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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии
საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

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GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

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WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx**. Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - <http://www.spinesurgery.ru/files/publish.pdf> и http://www.nlm.nih.gov/bsd/uniform_requirements.html В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректурa авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or computer-printed on a single side of standard typing paper, with the left margin of 3 centimeters width, and 1.5 spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - 12 (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf

In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned
Requirements are not Assigned to be Reviewed.**

ავტორთა საქურაღებოლ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx**. შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრაფიების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შედეგის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფხიხლებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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PHYTOCHEMICAL SCREENING AND LIPID LOWERING EFFECTS OF *TERMINALIA CHEBULA* FRUIT EXTRACTS IN ALBINO WISTAR RATS

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Abstract.

Terminalia chebula fruit is a medicinal plant high in bioactive compounds that have potential therapeutic benefits. The current study targeted to determine the phytochemical profiles and hypolipidemic effects of aqueous and methanol-based extracts of *Terminalia chebula* fruits in high-fat diets that made hyperlipidemic Wistar rats. According to qualitative phytochemical examination, the aqueous extract contained phenols, flavonoids, tannins and saponins, whereas the methanol extract contained alkaloids, tannins, and flavonoids. Induction of hyperlipidemia significantly raised total serum cholesterol, triglycerides, LDL, and VLDL levels in the group with high-fat diet when compared to the normal control. Treatment with the methanol extract of *Terminalia chebula* (200 mg/kg) resulted in significant decreases ($P < 0.05$) in blood total cholesterol (26.6%), triglycerides (17.3%), LDL cholesterol (43.8%), and VLDL cholesterol (17.3%) compared to hyperlipidemic control group. Similarly, the aqueous extract significantly decreased total cholesterol (15.8%), triglycerides (12.8%), LDL cholesterol (28.2%), and VLDL cholesterol (12.8%) ($P < 0.05$). Atorvastatin treatment resulted in a significant improvement in lipid parameters and acted as a positive control. No substantial increase in HDL cholesterol levels was seen in the extract-treated groups. In conclusion, *Terminalia chebula* fruit extracts had considerable hypolipidemic action, with the methanol extract exceeding the aqueous extract. These effects could be attributable to the presence of polyphenols and flavonoids, which supports *Terminalia chebula*'s potential use as a natural treatment for hyperlipidemia control.

Key words. *Terminalia chebula*, phytochemical screening, hyperlipidemia, lipid profile, hypolipidemic activity.

Introduction.

Hyperlipidemia is one of the most significant risk factors for coronary heart disease, stroke, ischemic heart disease and atherosclerosis, all of which are leading causes of death [1]. Hyperlipidemia and lipid abnormalities are thought to cause atherosclerotic cardiovascular diseases [2]. Obesity has emerged as another major medical condition in recent years, leading to the development of a variety of other serious disorders [3]. Millions of people suffer from obesity, which contributes to cardiovascular illness, and there are fewer potential treatments accessible [4]. As stated by World Health Organization, cardiovascular disorders account for more than half of all deaths. Cardiovascular diseases are projected to cause 12 million fatalities per year [5], while obesity is responsible for one million deaths in Europe each year [6]. Because existing hypolipidemic medications have severe adverse effects, herbal treatments are

safe, inexpensive, and readily available and over 80% of the world's population relies on plants for their medication [7]. Numerous medicinal plants contain high levels of antioxidants like nitrogen compounds, phenolic compounds, terpenoids, vitamins and other metabolites. Plant-derived products have been used in a variety of applications from ancient times to the present day, including medicine, nutrition, flavoring, cosmetics, beverages, and more [8]. As a result, the use of medical plants is expanding in many nations, with natural goods accounting for 35% of all pharmaceuticals [9]. Furthermore, synthetic medications are extremely expensive to develop. It is therefore critical that efforts be made to examine new medicinal plants in order to generate affordable medications [10]. Medicinal plants contain chemical compounds that have a specific physiological function on the human body, such as tannins, carbohydrates, alkaloids, steroids, terpenoids, flavonoids, and phenols [11]. The bioactive phytochemicals are produced by the primary or secondary metabolic processes of living organisms [12]. Secondary metabolites are chemically and taxonomically varied molecules with unknown functions; they are widely used in human therapy, veterinary medicine, agriculture, scientific research, and a variety of other applications [13]. *Terminalia chebula* is a member of the Combretaceae family, and its scientific categorization is indicated in Table 1.

Table 1. Taxonomy of *Terminalia chebula*.

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Myrtales
Family	Combretaceae
Genus	Terminalia
Species	Chebula

This plant contains a diverse range of phytochemicals which contribute to its hypolipidemic characteristics. Flavonoids, alkaloids, polyphenols, saponin, glycosides, and triterpenoids were extracted from *Terminalia chebula* fruits. *Terminalia chebula* is a blooming tree that stays green all year native to several areas of Asia (particularly Pakistan and India) and Africa nations [14]. This plant's fruits, stem, leaves and bark are all employed as antioxidants, anticancer, anti-inflammatory, cardioprotective agents and hepatoprotectant [15]. *Terminalia chebula*'s aqueous and methanol extracts have been shown to have antibacterial [16], scavenging for free radicals [17], and heart tonic properties [18]. We need a lot of scientific investigations on how an alcoholic extract of *Terminalia chebula* fruit lowers lipid levels [19]. Yet, additional research is required to establish the

full scope of anti-hyperlipidemic effect of *Terminalia chebula* fruit extract. As a consequence, in the current investigation, we studied the hypolipidemic impacts of an aqueous and alcohol extracts of *Terminalia chebula* fruit.

Materials and Methods.

Plant material and the extraction method: Dried fruit of *Terminalia chebula* was obtained from a local market in Mosul, Iraq, and identified by the Department of Botany at the Agriculture College/University of Mosul. The dried fruit had been washed, and dried in shade. After shade drying, the fruit was finely pulverized and stored in a tightly sealed container for future use. The coarse powder of *Terminalia chebula* (200 g) was packed in a Soxhlet device and extracted with distilled water and methanol for 72 hours. The solvent has been removed under reduced pressure using vacuum distillation, and the aqueous extract were dissolved in normal saline [20] and alcohol extract were suspended in normal saline and agitated thoroughly before each administration to ensure uniform dosing [21].

Phytochemical study of extracts: Extracts had been evaluated for inclusion of phytochemical substances including flavonoids, saponins, alkaloids, triterpenoids, tannins and glycosides [22]. The following methodologies had been used:

Phenols test: In a test tube, put 1ml of extract with a 5% FeCl₃ reagent. Phenolic chemicals are distinguished by their dark green color.

Alkaloids detection by Hager's Test: Some drops of Hager's reagent (a concentrated picric acid solution) had been added to the test solution; the appearance of a yellow precipitate indicates the presence of alkaloids.

Tannins detection by gelatin test: When a test substance is mixed to gelatin solution, it produces a white precipitate, showing that tannins are present.

Glycosides test by Keller Killiani test: The test sample got a few drops of glacial acetic acid and a solution of ferric chloride and stirred thoroughly. Concentrated sulphuric acid was applied and two layers formed. A glycoside test would be positive if the lower reddish-brown layer and the higher acetic acid layer turned bluish green.

Saponins test:

Foam Test - The test sample had been combined with water and stirred till frothy form, which remained stable for 15 minutes, indicating a positive result.

Flavonoids test:

Ferric chloride test: When the test sample is handled with five drops of ferric chloride liquid, a blackish red color appears, showing a presence of flavonoids.

Experimental animals: Forty male, healthy, mature albino rats of the Wistar strain weighing between 300 and 350 g had been obtained from the animal house at the College of Veterinary Medicine, University of Mosul. The animal house was adequately ventilated, and the animals had 12 ± 1 hour day/night schedules with adequate hygienic cages throughout the trial period. The animals were given water and pellet diet ad libitum.

Experimental design: Forty rats had been separated to five groups of eight individuals, as illustrated below:

Group I: Control rats got the standard food and water.

Group II: Negative control, receiving a high-fat diet per os for 30 days.

Group III: Positive control received atorvastatin (10 mg/kg p.o.) and a high-fat diet for 30 days.

Group IV: Rats were treated with *Terminalia chebula*'s aqueous extract and a high-fat diet for 30 days.

Group V: Rats were treated with *Terminalia chebula*'s methanol extract and a high-fat diet for 30 days.

Before the trial, the animals starved overnight and got free availability of drinking water. To ensure uniformity, each experiment was carried out in the morning. Total cholesterol was determined using Wybenga and Pillegi's one-step method, which is based on the interaction between cholesterol and cholesterol reagent (ferric chloride, ethyl acetate, and sulfuric acid) [23]. HDL from blood was determined using a two-step procedure, which involved first separating HDL from blood use a precipitating agent followed by precipitation. HDL was measured using a colorimetric reaction and cholesterol reagent [24]. Triglyceride (TG) was measured colorimetrically using an enzymatic reaction with glycerol-3-phosphate oxidase [25]. Friedelwald's formula was used to calculate LDL (TC-HDL-VLDL) and VLDL (Triglycerides-5) [26]. At the end of the investigation, rats were fasted for 14 hours. Blood was taken from the tail vein into glass tubes containing 1 mg/mL Na₂EDTA for biological serum measurement.

Statistical analysis: The experimental values were reported as mean ± SEM. The data were subjected to one-way ANOVA. P-values of less than 0.05 were considered statistically significant.

Results.

Phytochemical Analysis: A qualitative phytochemical evaluation of *Terminalia chebula* aqueous and alcohol extracts confirmed the presence of several beneficial components (Table 2). The aqueous extract revealed phenols, saponins, tannins, and flavonoids, with no glycosides or alkaloids. Conversely, alcohol extract includes phenols, tannins, alkaloids, and flavonoids, and no saponins or glycosides have been identified. Overall, alcohol extract included a wider range of chemical components than the water extract, especially among terms of alkaloid level. The phytochemical outcomes in Table 2 show that *Terminalia chebula* includes phenols, tannins, alkaloids, glycosides, and flavonoids.

Table 2. Phytochemical composition of *Terminalia chebula* aqueous and alcohol extracts.

Phytochemicals	Aqueous extract	Methanol extract
Phenols	+	+
Alkaloids	-	+
Tannins	+	+
Glycosides	-	-
Saponins	+	-
Flavonoids	+	+

'+' indicates the presence of: '-' indicates the absence of phytochemicals.

A high-fat diet given to Group II caused significant rises in total serum cholesterol, triglycerides, VLDL and LDL levels

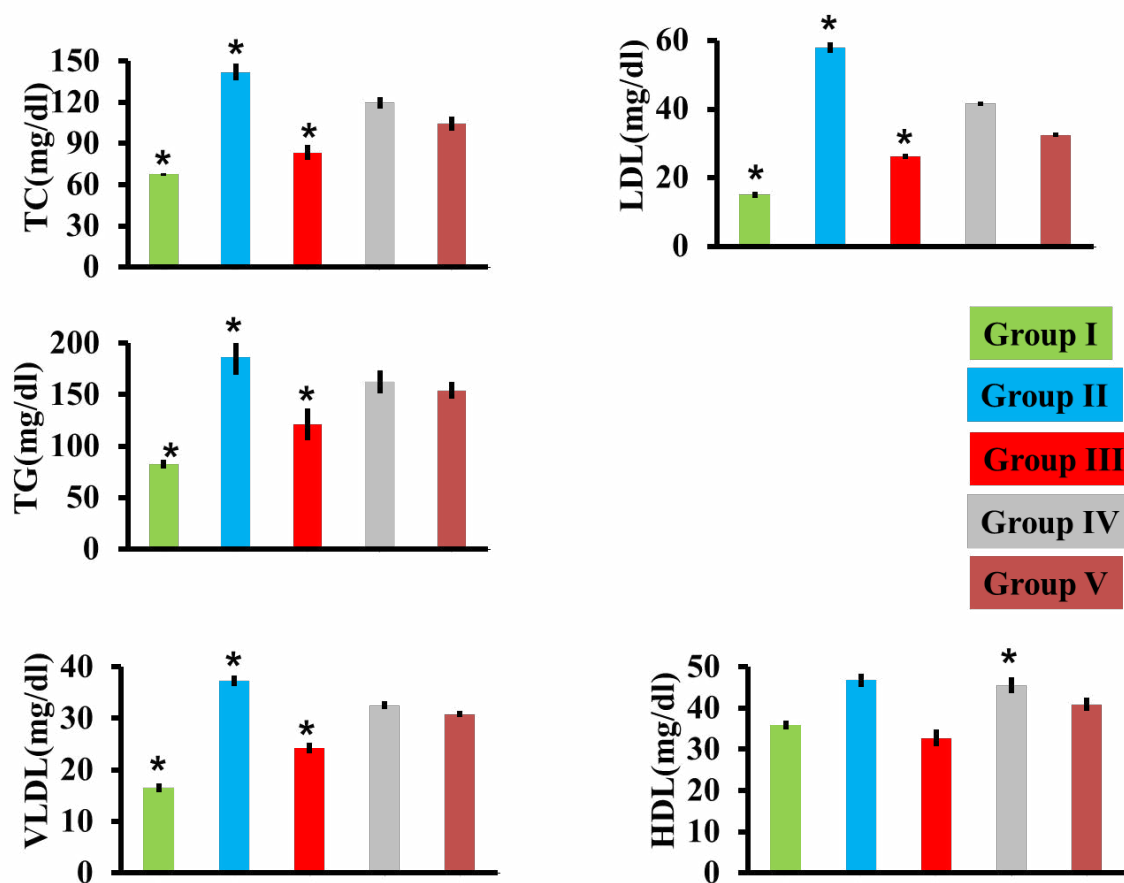


Figure 1. Effect of *Terminalia chebula* extracts on serum lipid profile in high-fat diet-induced hyperlipidemic rats. Group I: vehicle control; Group II: rats given high-fat diets (negative control); Group III: rats given high fat diet and atorvastatin (positive control); Group IV: rats given high fat diet and aqueous extract of *Terminalia chebula* 200 mg/kg; Group V: rats given high fat diet and methanol extract of *Terminalia chebula* 200 mg/kg. The results are expressed as mean \pm SEM (n=8). *Significant at $P < 0.05$ in comparison with Group II (high fat diet control).

comparing to the normal control group (Group I). In comparison to the high-fat diet group, atorvastatin (Group III) significantly lowered serum total cholesterol, triglycerides, LDL, and VLDL levels ($P < 0.05$).

Similarly, animals treated with the aqueous extract of *Terminalia chebula* (Group IV, 200 mg/kg) exhibited a major drop in total cholesterol, triglycerides, VLDL and LDL levels compared to Group II ($P < 0.05$). Treatment with the methanol extract of *Terminalia chebula* (Group V, 200 mg/kg) significantly decreased total serum cholesterol, triglycerides, LDL, and VLDL levels in comparing to the group with Group II received a high-fat diet ($P < 0.05$) showing a substantial hypolipidemic impact. Overall, the methanol extract had higher lipid-lowering efficacy than the aqueous extract. The high-fat eating group (Group II) had higher HDL cholesterol levels compared to the normal control group (Group I). Atorvastatin treatment (Group III) resulted in significantly reduced HDL levels compared to the high-fat eating group ($P < 0.05$). The administration of an aqueous and alcohol extracts of *Terminalia chebula* (Group IV) had no statistically significant effects on HDL cholesterol levels when compared to the high-fat eating group.

Discussion.

The current study's findings suggest that the phytochemical content of *Terminalia chebula* extracts has a significant

influence on its lipid-lowering actions. A qualitative phytochemical examination revealed that both the aqueous and methanol extracts include phenols, tannins, and flavonoids, however alkaloids were only found in the methanol extract and saponins only in the aqueous extract. These changes in phytochemical profiles appear to explain the observed variances in hypolipidemic effectiveness among the treatment groups. A diet with high-fat is a primary reason of hyperlipidemia, which has been associated to a number of health problems, includes high blood pressure, coronary heart disease, fatty liver disease, stroke, diabetes, and some malignancies [27]. A diet with high-fat increases the production of free radical, which leads to insulin resistance and systemic inflammation [28]. An elevated cholesterol level, along with higher quantities of elevated-triglyceride VLDL and elevated cholesterol LDL in the blood, is a known danger aspect for cardiovascular diseases [29]. Animal studies have additionally demonstrated that increasing the consume of high-calories results in an associated rise in the fatty acids level in the blood, as well as a rise in lipogenesis, resulting to fatty liver, that was good imitated by diet with high-fat [30]. This was considerably attenuated by *Terminalia chebula* extract, which has an anti-hyperlipemic action.

Atorvastatin is a statin, or 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitor. Statins block the production

of mevalonate, an enzyme that limits rate in cholesterol biosynthesis [31]. This reduces plasma LDL levels and increases hepatic absorption, lowering the risk of CVDs [32]. Statins are a potent cholesterol-lowering medicine in clinical practice [33] and their inclusion as a positive control within the trials provided a superior comparison for the anti-hyperlipemic action of *Terminalia chebula* extract. High-cholesterol intake promoted hyperlipidemia is related with elevated blood lipid levels [34]. In the high-fat diet model, administering the alcohol extract caused in a more a big drop in total serum cholesterol, triglycerides, VLDL and LDL values in comparison to the aqueous extract. The elevated activity could be linked to the presence of alkaloids in the alcohol extract, together with phenolic substances. Phenols and flavonoids are widely recognized for their antioxidant effects. They regulate lipid metabolism by reduce oxidative stress and regulating cholesterol synthesis [35].

Tannins are also known to diminish intestinal lipid absorption and boost fecal cholesterol excretion; this could contribute to the observed improvement in lipid profiles [36]. Despite saponins were identified in the aqueous extract, the absence of alkaloids may have limited its lipid-lowering effectiveness when compared to the alcohol extract. Saponins restrict cholesterol absorption by forming compounds that are insoluble with bile acids [37]; yet, their actions tend to be lesser when working alone. The higher efficacy of the alcohol extract reflects a synergistic interaction of alkaloids, flavonoids, phenols, and tannins, which may enhance metabolism of lipid and control of lipoprotein [38]. Interestingly, the high-fat eating group had greater HDL levels than the normal control group. Although this conclusion looks contradictory, comparable findings have been described in experimental models in which high-fat diet caused adaptive increases in HDL synthesis and decreased HDL catabolism as a compensated reaction to increasing lipid load. Such systems are considered to improve reverse cholesterol transfer in conditions of high dietary fat intake [39]. Additionally, eating a high-fat diet may alter HDL composition, resulting in an increase in cholesterol-rich or apo E-enriched HDL particles rather than a more beneficial lipid profile. Therefore, the HDL rise found in the high fat diet group should be viewed cautiously [40]. The solvent- dependent extraction of biologically active compounds highlights the significance of extraction technology in determining the health benefits of plant-based medicines [41]. The current investigation demonstrates that the alcohol extract of *Terminalia chebula* has greater hypolipidemic effect than the aqueous extract because it contains a broader spectrum of bioactive e phytochemicals. These findings point to *Terminalia chebula's* potential as an effective medicinal component in the management of dyslipidemia.

Despite those results, certain limitations should be noted. The study did not investigate HDL functional characteristics, which may have an impact on a biological explanation of the increased HDL seen in the high-fat eating group. Furthermore, the sample size was rather small, and longer study durations may be necessary to properly clarify lipid profile changes.

Conclusion.

Terminalia chebula extracts have been found to reduce

hyperlipidemia in rats given a high-fat diet. *Terminalia chebula* has significant antihyperlipidemic properties and could be utilized as a natural medication to treat diet-related hyperlipidemia. Additional isolation, characterization, and purification of the active constituents, as well as the finding of the molecular mechanism of action, could confirm *Terminalia chebula* extract as a treatment option for hyperlipidemia.

Ethical approval.

The study approved by Pharmaceutical Research Ethics Committee in the University of Mosul (Approval Letter No. PREC-26-6-24 on 23 Feb 2025).

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Conflict of interest.

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