GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 9 (378) Сентябрь 2026

ТБИЛИСИ - NEW YORK



ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press. Published since 1994. Distributed in NIS, EU and USA.

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.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

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 ВИНИТИ 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.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

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. Корректура 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 compu-ter-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 საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ 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. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის 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 ფჩხილებში 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.

GEORGIAN MEDICAL NEWS
NO 9 (378) 2026

Содержание:

Vadatchkoria R, Dondoladze K, Tsintsadze N, Kaushik A, Singh H.
HEALTH-RELATED CHALLENGES, PSYCHO-EMOTIONAL WELLBEING, AND ADAPTATION EXPERIENCES OF INTERNATIONAL STUDENTS IN A FOREIGN ACADEMIC ENVIRONMENT……6-13

Tan Kaiyou, Zhang Zhaoying.
EPIDEMIOLOGY AND POST-EXPOSURE MANAGEMENT OF RABIES EXPOSURES AT A COMMUNITY HEALTH CENTER: A 2024–2025 RETROSPECTIVE ANALYSIS……14-19

Josue Andres Orozco Pilco, Ximena del Rocío Robalino Flores, Silvia Paola Monar Basantes, Luisa Carolina González Ramírez.
RETICULOCYTE COUNT AND HEMATOLOGICAL INDICES IN MICROCYTIC HYPOCHROMIC ANEMIA: PREVALENCE AND PATTERNS AMONG INFANTS UNDER 24 MONTHS IN ANDEAN ECUADOR……20-25

Mirgul Kapakova, Jamilya Mansurova, Anar Kozhabayeva, Beshimbayeva Zhuldyz, Zhanar Toktarova, Meiramgul Tokbulatova, Galiya Assanova, Bolat Ashirov, Dariga Nurgalieva.
INDEPENDENT PREDICTORS OF SHORT-TERM MORTALITY IN PATIENTS WITH CHRONIC HEART FAILURE AND ANEMIA……26-32

Aynur Isayeva, Yusif Aliyev, Nergiz İmanova.
BASIC PRINCIPLES OF THE CONCEPT OF ACCELERATED POSTOPERATIVE RECOVERY AFTER SUBTOTAL COLECTOMY……33-36

David Gogoberidze, Irine Bakhutashvili.
MAJOR ADVERSE CARDIOVASCULAR EVENTS AFTER ACUTE CORONARY SYNDROME: DEFINITION, TIMING, RATES, MAIN RISK FACTORS, AND WAYS TO IMPROVE……37-43

Nataliya Byelyayeva, Pavlo Velychko, Olha Savitska, Zhanna Bogdan, Nataliia Ivantsev.
THE EFFECTIVENESS OF PSYCHOLOGICAL INTERVENTIONS IN MANAGING ANXIETY AND STRESS FOLLOWING TRAUMATICEVENTS……44-53

Hayfa A. Al-Olayan.
THIRTY-DAY INCIDENCE OF SURGICAL SITE INFECTION AND PERIOPERATIVE PROCESS COMPLIANCE IN A UNIVERSITY HOSPITAL DAY-SURGERY UNIT: A RETROSPECTIVE COHORT STUDY OF 200 PATIENTS……54-66

Grigoryan A.A, Makinyan L.G, Podlesnaya A.A, Imankulov M.A, Abu Zaalan V.M.
FACTORS ASSOCIATED WITH FUNCTIONAL OUTCOME AND SELECTION OF SURGICAL STRATEGY IN FOOT DROP SYNDROME ASSOCIATED WITH COMMON PERONEAL NEUROPATHY……67-72

Norah Hadi Mohammed, Tala Mustafa Ezzat, Fatima Alzahra Mukhtar, Ahmed. L. Osman, Marwan Ismail, Areeg Khalfallah, Ghina Yazbek, Sara Mohammed Ali, Abdelgadir Elamin Eltom.
CORRELATION OF HBA1C WITH INFLAMMATORY MARKERS AND NEUTROPHIL-TO-HIGH-DENSITY LIPOPROTEIN RATIO IN PATIENTS WITH TYPE 2 DIABETES MELLITUS: A RETROSPECTIVE CROSS-SECTIONAL STUDY……73-75

Zainab Haitham Fathi, Ammar A.Y. Almulathanon.
ASSOCIATION BETWEEN INFERTILITY AND SERUM LEVELS OF ANTI-MÜLLERIAN HORMONE, FOLLICLE-STIMULATING HORMONE, LUTEINIZING HORMONE, AND PROLACTIN ACCORDING TO VITAMIN D SUPPLEMENTATION STATUS……76-82

Zhadra Kalbagayeva, Zaituna Khismetova, Nazym Iskakova, Aliya Atabayeva, Bakytkul Toktabayeva, Aigul Tugelbayeva, Sultan Seidumanov, Kamila Akhmetova, Bibinur Sydykova.
HEALTH-RELATED QUALITY OF LIFE AND ASSOCIATED FACTORS AMONG PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE: A CROSS-SECTIONAL STUDY……83-89

Tamta Chikobava, Ann Margvelashvili, Manana Kalandadze, Nino Tebidze, Vladimer Margvelashvili.
ASSESSMENT AND NONPHARMACOLOGICAL GUIDANCE OF CHILDREN'S BEHAVIOR AND DENTAL ANXIETY IN PEDIATRIC DENTISTRY: A STRUCTURED NARRATIVE REVIEW……90-97

Eglantina Bulica, Admir Sinamati, Alketa Tandili, Gentian Vyshka.
ETHICAL AND DEONTOLOGICAL DIMENSIONS OF RETINOPATHY OF PREMATURITY CARE: TOWARD A EUROPEAN PERSPECTIVE……98-103

Tingliang Tao, Yun Huang, Mengdan Xu, Shaoguo Wang, Lihong Bao.
MACHINE LEARNING-BASED IDENTIFICATION OF KEY GENES AND DEVELOPMENT OF A PREDICTIVE NOMOGRAM FOR PERIODONTITISDIAGNOSIS……104-111

Ahmed Abdelhadi Ahmed Nasr, Selma E. Hago Dawd, Ammar Abdelmola, Husham O. Elzein, Menna Ibrahim ALbader, Ezeldine K Abdalhabib, Elryah I Ali, Alneil Hamza, Mohammed Ibrahim Saeed, Salah Eldin Omar Hussein, Sara Mohammed Ali, Ayman H. Alfeel, Amar Mohamed Ismail, Omer Fadul Idris.
ASSOCIATION OF SER447TER, HINDIII AND PVUII LIPOPROTEIN LIPASE GENE POLYMORPHISMS WITH LIPID PROFILE IN CORONARY HEART DISEASE……112-120

Indira Adilbekova, Nishangul Bozhbanbayeva, Saule Issenova, Gulmira Altynbayeva, Dilfuza Sultanmuratova.
MATERNAL AND CORD-BLOOD HOMOCYSTEINE AND NEONATAL S100B IN PRETERM BIRTH: ASSOCIATIONS WITH IN-HOSPITAL NEONATAL OUTCOMES IN A PROSPECTIVE COHORT……121-130

Hayder G Oufi, Rana Hussein Kutaif, Ruaa E. Alabd, Hawraa Hussein Abd, Ranya Riyadh Hameed, Esraa Adnan Al-Muhanna, Dina Amer Abd, Riham Taha Yousif.
CLINICAL AND CULTURAL PERSPECTIVES ON POLYCYSTIC OVARY SYNDROME (PCOS) IN WOMEN BASED ON SYMPTOM CLUSTERING AND DIAGNOSTIC TRENDS…….131-141

Ferat Sallahu, Anamarija Jankulovska, Altin Sallahu.
LYMPHOVASCULAR AND PERINEURAL INVASION IN RELATION TO THE PRESENCE AND BURDEN OF NODAL METASTASIS IN RESECTED GASTRIC CANCER…….142-146

Toapanta Yugcha Iván, Toapanta Paredes Ximena, León Corrales Luis Sebastián, Maisincho Proaño Erika Fernanda, Alvarado Buenaño Marlon Andrés, Reinoso Molina Marcos Rubiño.
SOCIODEMOGRAPHIC FACTORS ASSOCIATED WITH SUICIDE RISK AMONG URBAN AND RURAL ADOLESCENTS IN AMBATO, ECUADOR…….147-151

Elmira Amanova, Gaukhar Abassova, Gulnaz Kaishibayeva, Vitaliy Kovalchuk, Yessengeldi Ismailov, Marzhan Abdrazakova, Sandugash Alipbekova, Saule Tuktibayeva, Kanatzhan Kemelbekov, Adlet Yernazarov.
FREQUENCY OF NEUROPATHIC PAIN FEATURES AMONG NEUROLOGICAL OUTPATIENTS AND THEIR IMPACT ON QUALITY OF LIFE: A CROSS-SECTIONAL SCREENING STUDY OF 1,705 PATIENTS…….152-162

Shaikha Fatmah Al Sharqia, Magdy Ali Abdou Gouda, Praveen Kumar, Shima Ibrahim Ali.
PERCEIVED CAUSES AND CONSEQUENCES OF DIAGNOSTIC ERRORS IN THE SECOND-TRIMESTER FETAL ANOMALY SCAN…….163-171

Moldir Tleubayeva, Meyirbek Aimagambetov, Kirill Krylov, Yernar Mamyrov, Marat Syzdykbayev, Samatbek Abdrakhmanov, Gulshat Alimkhanova, Assel Tulebayeva, Roman Khripunov.
NUTRITIONAL SUPPORT IN SURGICAL PATIENTS. PROTEIN-ENERGY METABOLISM DISORDERS…….172-180

Eranov Sh. N, Urinbaev Payzilla, Khodjanov Iskandar Yunusovich, Eranov Nurali Fayziyevich, Khalimova Fariza Tursunbaevna.
COMPREHENSIVE INSTRUMENTAL AND FUNCTIONAL ASSESSMENT OF POST-TRAUMATIC ELBOW CONTRACTURE IN CHILDREN AT THE INITIAL STAGE OF REHABILITATION…….181-187

Diana Dzidziguri, Irakli Chkhikvishvili, Maka Mantskava, Eka Shekiladze, Ekaterine Bakuradze, Tornike Liverashvili, Nina Kipiani, Sophio Turabelidze-Robaqidze, Tamar Sanikidze.
PHYTOCHEMICAL CHARACTERISATION, RADICAL-SCAVENGING ACTIVITY AND EXPERIMENTAL MICROCIRCULATORY RESPONSES TO GEORGIAN CUCURBITA MOSCHATA FLESH-WITH-PEEL EXTRACT…….188-195

Tchernev G, Tchernev KG Jr, Kordeva S.
DERMATOLOGIC SURGERY PEARLS: KERATINOCYTE CANCER AFFECTING HIGH RISK FACIAL REGIONS - LOGARITHMIC SPIRAL FLAP FOR NASAL ALAR RECONSTRUCTION AND V-TO-T FLAP FOR LOWER LIP RECONSTRUCTION…….196-203

Yerzhan Khochshanov, Dulat Baltabayev, Svetlana Khan, Yelena Aisenova, Zhibek Dautbayeva, Zhanar Akhmetova, Viktoriya Nazarova, Assel Meiramova.
OCULAR SURFACE AND TEAR FILM CHANGES IN GRAVES' DISEASE ACCORDING TO THYROID EYE DISEASE STATUS…….204-209

Laktionova M, Barmanasheva Z, Onglas A, Kulzhanov M, Baimuratova M, Sarsenbaeva M.
PREVALENCE AND RISK FACTORS OF PELVIC ORGAN PROLAPSE AMONG WOMEN IN ALMATY: A HOSPITAL-BASED STU DY…….210-217

Ahmed Abdelhadi Ahmed Nasr, Tagwa Yousif Elsayed Yousif, Ravshanova Maftuna Zoxidjonovna, Husham O. Elzein, HabibAllaa Eldaw Mohamed, Ezeldine K Abdalhabib, Elryah I Ali, Alneil Hamza, Mohammed Ibrahim Saeed, Salah Eldin Omar Hussein, Ayman H. Alfeel, Amar Mohamed Ismail, Omer Fadul Idris.
LIPOPROTEIN LIPASE GENE POLYMORPHISMS AND THEIR ASSOCIATION WITH APOLIPOPROTEIN A-I AND B-100 CONCENTRATIONS IN PATIENTS WITH CORONARY HEART DISEASE: A CROSS-SECTIONAL GENETIC ASSOCIATION STUDY …….218-225

Khamdamova Muhayyoxon Tukhtasinovna, Khalilova Mekhriniso Tuymurodovna, Askarova Zebo Zafarjonovna, Yusupova Mekhribon, Kambarova Dildora Noxidovna, Khalimova Fariza Tursunbaevna.
MORPHOLOGICAL FEATURES OF THE CERVICAL EPITHELIUM AND STROMA IN CHRONIC RECURRENT CERVICITIS WITH AND WITHOUT SQUAMOUS INTRAEPITHELIAL LESIONS: A COMPARATIVE CROSS-SECTIONAL STUDY…….226-233

GEORGIAN MEDICAL NEWS
No 9 (378) 2026

PHYTOCHEMICAL CHARACTERISATION, RADICAL-SCAVENGING ACTIVITY AND EXPERIMENTAL MICROCIRCULATORY RESPONSES TO GEORGIAN CUCURBITA MOSCHATA FLESH-WITH-PEEL EXTRACT

Diana Dzidziguri[1], Irakli Chkhikvishvili[2,3], Maka Mantskava[2,4], Eka Shekiladze[2], Ekaterine Bakuradze[1], Tornike Liverashvili[1], Nina Kipiani[2], Sophio Turabelidze-Robaqidze[5], Tamar Sanikidze[2,3,4].

[1]*Ivane Javakhishvili Tbilisi State University, Tbilisi, Georgia.*

[2]*Tbilisi State Medical University, Tbilisi, Georgia.*

[3]*V. Bakhutashvili Institute of Medical Biotechnology, Tbilisi, Georgia.*

[4]*Beritashvili Centre of Experimental Biomedicine, Tbilisi, Georgia.*

[5]*European University, Tbilisi, Georgia.*

Abstract.

Aim: To compare phenolic and flavonoid contents and DPPH radical-scavenging activity among Georgian *Cucurbita moschata* preparations and assess acute hepatic and mesenteric microcirculatory responses to concentrated flesh-with-peel extract (FPE).

Materials and methods: Dried flesh with peel and seeds were extracted with 80% ethanol, and concentrated dry FPE was prepared from flesh with peel. Chemical endpoints were assessed using colourimetric assays, with four analytical measurements per preparation. Liver histology was examined 3 h after a single intraperitoneal FPE administration in **7-day-old neonatal male Wistar rats and young male Wistar rats weighing 120–140 g.** Neonatal hepatocyte mitotic activity was compared between control and exposed groups, with seven animals per group. Microcirculatory intensity was assessed before and after local FPE application in NaCl-crystal- and dextran-500-induced mesenteric stasis models, with five paired observations per model. Holm correction was applied across the two microcirculatory comparisons.

Results: Dry FPE exhibited the highest total phenolic content (8.085 ± 0.021 mg gallic acid equivalents/g dry weight), total flavonoid content (7.405 ± 0.056 mg quercetin equivalents/g dry weight), and DPPH radical-scavenging activity (63.18 ± 0.28%). Corresponding values were 4.970 ± 0.063, 3.883 ± 0.054, and 54.15 ± 0.44% for flesh with peel, and 2.100 ± 0.039, 2.030 ± 0.100, and 46.03 ± 0.30% for seeds. ANOVA indicated differences among preparations for all three endpoints ($p < 0.001$). Liver architecture appeared broadly preserved. Neonatal mitotic indices were 8.06 ± 1.87‰ in controls and 8.66 ± 1.72‰ after FPE exposure (Welch's t-test, $p = 0.544$). Following local FPE application, microcirculatory intensity increased from 0.36 ± 0.09 to 0.82 ± 0.13 in the NaCl model and from 0.50 ± 0.07 to 0.72 ± 0.04 in the dextran-500 model (Holm-adjusted $p = 0.0050$ for both).

Conclusions: Dry FPE combined the highest phenolic and flavonoid indices with the greatest DPPH radical-scavenging activity among the tested preparations. Local application was followed by increased microcirculatory intensity in both stasis models, while acute hepatic assessment showed broadly preserved architecture and no significant change in neonatal mitotic activity. These complementary findings support standardised preclinical investigation of FPE composition and potential microvascular actions.

Key words. *Cucurbita moschata*, flesh-with-peel extract, phenolics, flavonoids, DPPH, liver histology, microcirculation.

Introduction.

Pumpkin (*Cucurbita spp.*) is a source of phenolics, flavonoids, carotenoids, and other constituents of interest for nutritional and preclinical research [1-5]. Their distribution varies among flesh, peel, and seeds and is influenced by species, cultivar, maturity, and processing [3,4,6-8]. A central scientific question is how preparation-dependent differences in chemical composition relate to measurable biological responses. Addressing this question requires characterisation of the preparation used in the biological experiments alongside assessment of its functional activity.

Pumpkin tissues offer distinct but potentially complementary sources of bioactive compounds. Comparative studies have documented differences in phenolic content and antioxidant activity among anatomical fractions [6-8]. Chromatographic analyses have identified epicatechin and glycosylated derivatives of quercetin, kaempferol, and isorhamnetin in pumpkin byproducts, demonstrating their phytochemical diversity [9]. Seeds also contain a distinct lipid fraction [10]. These differences make preparation-specific assessment important, while findings from *Cucurbita maxima* and *Cucurbita pepo* provide comparative context for investigating *Cucurbita moschata* [7,10-12]. Combined flesh-with-peel preparations are therefore of interest as materials in which chemical composition and biological activity can be examined together.

Microcirculation provides a functional setting for investigating interactions between plant-derived constituents, blood cells, and vascular tissue. Altered redox balance and haemorrheological disturbances have been linked to impaired microcirculatory function [13,14]. Chemical radical-scavenging assays can help characterise extracts, whereas experimental microcirculatory measurements provide complementary information about their responses in living tissue. Combining these levels of assessment can strengthen the biological relevance of extract characterisation and identify hypotheses for subsequent mechanistic investigation.

Evidence concerning erythrocyte responses supports this approach. Bilto and Abdalla [15] showed that several isolated flavonoids protected human erythrocytes against experimentally induced loss of filterability and modified sedimentation and osmotic fragility, with responses differing among compounds.

Fathima et al. [16] also reported erythrocyte membrane-stabilising activity of a methanolic *C. pepo* fruit extract. Together, these findings provide a rationale for investigating whether interactions with erythrocyte membranes contribute to the microcirculatory responses associated with pumpkin preparations. The possible connection between pumpkin phytochemistry and haemorrheological function is scientifically relevant because it offers a testable explanation for functional changes beyond chemical radical scavenging alone.

Acute hepatic assessment adds a complementary dimension by characterising the immediate tissue response to extract exposure. Liver architecture and hepatocyte mitotic activity provide distinct morphological and cellular endpoints. In neonatal rats, mitotic activity is interpreted in the context of active developmental hepatocyte proliferation [17]. Integrating these observations with chemical measurements and experimental microcirculation allows the preparation to be assessed across several biological levels.

The aim of this study was to compare total phenolic content, total flavonoid content, and DPPH radical-scavenging activity in three preparations from a single lot of Georgian *C. moschata*-flesh with peel, seeds, and concentrated dry flesh-with-peel extract (FPE) - and to assess the acute hepatic response to FPE and changes in mesenteric microcirculatory intensity following its local application in NaCl-crystal- and dextran-500-induced stasis models.

The scientific value of this exploratory study lies in bringing preparation-specific chemical measurements together with hepatic and microcirculatory observations. The use of two stasis models permits assessment of the consistency of the microcirculatory response across different experimental settings. This integrated design provides a basis for selecting standardised preparations, defining relevant functional endpoints, and developing focused hypotheses about the constituents and mechanisms involved in FPE activity.

Materials and Methods.

Plant material and extraction:

Cucurbita moschata fruits were obtained from a local market in Tbilisi, Georgia, and identified by morphological features. Flesh with peel was separated from the seeds, and both fractions were dried at 60 °C and milled. Material was processed as a single experimental lot. For analytical extraction, 5 g of flesh-with-peel or seed powder was extracted three times with 20 mL of 80% ethanol for 1 h per extraction. The pooled extracts from each preparation were vacuum-concentrated below 40 °C to a final volume of 10 mL, corresponding to 0.5 g of starting dry material per mL. Dry flesh-with-peel extract (FPE) was prepared exclusively from pumpkin flesh and peel; seeds were excluded. Dried flesh-with-peel powder (50 g) was extracted three times with 200 mL of 80% ethanol for 1 h per extraction. The extracts were pooled, filtered, vacuum-concentrated below 40 °C, and dried. The extraction yield was 32% (w/w), corresponding to 16 g of dry FPE from 50 g of starting dried flesh-with-peel material. Dry FPE was stored at −80 °C until use.

Total phenolic content, flavonoids, and DPPH activity:

We measured DPPH radical-scavenging activity spectrophotometrically at 515 nm after a 30-min reaction with 2,2-diphenyl-1-picrylhydrazyl. Scavenging was calculated as R (%) = [(C − S)/C] × 100, where C and S denote the absorbance of the DPPH control and the sample reaction mixture, respectively. Results were expressed as the percentage decrease in DPPH absorbance under the assay conditions used.

Total phenolic content was determined using the Folin–Ciocalteu assay at 725 nm with gallic acid as the calibration standard. Phenolic and flavonoid assay values were expressed as milligrams of gallic acid equivalents (GAE) and quercetin equivalents (QE), respectively, per gram of dry weight (DW). DPPH radical-scavenging activity was expressed as percentage inhibition. Four analytical measurements were performed per preparation.

Total flavonoid content was determined using the $AlCl_3$ colourimetric assay at 410 nm with quercetin as the calibration standard. Results are presented as mean ± standard deviation (SD) and describe analytical variation within the tested lot.

Experimental animals and hepatic assessment:

Male Wistar rats were used for the hepatic assessment, including 7-day-old neonatal (suckling) rats and 7–8-week-old young rats weighing 120–140 g. For each age group, seven animals were assigned to the control group and seven to the FPE-exposed group. Neonatal rats were selected because the early postnatal liver undergoes active growth and developmental hepatocyte proliferation, providing a biologically relevant setting for assessing whether acute FPE exposure alters hepatocyte mitotic activity [17].

FPE was administered once intraperitoneally. All doses refer to the mass of recovered dry FPE. Older rats weighing 120–140 g received 1 mg of dry FPE in 0.1 mL per animal, corresponding to a solution concentration of 10 mg/mL and a body-weight-adjusted dose of 7.14–8.33 mg/kg. Seven-day-old neonatal rats received 0.1 mg of dry FPE in 0.1 mL per animal, corresponding to 1 mg/mL. Based on a total phenolic content of 8.085 mg gallic acid equivalents (GAE)/g dry FPE, the 1-mg dose contained an estimated 8.085 µg GAE, equivalent to 57.75–67.38 µg GAE/kg in rats weighing 120–140 g. The 0.1-mg neonatal dose contained an estimated 0.8085 µg GAE per animal. These quantities represent Folin–Ciocalteu assay equivalents, rather than the measured mass of individual phenolic compounds.

Colchicine (1 mg/kg body weight) was administered 1 h after FPE injection, and liver tissue was collected 3 h after FPE administration.

Liver tissue was fixed in 4% buffered formaldehyde, dehydrated through graded alcohols, embedded in paraffin, sectioned at 5–7 µm, and stained with haematoxylin and eosin (H&E). Mitotic activity was assessed by counting metaphase figures among 5,000 hepatocytes per animal. The mitotic index was calculated as (number of metaphase figures/5,000) × 1,000 and expressed in ‰. Each animal constituted one biological replicate.

Mesenteric microcirculation and stasis models:

Mesenteric microcirculation was examined by Leitz biomicroscopy in male Wistar rats with a mean body weight of 170 ± 40 g. Two experimental stasis models were used: local stasis induced by placing a NaCl crystal on the mesenteric capillary network and stasis induced by administration of high-molecular-weight dextran 500. Premedication consisted of a

2% promedol solution at 0.02 mL/100 g body weight, followed by a 4% chloral hydrate solution at 1 mL/100 g body weight for anaesthesia, corresponding to doses of 4 and 400 mg/kg, respectively. FPE was applied locally to the affected mesenteric region.

The available dataset comprised five paired microcirculatory index observations per stasis model, obtained after stasis induction, before and after local FPE application. Pre-FPE and post-FPE values were summarized separately using arithmetic means, calculated as $\bar{x} = \Sigma_{i=1}^{5} x_i/5$, where x_i denotes an individual recorded index value. Paired changes were calculated as $\Delta_i = I_{post,i} - I_{pre,i}$, and the mean paired change as $\bar{\Delta} = \Sigma_{i=1}^{5} \Delta_i/5$. Comparisons used the reported two-sided paired t-test p values, with Holm correction applied across the two stasis models.

Ethics statement:

The study was approved by the Animal Research Ethics Committee of Tbilisi State Medical University.

Statistical analysis:

Chemical assay results and neonatal mitotic indices are presented as mean ± standard deviation (SD). Differences among the three preparations were assessed using one-way analysis of variance (ANOVA), and neonatal hepatocyte mitotic indices were compared using Welch's independent-samples t-test. Each preparation had four analytical observations, reflecting within-lot repeatability. Accordingly, the ANOVA results were interpreted as comparisons among the tested preparations rather than evidence of differences across independently produced batches. No, post hoc pairwise comparisons were performed.

Pearson correlations were calculated by pooling the 12 analytical observations across the three preparations. These correlations were interpreted as descriptive pooled associations that may primarily reflect differences among preparations, rather than within-preparation or dose–response relationships.

For the microcirculatory comparisons, the reported two-sided paired t-test p-values were used, separately for the NaCl- and dextran-500-induced stasis models, with five paired observations per model. Holm correction was applied across the two comparisons. Confidence intervals were calculated as unadjusted 95% intervals and were not corrected for multiple comparisons.

Paired changes were defined as post-FPE minus pre-FPE values. Approximate confidence intervals and effect sizes were reconstructed from the reported mean paired changes and unadjusted two-sided p-values, assuming paired t-tests with five pairs and four degrees of freedom. The absolute t statistic was obtained from the inverse cumulative Student's t distribution. The calculations were:

$|t| = t(1 - p/2,4)$

$SE\Delta = |\bar{\Delta}| / |t|$

$SD\Delta = SE\Delta \times \sqrt{5}$

95% $CI = \bar{\Delta} \pm t(0.975,4) \times SE\Delta$

$d_z = \bar{\Delta} / SD\Delta$

Here, t(q, 4) denotes the q quantile of Student's t distribution with four degrees of freedom; $\bar{\Delta}$ denotes the mean paired change, SEΔ its standard error, and SDΔ the standard deviation of the within-pair changes. SDΔ differs from the separate pre-FPE and post-FPE standard deviations. These reconstructed estimates are approximate because the reported mean changes and p values were rounded, and they could not be independently verified against individual paired observations.

All analyses were considered exploratory owing to the small sample sizes. All hypothesis tests were two-sided, with statistical significance defined as $p < 0.05$; Holm-adjusted p values were used for the two microcirculatory comparisons.

Results.

Phenolic content and DPPH radical scavenging across preparations:

Dry FPE exhibited the highest total phenolic and flavonoid contents and DPPH radical-scavenging activity among the three preparations (Table 1 and Figure 1). Total phenolic content was 8.085 ± 0.021 mg GAE/g DW in dry FPE, 4.970 ± 0.063 mg GAE/g DW in flesh with peel, and 2.100 ± 0.039 mg GAE/g DW in seeds. The corresponding total flavonoid contents were 7.405 ± 0.056, 3.883 ± 0.054, and 2.030 ± 0.100 mg QE/g DW, respectively. DPPH radical-scavenging activity was 63.18 ± 0.28%, 54.15 ± 0.44%, and 46.03 ± 0.30%, respectively. One-way ANOVA indicated differences among the preparations for all three endpoints ($p < 0.001$).

Compared with flesh with peel, dry FPE had 62.7% higher total phenolic and 90.7% higher total flavonoid assay values. DPPH radical-scavenging activity was 9.03 percentage points higher, corresponding to a relative increase of 16.7%. These results describe the tested experimental lot under the stated assay conditions. The dry-extract yield was 32% (w/w); recovery and enrichment of individual compounds were not quantified.

Across the 12 pooled analytical observations from the three preparations, Pearson correlations were r = 0.999 for DPPH radical-scavenging activity versus total phenolic content and r = 0.988 versus total flavonoid content. These correlations primarily reflect differences among the three preparation means and are interpreted as descriptive between-preparation associations. They do not demonstrate within-preparation relationships, individual-level dose–response effects, or a causal contribution of phenolics or flavonoids to radical-scavenging activity.

Acute hepatic observations and neonatal hepatocyte mitotic index:

Liver micrographs showed generally intact tissue architecture in control and FPE-exposed neonatal rats, with mitotic figures present in both groups (Figure 2). The neonatal hepatocyte mitotic index was 8.06 ± 1.87‰ in the control group and 8.66 ± 1.72‰ after FPE exposure (seven animals in each group; Welch's t-test, p = 0.544; Figure 3). The mean difference was +0.60‰. Based on rounded group summaries and assuming independent observations, the approximate 95% confidence interval for the difference between FPE and control was -1.49 to 2.69‰. Thus, no statistically significant difference was detected.

Liver micrographs from young male Wistar rats weighing 120–140 g likewise showed no obvious disruption of tissue architecture (Figure 4). These observations describe the examined tissue sections collected 3 h after FPE administration.

Microcirculatory intensity after local FPE application:

Local FPE application was followed by an increase in the

Table 1. *Total phenolic content, total flavonoid content, and DPPH radical-scavenging activity in Cucurbita moschata preparations. Values are presented as mean ± SD of four analytical observations per preparation from a single experimental lot. GAE, gallic acid equivalents; QE, quercetin equivalents; DW, dry weight. GAE and QE denote quantities expressed relative to the respective calibration standards and do not represent the masses of individually identified compounds.*

Preparation	Total phenolics mg GAE/g DW	Total flavonoids mg QE/g DW	DPPH scavenging %
Dry FPE	8.085 ± 0.021	7.405 ± 0.056	63.18 ± 0.28
Flesh with peel	4.970 ± 0.063	3.883 ± 0.054	54.15 ± 0.44
Seeds	2.100 ± 0.039	2.030 ± 0.100	46.03 ± 0.30

Table 2. *Microcirculatory index before and after local FPE application in two experimental stasis models.*

Stasis model	After stasis, before FPE: mean ± SD	After FPE: mean ± SD	Mean paired change	unadjusted p	Holm-adjusted p	Approximate 95% CI for mean change	Estimated Cohen's d_z
NaCl crystal	0.36 ± 0.09	0.82 ± 0.13	+0.46	0.0025	0.0050	0.27–0.65	3.02
Dextran 500	0.50 ± 0.07	0.72± 0.04	+0.22	0.0042	0.0050	0.12–0.32	2.63

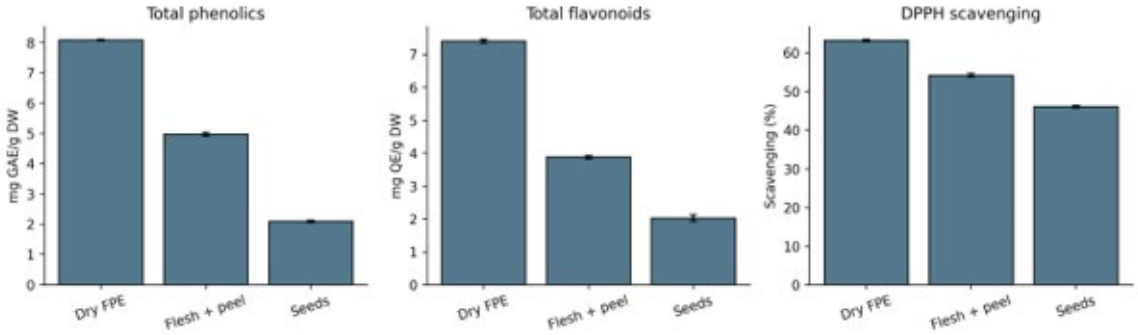


Figure 1. *Total phenolics (mg GAE/g DW), total flavonoids (mg QE/g DW) and DPPH radical scavenging (%) in the three preparations. Bars show mean ± SD of four analytical observations from one lot. ANOVA, $p < 0.001$ for each endpoint. Error bars describe within-lot analytical variation.*

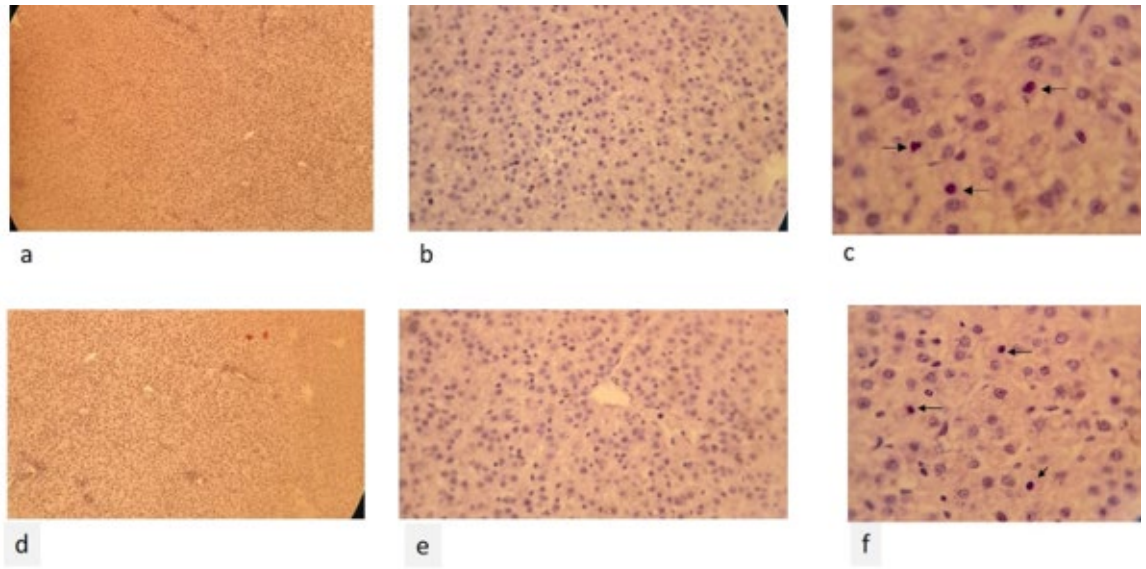


Figure 2. *Liver histology in 7-day-old neonatal male Wistar rats. a–c, control; d–f, FPE-exposed animals. H&E. Reported ocular × objective magnifications: a,d, 5×10; b,e, 5×40; c,f, 5×90 (total 50×, 200× and 450×). Arrows indicate mitotic figures.*

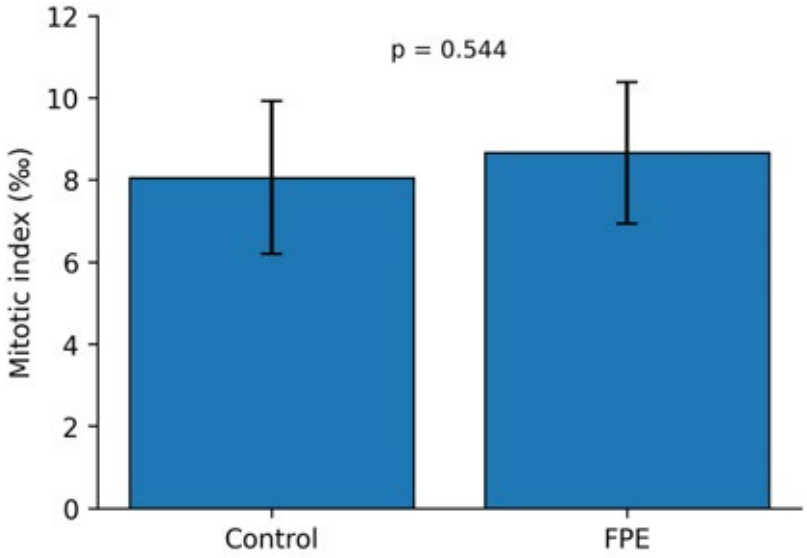


Figure 3. *Hepatocyte mitotic index in 7-day-old neonatal male Wistar rats. Mean ± SD of seven animals per group; Welch's t-test, p = 0.544.*

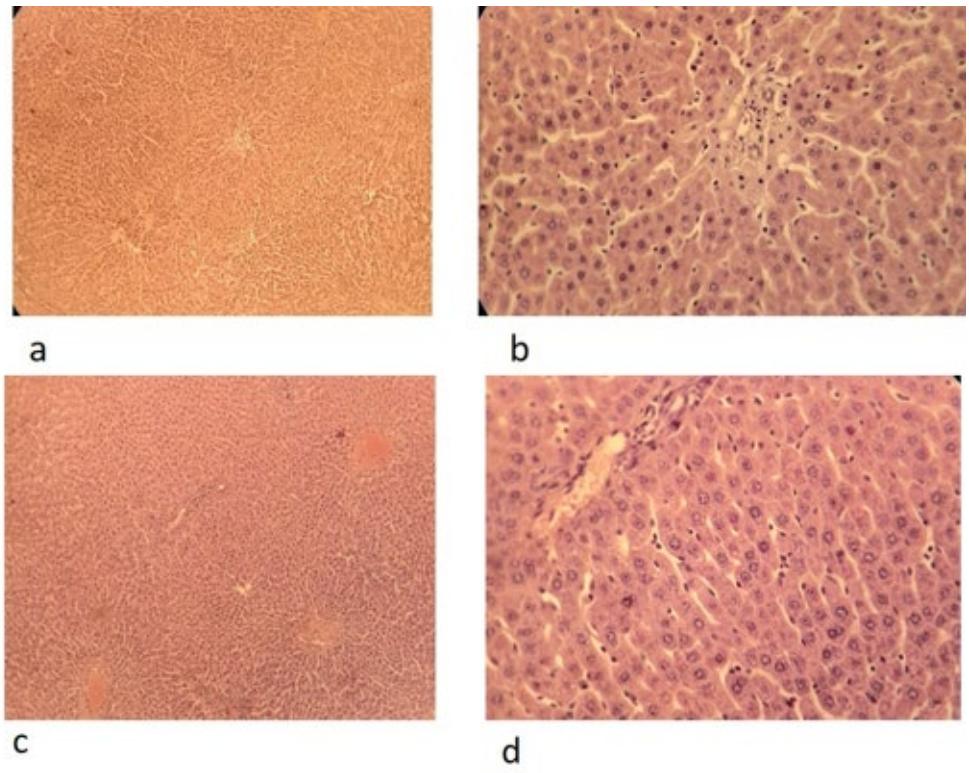


Figure 4. *Liver histology in yang male Wistar rats weighing 120–140 g. a,b, control; c,d, FPE-exposed animals. H&E. Reported ocular × objective magnifications: a,c, 5×10; b,d, 5×40 (total 50× and 200×).*

recorded microcirculatory index in both experimental models (Table 2). In the NaCl-induced stasis model, the mean index increased from 0.36 to 0.82, corresponding to a mean paired change of +0.46 index units (paired t-test, p = 0.0025; Holm-adjusted p = 0.0050). In the dextran-500 model, the mean increased from 0.50 to 0.72, corresponding to a mean paired change of +0.22 index units (paired t-test, p = 0.0042; Holm-adjusted p = 0.0050).

The increases calculated from the group means were approximately 128% and 44%, respectively, relative to the post-stasis, pre-FPE values. Exact numerical pre-stasis measurements were unavailable; therefore, baseline-normalised values could not be calculated. These percentages describe increases from the post-stasis state and do not quantify restoration of normal microcirculation.

Approximate unadjusted 95% confidence intervals for the mean paired changes were 0.27–0.65 index units in the NaCl model and 0.12–0.32 index units in the dextran-500 model. Corresponding estimated paired Cohen's d z values were 3.02 and 2.63. These estimates were reconstructed from rounded

mean changes and reported p-values, assuming paired t-tests with five observations and four degrees of freedom. These findings indicate an increase in the recorded microcirculatory index following local FPE application in both experimental stasis models.

Values are presented as mean ± standard deviation (SD), with five paired observations per model. Mean paired changes were calculated as post-FPE minus pre-FPE values. Comparisons used two-sided paired t-tests, with Holm correction applied across the two comparisons. Approximate 95% confidence intervals and paired Cohen's d_z values were reconstructed from rounded mean changes and unadjusted p-values, assuming four degrees of freedom. These estimates could not be verified against individual paired observations. Confidence intervals are unadjusted for multiple comparisons. CI, confidence interval; FPE, flesh-with-peel extract.

Discussion.

The present study links the chemical characterisation of a pumpkin flesh-with-peel extract (FPE) with its short-term hepatic and microcirculatory responses. Dry FPE exhibited the highest phenolic and flavonoid indices and DPPH radical-scavenging activity among the tested preparations. Local application was followed by increased microcirculatory index in two experimentally induced stasis models, while neonatal hepatocyte mitotic activity showed no statistically significant difference following a single intraperitoneal exposure. The scientific significance of these findings lies in the combination of chemical and functional observations, which provides a basis for investigating how pumpkin-derived constituents interact with the microvascular environment.

Dry FPE contained 62.7% more phenolic equivalents and 90.7% more flavonoid equivalents than flesh with peel, together with 16.7% greater DPPH radical-scavenging activity. The concordant differences across these endpoints indicate that preparation influenced both the measured chemical composition and scavenging capacity. This pattern is consistent with the variation in phytochemical profiles reported across pumpkin tissues, genotypes, and processing conditions [3-8]. Chromatographic evidence further supports the chemical relevance of pumpkin tissues: Leichtweis et al. [9] identified epicatechin and glycosylated derivatives of quercetin, kaempferol, and isorhamnetin in pumpkin byproducts, with substantial variation among tissues and genotypes. These findings place the present results within a broader body of evidence identifying pumpkin materials as sources of chemically diverse phenolic constituents.

The Folin–Ciocalteu and $AlCl_3$ measurements provide complementary, calibration-based descriptions of the preparations. Their interpretation as phenolic and flavonoid equivalents allows comparisons under the same analytical conditions, while recognising that they represent assay responses rather than the masses of individual compounds. Because flavonoids belong to the broader phenolic class, these values describe overlapping aspects of extract composition and should be interpreted together rather than summed. The small analytical standard deviations indicate low within-lot analytical variation within the tested lot.

The strong pooled associations of DPPH activity with phenolic content ($r = 0.999$) and flavonoid content ($r = 0.988$) reinforce the concordance between chemical indices and scavenging activity across preparations. Their principal significance is the coherent separation of the preparation profiles: higher phenolic and flavonoid measurements accompanied greater DPPH scavenging. These pooled associations primarily reflect between-preparation differences and do not establish within-preparation relationships, dose–response effects, or the contribution of individual constituents. The measurable scavenging activity of the seed preparation also indicates that the overall response reflects the properties of the extract as a mixture. Published information on pumpkin-seed composition provides additional nutritional and chemical context [10].

The microcirculatory findings extend the investigation beyond a chemical scavenging assay. Following local FPE application, the intensity index increased by 0.46 units in the NaCl-induced model and 0.22 units in the dextran-500 model. Both comparisons remained statistically significant after Holm correction. The directionally consistent changes across two experimental models support the biological relevance of the observation and provide a rationale for examining FPE–microvascular interactions. The relative increases of approximately 128% and 44% express the magnitude of change from the post-stasis state; they should be understood as increases in the recorded index rather than percentages of normal circulation restored.

The approximate confidence intervals and estimated paired effect sizes likewise indicate substantial changes within the recorded comparisons. Their interpretation is strongest when considered alongside the absolute index changes and the consistency of direction across models. Because these estimates were derived from rounded summary values, they provide an approximate description of response magnitude. The overall pattern supports further investigation of a local microcirculatory action, with causal attribution requiring comparison against the time course of the corresponding experimental controls.

An erythrocyte-mediated contribution to the microcirculatory response is biologically plausible. Fathima et al. [16] reported that a methanolic extract of Cucurbita pepo fruit reduced haemolysis in erythrocyte membrane-stabilisation assays. Although membrane resistance to haemolysis and erythrocyte rheology are distinct properties, this observation provides evidence that pumpkin extracts can interact with erythrocyte membranes. Bilto and Abdalla [15] demonstrated that several isolated flavonoids, including quercetin and rutin, protected human erythrocytes against experimentally induced loss of filterability. Their effects on sedimentation and osmotic fragility differed among compounds, indicating that erythrocyte responses depend on molecular structure and experimental conditions. Together, these studies support erythrocyte membrane properties as a candidate link between flavonoid-containing preparations and microcirculatory behaviour.

This interpretation is particularly relevant to the dextran-associated stasis model because Bilto and Abdalla [15] examined flavonoid effects in experiments that included dextran-induced erythrocyte aggregation. The literature therefore provides a mechanistic bridge between flavonoid chemical properties and the cellular processes that may influence circulation in

this experimental setting. For FPE, modulation of erythrocyte behaviour represents a candidate mechanism for the observed microcirculatory response. Identification of active extract constituents combined with measurements of erythrocyte deformability, aggregation, and blood viscosity would allow this hypothesis to be tested directly.

A complementary hypothesis involves redox-sensitive vascular responses. Previous work linking oxidative stress and haemorrheological disturbances [13,14] provides a framework in which interactions with erythrocytes and the vascular wall may jointly influence microcirculation. The coexistence of DPPH scavenging and a local microcirculatory response makes this hypothesis relevant to FPE, although it does not establish that radical scavenging mediated the functional change. The present findings define a testable relationship among extract composition, redox activity, cellular behaviour, and microvascular responses.

The hepatic observations provide a complementary assessment of the immediate tissue response to FPE exposure. The liver tissue architecture appeared broadly preserved in the examined images, and neonatal mitotic activity did not differ significantly between groups during the three-hour observation period. The mean difference of +0.60‰, with an approximate 95% confidence interval of −1.49 to 2.69‰, describes the range of changes compatible with the immediate hepatic response under the tested exposure conditions. In neonatal animals, the mitotic endpoint is interpreted in the context of active developmental hepatocyte proliferation [17] and does not establish adult liver regeneration, equivalence between treatments, or long-term safety.

Taken together, the results support FPE as a chemically active pumpkin preparation associated with increased microcirculatory index after local application. The literature strengthens the biological plausibility of this observation by documenting phenolic constituents in pumpkin tissues, erythrocyte membrane interactions with pumpkin extracts, and rheological effects of selected flavonoids. The contribution of the present study is therefore a coherent experimental starting point for connecting preparation-related chemical properties with microvascular function. Establishing this connection through standardised extracts and direct vascular and erythrocyte measurements in further investigations would clarify the functional significance of the observed response.

Strengths and Limitations.

A strength of this study is the integration of chemical characterisation, acute hepatic assessment, and paired microcirculatory measurements in two experimental stasis models. This approach brings together complementary observations and provides a basis for investigating relationships between FPE composition and microvascular responses.

The study was designed as an exploratory investigation using a single plant lot and small animal groups. Chemical assays characterised total phenolic and flavonoid indices and DPPH radical-scavenging activity, while the hepatic observations described the immediate post-exposure response. Pooled correlations demonstrated associations across the tested extracts. Chemical antioxidant activity was assessed using the DPPH assay alone. Complementary 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid (ABTS) or Fluorescence Recovery After Photobleaching (FRAP) measurements would strengthen the characterisation of the extract's antioxidant property.

Microcirculatory confidence intervals and effect sizes were estimated from rounded summary statistics and should therefore be interpreted as approximate. Changes were assessed relative to the post-stasis, pre-FPE condition rather than the original pre-stasis baseline.

These features define the experimental scope and guide further work. Evaluation of independent extract batches, detailed phytochemical profiling, and longer-term biological assessments would strengthen the evidence and clarify the mechanisms underlying the observed microcirculatory responses.

Conclusion.

Dry flesh-with-peel extract from the tested *Cucurbita moschata* lot exhibited the highest phenolic and flavonoid indices and DPPH radical-scavenging activity among the three preparations. Acute hepatic observations showed broadly preserved tissue architecture and no statistically significant change in neonatal hepatocyte mitotic activity. Local FPE application was followed by significant increases in the microcirculatory index in both experimental stasis models. These complementary findings support further investigation of standardised FPE preparations and the constituents potentially involved in their microvascular responses.

Funding.

This article presents original research that has not been previously published. The study was conducted within the framework of the project "Extraction «green», stabilization and valorisation of bioactive components of Ribes nidrigolaria et Cucurbita maxima" (ExtraVert_CBA; DRECO-7859_SER-ECO), AUF, France.

Conflicts of interest.

The authors declare no conflicts of interest.

Author contributions.

Diana Dzidziguri contributed to study design and the hepatic animal experiments. Irakli Chkhikvishvili contributed to study design, plant extraction, and phytochemical investigation. Maka Mantskava contributed to study design, the microcirculation experiments, and data collection. Eka Shekiladze and Ekaterine Bakuradze contributed to data collection. Tornike Liverashvili contributed to experimental work. Nina Kipiani contributed to data analysis. Sophio Turabelidze-Robaqidze contributed to methodological planning. Tamar Sanikidze contributed to manuscript preparation. All authors reviewed and approved the final manuscript.

Data availability.

The data supporting the conclusions of this study are available from the authors upon request.

REFERENCES

1. Ghendov-Mosanu A, Netreba N, Balan G, et al. Effect of bioactive compounds from pumpkin powder on the quality and textural properties of shortbread cookies. Foods. 2023;12:3907.

2. Kulczyński B, Sidor A, Gramza-Michałowska A. Antioxidant potential of phytochemicals in pumpkin varieties belonging to *Cucurbita moschata* and Cucurbita pepo species. CyTA J Food. 2020;18:472-484.
3. Matić M, Stupar A, Pezo L, et al. Eco-Friendly Extraction: A green approach to maximizing bioactive extraction from pumpkin (*Cucurbita moschata L.*). Food Chem X. 2024;22:101290.
4. Mokhtar M, Bouamar S, Di Lorenzo A, et al. The influence of ripeness on the phenolic content, antioxidant and antimicrobial activities of pumpkins (*Cucurbita moschata* Duchesne). Molecules. 2021;26:3623.
5. Yang Z, Amrit BK, Zhao W, et al. Bioaccessibility and bioavailability changes of phenolic compounds in pumpkins (*Cucurbita moschata*): a review. Food Biosci. 2022;47:101753.
6. Indrianingsih AW, Rosyida VT, Apriyana W, et al. Comparisons of antioxidant activities of two varieties of pumpkin (*Cucurbita moschata* and Cucurbita maxima) extracts. IOP Conf Ser Earth Environ Sci. 2019;251:012021.
7. Rakass S, Babiker HAA, Oudghiri-Hassani H. Comparative evaluation of total phenolic content, total flavonoids content and antioxidant activity in skin and pulp extracts of Cucurbita maxima. Mor J Chem. 2018;6:218-226.
8. Stryjecka M, Krochmal-Marczak B, Cebulak T, et al. Assessment of phenolic acid content and antioxidant properties of the pulp of five pumpkin species cultivated in Southeastern Poland. Int J Mol Sci. 2023;24:8621.
9. Leichtweis MG, Molina AK, Pires TCS, et al. Biological activity of pumpkin byproducts: antimicrobial and antioxidant properties. Molecules. 2022;27:8366.
10. Hagos M, Yaya EE, Chandravanshi BS, et al. Determination of fatty acids composition by GC-MS and physicochemical parameters of pumpkin (*Cucurbita maxima*) seed oil cultivated in Ethiopia. Bull Chem Soc Ethiop. 2023;37:565-577.
11. Hagos M, Redi-Abshiro M, Chandravanshi BS, et al. New analytical methods for the determination of ascorbic acid content in aqueous extracts of flesh, peel and seeds of pumpkin (Cucurbita maxima). Bull Chem Soc Ethiop. 2022;36:277-290.
12. Hussain A, Kausar T, Sehar S, et al. Determination of total phenolics, flavonoids, carotenoids, beta-carotene and DPPH free radical scavenging activity of biscuits developed with different replacement levels of pumpkin (Cucurbita maxima) peel, flesh and seed powders. Turk J Agric Food Sci Technol. 2022;10:1506-1514.
13. Chkhitauri L, Sanikidze T, Giorgadze E, et al. Comprehensive study of the rheological status and intensity of oxidative stress during the progression of type 2 diabetes mellitus to prevent its complications. Clin Hemorheol Microcirc. 2023;83:69-79.
14. Chkhitauri L, Shekiladze E, Mantskava M, et al. Impact of hyperglycemia on erythrocyte membrane Band 3 protein (BP3). Experimental and Clinical Medicine Georgia. 2023;2:7-11.
15. Bilto YY, Abdalla SS. Effects of selected flavonoids on deformability, osmotic fragility and aggregation of human erythrocytes. Clin Hemorheol Microcirc. 1998;18:165-173.
16. Fathima SN, Firdous SM, Pal S, et al. Assessment of in vitro antioxidant and anti-inflammatory activities of pumpkin (Cucurbita pepo) natural plant. Nat Prod Commun. 2024.
17. Hurley E, Zabala V, Boylan JM, et al. Hepatic gene expression during the perinatal transition in the rat. Gene Expr. 2018;19:1-13.