea, pain, vomiting, and even death [12, 13]. As a result of ingestion of 50-100 ml of formalin, complicated clinical symptoms of vasodilation, hypovolaemia, and myocardial effects were recorded [14]. The patient ended up with circulatory shock, gastric ulceration, and metabolic acidosis two hours post-ingestion of the poison with the development of disseminated intravascular coagulation and seizures [12, 15].

In Iraq, online searching detected that there were different studies that used formalin experimentally either to induce pain [16], oedema [17], and inflammation [18], or to detect inhibitory activity for the growth of microorganisms [19], and its effect on fish [20, 21]. However, systemic formalin intoxication has not been adequately characterized due to the absence of data concerned with the effect of ingestion of formalin. Hence, this study was carried out to detect the effect of formalin on the body's lipid profile including cholesterol, LDL, HDL, VLDL and TG with an investigation of the protective role of vitamin C on these parameters.

Material and Methods

Animals and samples

A total of 24 adult male albino rats weighing 175-250 grams and aged 10-14 weeks old were purchased for the current study from the local animal house and subjected to a preparation period for 1 week; during which, the study animals were kept at 22-25°C of temperatures, 12 hours for light and dark, and left free for a pellet fed and drinking water. Then, the study animals were divided equally into 4 groups:

1. Control group: Rats of this group were drenched with distilled water only.
2. Experimental group 1 (EG1): Rats of this group were drenched with a daily dose of 200 ppm of formalin.
3. Experimental group 2 (EG2): Rats of this group were drenched with a daily dose of 300 ppm of formalin.
4. Experimental group 3 (EG3): Rats of this group were drenched with a daily dose of 300 ppm of formalin and 100 mg/Kg B.W orally of vitamin C.

During the study period that continued for 30 days, the study animals were free to arrive to diet and water. After the end of the study, all animals were weighed and subjected to direct collection of blood samples from the heart under aseptic conditions and using of a disposable syringe in a free-anticoagulant glass tubes. Post centrifugation of blood tubes at 3000 rpm for 5 minutes, the obtained sera were aspirated by plastic pipette and transferred into 1.5 ml Eppendorf tubes that were kept frozen at -20ºC until be tested for detection of lipid profile.

Laboratory assessment of lipid profile

Following the manufacturer instructions of the Automatic Biochemistry Analyzer; Cobas C 111 (Roche, Germany), the serum samples of study animals of all groups were tested.

Statistical analysis

Data from study groups were documented and analyzed statistically by the One-Way ANOVA in the GraphPad Prism (6.0.1) Software. Differences between values (Mean ± Standard Deviation) of study groups were considered significant at $P<0.05$ (*), $P<0.01$ (**), $P<0.001$ (***), and $P<0.0001$ (****) [22].

Results

The findings of this study showed that the values of serum cholesterol were elevated significantly ($P<0.05$) in rats of experimental groups; EG1 (55.18 ± 0.77 mg/dl), EG2 (60.79 ± 1.33 mg/dl) and EG3 (51.86 ± 1.02 mg/dl) when compared to this of the control group (48.28 ± 0.55 mg/dl). However, a significant reduction ($P<0.05$) was seen in the values of EG3 when compared to those of both EG1 and EG2 (Fig. 1, Table 1).

Concerning LDL, significantly higher ($P<0.05$) values were reported in EG1 (24.66 ± 1.41 mg/dl), EG2 (27.44 ± 1.36 mg/dl), and EG3 (19.56 ±1.48 mg/dl) than this of negative control (9.72 ± 1.19 mg/dl). In comparison between the experimental groups, higher values were shown in EG2 while lowered value was detected in EG3 (Fig. 2, Table 2).

For VLDL, there was significant elevation ($P<0.05$) in values of experimental groups; EG1 (11.884 ± 0.169 mg/dl), EG2 (12.665 ± 0.157 mg/dl), and EG3 (11.231 ± 0.224 mg/dl) rather than the value of control group (9.784 ± 0.098 mg/dl). In comparison between values of experimental groups, the higher values were shown in EG1 and EG2; while, the lower value was reported in EG3 (Fig. 3, Table 3).

Regarding the concentration of serum HDL, values of EG1 (18.18 ± 0.38 mg/dl), EG2 (20.338 ± 0.465 mg/dl) and EG3 (24.319 ± 0.802 mg/dl) were decreased significantly ($P<0.05$) compared to this of the control group (28.781 ± 0.719 mg/dl). Among rats of experimentally groups, higher decreases were showed in EG1 and EG2; while, the lowered reduction was seen in EG3 (Fig. 4, Table 4).

For serum TG, significant elevation ($P<0.05$) was observed in values of EG1 (66.39 ± 0.75 mg/dl), EG2 (74.02 ± 0.44 mg/dl) and EG3 (58.66 ± 1.12 mg/dl) compared to this of the control group (48.9 ± 0.47 mg/dl). Among experimental groups, higher

values were shown in EG1 and EG2 while lowered value was recorded in EG3 (Fig. 5, Table 5).

Discussion

It is well recognized that environmental problems have increased exponentially in recent decades, mainly due to the rapid growth of the human and animal populations and to increased demand for several household materials [23-25]. While technological development has improved the quality of life, it has on the other hand created a number of health hazards. Results of present study indicate that oral administration of formalin significantly increases the concentrations of cholesterol, LDL, VLDL and TG, but significant decrease was seen in concentration of HDL. Cholesterol is a waxy substance that need by the body to build healthy cells, but when elevate, it develops the fatty deposits that grow gradually to cause a difficult in blood flow through blood vessels and increasing the risk of cardiovascular diseases [26, 27]. Excess cholesterol accumulation in various tissues and organs plays a critical role in the pathogenesis of multiple diseases, such as chronic kidney diseases, diabetes and liver diseases, through multiple mechanisms [28, 29]. Many studies were confirmed an increasing the level of serum cholesterol as a result of exposure to chemical toxicity such as polyfluoroalkyl chemicals [30]; Teflon, food wrappers and dozens [31]; cadmium [32]; chromium [33] and lead [34]. TG is another waxy fats that give the body energy in normal levels; but when increase, it combined with cholesterol rising the risk of disease occurrence and changing the health status. Chlorinated pesticide and polychlorinated biphenyls [35], lead [36], and cadmium [37] are the most toxic chemicals have related to increasing of serum TG. However, the increasing of LDL and VLDL with decreasing concentration of HDL might be attributed to formalin toxicity that induces excessive disturbances in antioxidant level and eliciting of oxidative stress damage that result in many patho-physiological processes and disease development. Also, formalin may interfere with the metabolism of lipids, proteins, and vitamins with the reducing the potential of removal of free radicals which critically injure the biological cell membrane.

There has been an extensive research in the field of finding suitable preventive and therapeutic measures against toxicity of chemicals. Vitamin C, as chelating agent is reported in treatment of different toxicities by reducing the possibility of chemical interacts with the critical biomolecules and factors inducing oxidative damage [38-40]. Also, it shown that vitamin has an antioxidant activity and encompasses very different processes as free radical scavenger and reduces the level of lipid perioxidation [41-43]. In this study, it was reported that treatment of formalin toxicity with vitamin C alone resulted in significant amelioration of lipid profile.

Conclusion

Based on our results, there is a significant association between formalin and lipid profile; therefore, accidental exposure to formalin can cause an alteration in cholesterol, LDL, VLDL, HDL, and TG leading to increase the risk of acute or chronic toxicity, and then, the occurrence of diseases. Our study showed that the locally and globally formalin-related studies are few and need to be supported to detect pathogenesis and mode of action for formalin toxicity. In addition, there are many materials used in the workplace that can be hazardous when they come into contact with or be absorbed into the body. Hence, furthermore local studies are of great importance to provide additional data. The protective role of vitamin C in amelioration of lipid profile has been demonstrated in this study. The using of combined supplementation with vitamin C against the chemical toxicity needs to be aimed in future studies.

Acknowledgments

Not applicable.

Funding statement

This study didn't receive any funding support

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

This study follows the ethics guidelines of the College of Veterinary Medicine, University of Wasit, Iraq (ethics approval number; 157/02/2021).

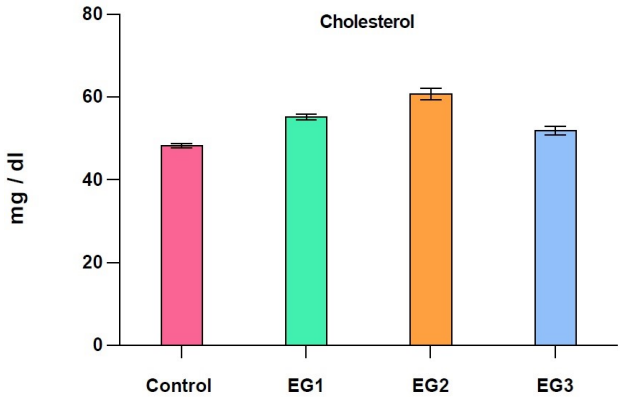

Fig.1. Results of serum cholesterol among rats of study groups.

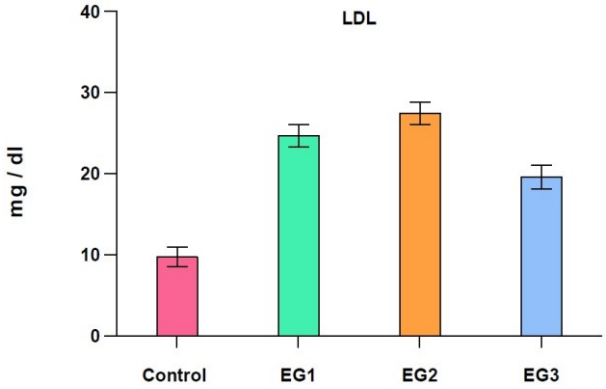

Fig.2. Results of serum LDL among rats of study groups.

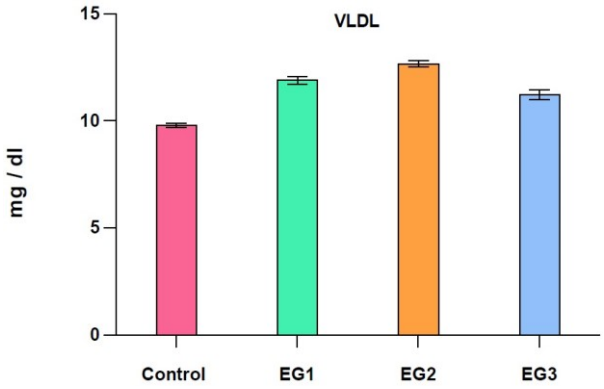

Fig.3. Results of serum VLDL among rats of study groups.

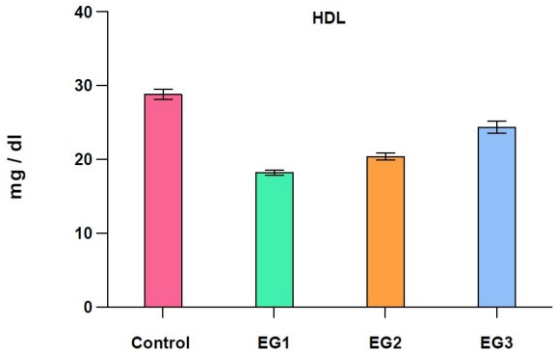

Fig.4. Results of serum HDL among rats of study groups.

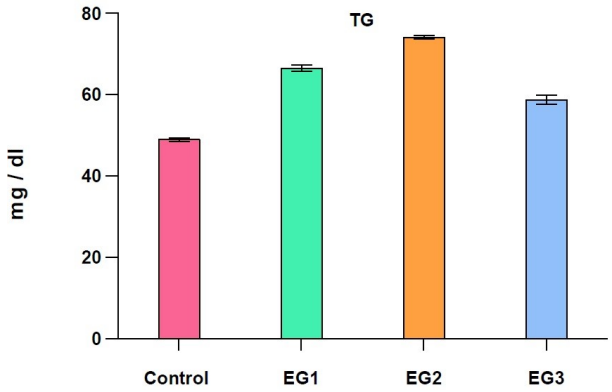

Fig.5. Results of serum TG among rats of study groups.

TABLE 1. Statistical association between the values of cholesterol among different study groups.

Group	Control	EG1	EG2	EG3
Control	----------	----------	----------	----------
EG1	0.0432 *	----------	----------	----------
EG2	0.0232 *	0.0313 *	----------	----------
EG3	0.0470 *	0.0201 *	0.0315 *	----------

*Significance (P<0.05).

TABLE 2. Statistical association between the values of LDL among different study groups.

Group	Control	EG1	EG2	EG3
Control	----------	----------	----------	----------
EG1	0.0224 *	----------	----------	----------
EG2	0.0114 *	0.0765	----------	----------
EG3	0.0275 *	0.0353 *	0.0297 *	----------

*Significance (P<0.05).

TABLE 3. Statistical association between the values of VLDL among different study groups.

Group	Control	EG1	EG2	EG3
Control	----------	----------	----------	----------
EG1	0.0522	----------	----------	----------
EG2	0.0416 *	0.0891	----------	----------
EG3	0.0484 *	0.0791	0.0677	----------

*Significance (P<0.05).

TABLE 4. Statistical association between the values of HDL among different study groups.

Group	Control	EG1	EG2	EG3
Control	----------		----------	----------
EG1	0.0113 *	----------	----------	----------
EG2	0.0147 *	0.0592	----------	----------
EG3	0.0455 *	0.0376 *	0.0458 *	----------

*Significance (P<0.05).

TABLE 5. Statistical association between the values of TG among different study groups.

Group	Control	EG1	EG2	EG3
Control	----------	----------	----------	----------
EG1	0.0275 *	----------	----------	----------
EG2	0.01304 *	0.0745	----------	----------
EG3	0.0387 *	0.0399 *	0.0351 *	----------

*Significance (P<0.05).

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التأثير الفسيولوجي للفورمالين على مستوى الدهون والدور الوقائي لفيتامين ج

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الملخص

لقد كانت تأثيرات الفورمالين القاتلة للجراثيم موضع نقاش كبير في السنوات القليلة الماضية ، إلا أنه تم إهمال دراسة تأثير هذه المادة على الحيوان والإنسان . ومن هنا ، صممت هذه الدراسة لتقييم تأثير الفورمالين على صورة الدهون [الكوليسترول ، البروتين الدهني منخفض الكثافة (LDL) ، البروتين الدهني عالي الكثافة (HDL) ، البروتين الدهني منخفض الكثافة جدًا (VLDL) والدهون الثلاثية (TG)] والدور الوقائي لفيتامين C . تم شراء 24 فأرًا أبيضًا من الذكور البالغين ، وإعدادهم ، وتقسيمهم بالتساوي إلى ٤ مجموعات ؛ السيطرة (اعطائها الماء المقطر) ، EG1 (اعطائها 200 جزء في المليون من الفورمالين يوميا) ، EG2 (اعطائها 300 جزء في المليون من الفورمالين يوميا) و EG3 (اعطائها 300 جزء في المليون من الفورمالين و 100 ملغم / كغم من وزن الجسم من فيتامين C يوميا). بعد ذلك تم إخضاع جميع حيوانات الدراسة لجمع الدم من القلب مباشرة والحصول على الأمصال. أظهرت نتائج تحليل الدهون للمجموعة المعالجة تجريبياً بالفورمالين زيادة معنوية في تركيزات الكوليسترول في الدم ، LDL ، VLDL وTG ، ولكن لوحظ انخفاض كبير في تركيز HDL . استنادا إلى النتائج التي توصلنا إليها ، هناك ارتباط كبير بين الفورمالين وملف الدهون . لذلك ، فإن التعرض العرضي للفورمالين يمكن أن يسبب تغيراً في مستويات الكوليسترول ، LDL ، VLDL، HDL وTG مما يؤدي إلى زيادة خطر التسمم الحاد أو المزمن ، ومن ثم حدوث الأمراض . أظهرت دراستنا أن الدراسات المتعلقة بالفورمالين محليًا وعالميًا قليلة وتحتاج إلى الدعم للكشف عن التسبب في المرض وطريقة عمل سمية الفورمالين . بالإضافة إلى ذلك، هناك العديد من المواد المستخدمة في مكان العمل يمكن أن تكون خطرة عندما تتلامس مع الجسم أو يتم امتصاصها فيه . ومن ثم ، فإن الدراسات المحلية ذات أهمية كبيرة لتوفير بيانات إضافية .

الكلمات الدالة: دراسة تجريبية ، الكولسترول ، البروتينات الدهنية ، الدهون الثلاثية ، العراق .