



## Evaluating the effect of aqueous and alcoholic extracts of ginger on the lipid profile of hyperlipidemia in male albino rats

Nabaa Adnan Ibrahim

Department of Biology, College of Education For Women, University of Tikrit-Iraq

A. P. Dr. Hala Hameed Majeed

Department of Biology, College of Education For Women, University of Tikrit-Iraq

Corresponding Author <sup>1</sup>E-mail:NABAA.ADNAN462@st.tu.edu.iq1

### Abstract

The purpose of this study was to evaluate how ginger aqueous-alcoholic extracts affected the lipid profile of male albino rats who were hyperlipidemic. From December 2024 to February 2025, the study was conducted at Tikrit University's College of Education for Pure Sciences and the animal house of Veterinary Medicine College. Male albino rats of the Sprague Dawley strain, weighing 160–200 g and aged 2-3 months, were used in the investigation. There were forty-two animals used. Six equal groups were randomly assigned: a healthy control group (group 1), a hyperlipidemia group fed a high-fat diet supplemented with 2% cholesterol (group 2), and four treatment groups that received alcoholic and aqueous extracts of ginger either simultaneously or sequentially after hyperlipidemia was induced. Total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL-C), low-density lipoprotein (LDL-C), and very-low-density lipoprotein (VLDL-C) were among the biochemical parameters of the blood lipid profile that were estimated. The levels of serum TC, TG, LDL-C and VLDL-C were significantly ( $P \leq 0.05$ ) higher in the hyperlipidemia group than in the healthy control group while there was decrease in HDL-C level. This bears out the successful induction of hyperlipidemic state in this cohort. On the other hand, groups receiving aqueous and alcoholic ginger extracts clearly had a beneficial effect on lipid profile as evidenced by marked reduction in lesions causing markers along with elevation of HDL-C compared to those on positive control, either co-treated or later treated. The alcoholic extract was relatively better in few attributes. The results suggest that the aqueous and alcoholic ginger extracts exhibit potent protective/therapeutic activities for correction of lipid profile disturbances caused by high-fat diet, with no negative effects. This is also consistent with their prospective usage as safe natural supplements for the management of blood lipids.

**Keywords:** Male white rats, hyperlipidemia, lipid profile, alcoholic and aqueous extract of ginger.



## تقييم تأثير المستخلصين المائي والكحولي للزنجبيل في مستوى الدهون لدى الجرذان البيضاء الذكور المصابة بفرط شحميات الدم

نبأ عدنان ابراهيم

<sup>1</sup>ا قسم علوم حياة، كلية التربية للبنات، جامعة تكريت -العراق

أ.م.د. حلا حميد مجيد

قسم علوم حياة، كلية التربية للبنات، جامعة تكريت -العراق

Corresponding Author E-mail: NABAA.ADNAN462@st.tu.edu.iq1

### الملخص

هدفت هذه الدراسة إلى تقييم تأثير المستخلصين المائي والكحولي للزنجبيل في مستوى الدهون في مصل الدم لدى الجرذان البيضاء الذكور المصابة بفرط شحميات الدم. أجريت الدراسة خلال الفترة من كانون الأول 2024 إلى شباط 2025 في كلية التربية للعلوم الصرفة بجامعة تكريت وبيت الحيوانات التابع لكلية الطب البيطري. استُخدمت في الدراسة جرذان بيضاء ذكور من سلالة Sprague Dawley ، بأوزان تراوحت بين 160-200 غم وأعمار 2-3 أشهر، حيث بلغ عدد الحيوانات المستخدمة 42 جرذاً. قُسمت الحيوانات عشوائياً إلى ست مجموعات متساوية شملت: مجموعة السيطرة السليمة (المجموعة الأولى)، مجموعة فرط شحميات الدم التي غُذيت على حمية عالية الدهون مدعمة بـ 2% كوليسترول (المجموعة الثانية)، وأربع مجموعات علاجية عولجت بالمستخلصين الكحولي والمائي للزنجبيل إما بالتزامن مع إحداث فرط شحميات الدم أو بعد إحداثه. تم تقدير المعايير الكيميائية الحيوية لمستوى دهون الدم، والتي تضمنت الكوليسترول الكلي (TC) ، الدهون الثلاثية (TG) ، البروتينات الدهنية عالية الكثافة (HDL-C) ، البروتينات الدهنية منخفضة الكثافة (LDL-C)، والبروتينات الدهنية منخفضة الكثافة جداً (VLDL-C) أظهرت النتائج ارتفاعاً معنوياً ( $P \leq 0.05$ ) في مستويات TC و TG و LDL-C و VLDL-C في مجموعة فرط شحميات الدم مقارنةً بمجموعة السيطرة السليمة، مع انخفاض مستوى HDL-C ، مما يؤكد نجاح إحداث حالة فرط شحميات الدم في هذه المجموعة. في المقابل، أظهرت المجموعات المعالجة بالمستخلصين المائي والكحولي للزنجبيل تحسناً واضحاً في مستوى الدهون، تمثل بانخفاض ملحوظ في المؤشرات المسببة للآفات وارتفاع مستوى HDL-C مقارنةً بمجموعة السيطرة الموجبة، سواء عند المعالجة المترامنة أو اللاحقة. كما تبين أن المستخلص الكحولي كان أكثر فاعلية نسبياً في بعض المؤشرات. تشير نتائج الدراسة إلى أن المستخلصين المائي والكحولي للزنجبيل يمتلكان نشاطاً وقائياً وعلاجياً فعالاً في تصحيح اضطرابات مستوى الدهون الناتجة عن الحمية عالية الدهون، دون إحداث تأثيرات سلبية، مما يدعم إمكانية استخدامهما كمكملات طبيعية آمنة لإدارة مستويات دهون الدم.

**الكلمات المفتاحية:** الجرذان البيضاء الذكور، فرط شحميات الدم، مستوى الدهون، المستخلص المائي والكحولي للزنجبيل.

### Introduction:

One of the most significant health issues of the twenty-first century is obesity. Approximately 2.5 billion persons were > overweight in 2022, including nearly 890 million adults who were obese, according to recent reports from the World Health Organization<sup>52</sup> and the NCD Risk Factor Collaboration<sup>53</sup>. The combined number



of people classified as obese reached 1 billion. These are increases in the epidemic over previous estimates for 2013 of 1.6 billion overweight, and 400 million obese individuals. It's obvious to all that obesity is no more a local, an individual or societal problem; it has become a global epidemic of the XXI-st century that can be stopped and treated by multiple level preventive measures (NCD, 2023; WHO, 2023). Obesity is associated with increased metabolic disorders, including hyperlipidemia manifested by raised plasma cholesterol and triglyceride levels. Hyperlipidemia is a strong risk factor for atherosclerosis, cardiovascular diseases and non-alcoholic steatohepatitis. Different kinds of animal models, such as animals fed a high-cholesterol or high-fat diet, are useful to mimic these pathological changes. These diets result in increased levels of total cholesterol, LDL-C and triglycerides as well as induction of oxidative stress and hepatic steatosis thereby serving a useful model to assess the efficiency of new potential preventive or therapeutic approaches (Bays, 2023). In this line, ginger (*Zingiber officinale*) is an interesting medicinal plant extensively used all over the world as a food and folk medicine. Being rich in bioactive phenolic components, such as 6-gingerol and 6-shogaol, it has received more research attention. The bioactive of these compounds have promising antioxidant and anti-inflammatory potential effect, as well modulating lipid and carbohydrate metabolisms pathways. Some of its molecular targets include activation of the AMPK pathway (cellular energy regulator), inhibition of SREBP-1c (lipid synthesis driver), reduction in ACC (acetyl-CoA carboxylase) activity, decreasing fatty acid biosynthesis rate, promotion of mitochondrial FA oxidation and inactivation inflammatory pathways such as NF- $\kappa$ B; these biochemical interferences might justify ginger's possible role in controlling body lipids levels and protecting liver from increased lipids damaging effects (Zhou et al., 2022; Stoilova et al., 2023)..

### **Materials and Methods:**

From December 2024 to February 2025, this study was carried out at Tikrit University's Veterinary Medicine Department and the labs of the College of Education for Pure Sciences. Male albino rats of the Sprague Dawley strain, weighing between 160 and 200 grams and aged two to three months, were employed in the investigation. 42 mature males participated in the study; they were split into six equal groups of seven animals each at random. The first group, which was the control group, received physiological saline and a regular meal. The second group, referred to as the high-fat group, was fed a high-fat diet supplemented with 2% cholesterol for 60 days. For 60 days, the third group was given an aqueous ginger extract along with a high-fat diet. For 60 days, the fourth group was given an alcoholic ginger extract along with a high-fat diet.. The fifth group: I was given high-fat diets for 30 days and then I was given an aqueous extract of ginger for 30



days. Group 6: I was given high-fat diets for 30 days and then I was given an alcoholic extract of ginger, alternately, for 30 days.

### **Preparation of Alcoholic and Aqueous Ginger Extracts:**

To prepare the alcoholic extract, 50 grams of dry ginger powder were weighed and placed in a 500 ml conical flask. 250 ml of appropriately concentrated ethanol was then added. Similarly, an aqueous extract was prepared by placing 50 grams of ginger powder in another flask filled with 500 ml of deionized water.

Both solutions were mixed using a stirrer and hotplate without heating for half an hour to ensure homogeneity. The solutions were then transferred to a shaker and stirred continuously for 24 hours at room temperature.

After the shaking period, the mixtures were filtered through two layers of clean cheesecloth to remove any undissolved sediment. The filtered aqueous part (water + ginger) was dried in Petri dishes in an oven at the necessary temperature for about three hours to get dry extract. The dry extract was collected, scraped lightly and stored in opaque glass bottles with air-tight seal to protect it from both light and UV light. This preparative procedure was repeated several times to allow us the extraction of an extract adequate for subsequent experiments.

### **Results:**

The findings in Table (1) revealed that cholesterol and triglyceride levels significantly increased ( $P \leq 0.05$ ) in the second group (positive control), which received high-cholesterol diet during all periods of the experiment period. Their concentrations reached  $(3.25 \pm 138.79)$  mg/dl and  $(3.46 \pm 187.25)$  mg/dl, respectively, compared to the healthy control group. Conversely, a significant decrease ( $P \leq 0.05$ ) in total cholesterol and triglyceride concentrations was observed in the groups treated with the aqueous and alcoholic extracts of ginger, including the third group (protective)  $(1.67 \pm 98.56)$  mg/dl and  $(2.33 \pm 136.14)$  mg/dl, the fourth group (protective)  $(1.56 \pm 81)$  mg/dl and  $(2.06 \pm 103.98)$  mg/dl, and the fifth group (Treatment)  $(1.57 \pm 112.14)$  mg/dl and  $(3.29 \pm 145.4)$  mg/dl, and the sixth group (Treatment)  $(0.73 \pm 96.47)$  mg/dl and  $(1.28 \pm 123.11)$  mg/dl, compared to the positive control group. A significant decrease in HDL-C concentration was observed in the second group (positive control) that received the cholesterol diet throughout the experiment, with a concentration of  $(0.17 \pm 27.81)$  mg/dl, compared to the healthy control group, which had a concentration of  $(2.09 \pm 43.95)$  mg/dl. On the other hand, the groups treated with the alcoholic and aqueous extracts of ginger showed a substantial rise ( $P < 0.05$ ) in high-density lipoprotein cholesterol (HDL-C), including the third (protective) group  $(1.58 \pm 33.12)$  mg/dl, the fourth (protective) group  $(1.49 \pm 38.56)$  mg/dl, the fifth (treatment) group  $(0.45 \pm 31.28)$  mg/dl, and the



sixth (treatment) group ( $0.68 \pm 36.49$ ) mg/dl. Compared to the positive control group.

**Table (1): Effects of alcoholic and aqueous ginger extracts on blood serum levels of triglycerides (TG), total cholesterol (TC), high-density lipoproteins of cholesterol (HDL-C), low-density lipoproteins of cholesterol (LDL-C), and very-low-density lipoproteins of cholesterol (VLDL-C) in male albino rats with hyperlipidemia.**

Variables Groups	TC	TG	HDL-C	LDL-C	VLDL-C
G1	$75.83 \pm 0.94$ E	$92.53 \pm 1.58$ e	$43.95 \pm 2.09$ a	$13.37 \pm 0.07$ C	$18.50 \pm 0.42$ c
G2	$138.79 \pm 3.25$ A	$187.25 \pm 3.46$ a	$27.81 \pm 0.17$ c	$73.53 \pm 2.46$ A	$37.45 \pm 0.89$ a
G3	$98.56 \pm 1.67$ C	$136.14 \pm 2.33$ c	$33.12 \pm 1.58$ bc	$38.21 \pm 1.65$ bc	$27.23 \pm 0.46$ b
G4	$81 \pm 1.56$ D	$103.98 \pm 2.06$ d	$38.56 \pm 1.49$ ab	$21.56 \pm 0.93$ c	$20.79 \pm 0.38$ bc
G5	$112.14 \pm 1.57$ B	$145.4 \pm 3.29$ b	$31.28 \pm 0.45$ bc	$51.78 \pm 1.64$ b	$29.08 \pm 0.54$ ab
G6	$96.47 \pm 0.73$ Cd	$132.11 \pm 1.28$ cd	$36.49 \pm 0.68$ ab	$33.56 \pm 1.19$ bc	$26.42 \pm 0.47$ bc

\* Values are expressed as the arithmetic mean  $\pm$  standard error.

\* Number of rats (7) in each group.

\* Numbers followed by different column letters indicate a statistically significant difference at a probability level of ( $P \leq 0.05$ ).

### Discussion:

Ginger extract significantly reduces total cholesterol and triglyceride levels in animal models with hyperlipidemia. These findings are consistent with those of Kinabalu (2023), Naidu et al. (2025), and Akomolafe et al. (2025), which suggest



that this effect is due to the ability of active ginger compounds, such as 6-gingerol and shogaol, to inhibit the activity of HMG-CoA reductase, the enzyme responsible for endogenous cholesterol synthesis in the liver. In addition, ginger extract stimulates the lipoprotein lipase enzyme that converts triglycerides to free fatty acids and glycerol in serum, leading to less accumulation of these lipids in circulation and better blood lipid profile.

Orally supplemented alcoholic and aqueous extracts of *Zingiber officinale* resulted in a significant rise in the serum HDL-C levels of experimental animals fed HFD. These findings are in agreement with Shaukat et al. (2023), Abdelhamid et al. (2024), and Aboismaiel et al. (2024), who explained the mechanisms of HDL-C enhancement by ginger that included inhibition of hepatic cholesterol gene expression, and LCAT activity stimulation leading to generation of mature HDL particles. They also showed that *Zingiber officinale* reduced the aftermath of oxidative stress factors and prevents the modification of HDL molecules by oxidative process, so while stability and plasma circulating capacity be increased and then it appears an elevated HDL-C levels (Abdelhamid et al., 2024).

## Conclusion

The present investigation has clearly shown that dietary hyperlipidemia produced in male albino rats results in marked alterations of the blood lipids. After combined and consecutive oral medication with aqueous extract of ginger, alcoholic extract of ginger or both extracts in rats there was a prominent beneficial impact on lipid profiles that included reduction in atherosclerotic cholesterol as well as elevation in HDL cholesterol. The higher efficacy in modification of some lipid profiles was showed by the alcoholic extract. No adverse effects were recorded, thus implicating the safety of the two extracts. These results indicate that the extracts of ginger have potent lipid regulating, preventive and curative effects and can be used as natural products for treatment of dyslipidemias..

## References :

1. NCD Risk Factor Collaboration (NCD-RisC). (2023). Worldwide trends in obesity and body mass index since 1990: A pooled analysis of 2221 population-based studies with 220 million participants. *The Lancet*, 401(10383), 1390–1406.
2. World Health Organization (WHO). (2023). Obesity and overweight. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>.



3. Bays, H. E. (2023). Adiposopathy, dyslipidemia, and atherosclerosis: The role of dysfunctional adipose tissue in cardiovascular disease. *Journal of Clinical Lipidology*, 17(1), 20–34.
4. Zhou, H., Deng, Y., & Zhang, J. (2022). Molecular mechanisms of ginger in regulating lipid metabolism: A review. *Nutrients*, 14(15), 3110.
5. Stoilova, I., Krastanov, A., & Stanchev, V. (2023). Antioxidant and lipid-lowering properties of ginger phenolic compounds: Mechanistic insights. *Phytomedicine*, 115, 154765.
6. Shaukat, M. N., Nazir, A., & Fallico, B. (2023). Ginger bioactives: a comprehensive review of health benefits and potential food applications. *Antioxidants*, 12(11), 2015
7. Aboismaiel, M. G., Amin, M. N., & Eissa, L. A. (2024). Renoprotective effect of a novel combination of 6-gingerol and metformin in high-fat diet/streptozotocin-induced diabetic nephropathy in rats via targeting miRNA-146a, miRNA-223, TLR4/TRAF6/NLRP3 inflammasome pathway and HIF-1 $\alpha$ . *Biological Research*, 57(1), 47
8. Abdelhamid, M. S., Sherif, M. H., Abaza, H. R., El-Maghraby, L. M., Watad, S. H., & Awad, A. E. (2024). Zingiber officinale extract maximizes the efficacy of simvastatin as a hypolipidemic drug in obese male rats. *Food Science & Nutrition*, 12(3), 1940-1954
9. Kinabalu, K. (2023). Antihyperlipidemic and hepatoprotective effect of Zingiber cassumunar rhizome extract in high-fat diet-induced hyperlipidemic rats: the role of antioxidant activity. *Sains Malaysia*, 52(9), 2559-2569
10. Naidu, D., Althaf Umar, K. P., Muhsina, K., Augustine, S., Jeengar, M. K., & S. K., K. (2025). Zingiberaceae in Cardiovascular Health: A review of adipokine modulation and endothelial protection via adipocyte-endothelial crosstalk mechanism. *Current Nutrition Reports*, 14(1), 66
11. Akomolafe, S. F., Atoyebi, D. A., Ogundare, M. A. B., & Akinlua, I. (2025). Effect of dietary supplementation with raw and boiled ginger (*Zingiber officinale* Roscoe) rhizome on biochemical parameters of rats fed high cholesterol diet. *Nutrition*, 50(1), 11.