GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 1 (346) Январь 2024

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 1 (346) 2024

Содержание:

GEORGIAN MEDICAL NEWS
No 1 (346) 2024

GROWTH INHIBITORY EFFECT OF *HOUTTUYNIA CORDATA* EXTRACT ON *STREPTOCOCCUS MUTANS*

Su-Bin Yu[1], Yu-Ri Choi[2], Seoul-Hee Nam[3]*.

[1]*Department of Dental Hygiene, Gimhae College, Gimhae-si, 50811, Republic of Korea.*

[2]*Department of Dental Hygiene, Hallym polytechnic University, Chuncheon-si, 24210, Republic of Korea.*

[3]*Department of Dental Hygiene, College of Health Sciences, Kangwon National University, Samcheok-si, 25949, Republic of Korea.*

Abstract.

Houttuynia cordata is an herbal plant distributed throughout Asia. *H. cordata* has many bioactive properties, including antibacterial properties. The antibacterial effects of *H. cordata* on *S. mutans* remain unknown. Therefore, we treated *S. mutans* with 1, 3, 5, 10, 20, 30, or 40 mg/mL *H. cordata* extract at 37 °C for 24 h. The antibacterial effect of *H. cordata* against *S. mutans* was confirmed using colony forming unit assay and disk diffusion assays. The results of the cell concentration assay demonstrated that *H. cordata* inhibited the growth of *S. mutans* in a dose-dependent manner. Prominent growth inhibition was observed after treatment with 10 mg/mL *H. cordata* extract, and these findings were statistically significant. In addition, no colonies of *S. mutans* were detected after treatment with 40 mg/mL *H. cordata*. Disk diffusion assays revealed that 20 mg/mL of *H. cordata* created a zone of growth inhibition of 11 mm. Therefore, our findings suggest the possibility of using *H. cordata* in the treatment and prevention of dental caries.

Key words. Antibacterial effect, cell viability, dental caries, *Streptococcus mutans, Houttuynia cordata*.

Introduction.

Dental biofilms in the oral cavity are associated with the pathogenesis of several oral diseases, including dental caries and periodontitis. Dental caries formation begins with the demineralization of hard tooth tissues such as the enamel and dentin, followed by necrosis of the dental pulp tissue. The cariogenic microbiome, including *Streptococcus mutans*, *Streptococcus sobrinus, Streptococcus cricetus,* and *Streptococcus rattus* present in the oral cavity, produce lactic acid and they can survive in low pH environments and demineralize the teeth. In particular, *S. mutans* is the main etiological factor of dental caries. *S. mutans* forms initial colonies on the tooth surface and develops a mature dental biofilm by producing extracellular polysaccharides [1-3]. The activity of cariogenic bacteria should be regulated to prevent dental caries. Many antiseptics, such as toothpaste, chlorhexidine, and mouthwash, are widely used to control the growth of these bacteria [1,4,5]. However, chlorhexidine application has side effects such as tooth discoloration and human cytotoxicity [6,7]. A previous study reported that a coconut oil-derived mouthwash is as effective as chlorhexidine in inhibiting *S. mutans* growth [8]. Therefore, it is necessary to develop natural and preventive agents that inhibit cariogenic bacterial growth without side effects.

Houttuynia cordata Thunb. is a perennial herb belonging to the Saururaceae family and has been extensively distributed in Southeast Asia for many centuries. *H. cordata* has several bioactive components such as flavonoids and alkaloids. Further, *H. cordata* possesses diverse pharmacological properties such as anti-inflammatory, antiviral, anticancer, antioxidant, and antibacterial properties. *H. cordata* has been reported to show anti-*Staphylococcus aureus* activity. *S. aureus*, a gram-positive microorganism, is usually detected in the human skin, gastrointestinal tract, and oral-nasal cavity [9]. Sekita et al. reported that an aqueous solution of *H. cordata* ethanol extract significantly suppresses biofilm mass formation in methicillin-resistant *Staphylococcus aureus*, *Fusobacterium nucleatum*, *Candida albicans*, and *S. mutans* [10]. In addition, *H. cordata* exhibits immune-enhancing activities in the human gastrointestinal tract and oral cavity, and it functions as an innate immune mediator [11,12]. However, there have been few studies on the antibacterial effects of *H. cordata* on *S. mutans* in dental caries. Thus, we investigated the growth inhibitory effect of *H. cordata* on *S. mutans* via cell viability assays and the disk diffusion method. We aimed to identify a novel preventive agent against dental caries.

Materials and Methods.

***S. mutans* culture:**

S. mutans (KCTC 3065/ATCC 25175) was obtained from the Korean Collection for Type Cultures (Daejeon, Korea). *S. mutans* was incubated in brain heart infusion (BHI) medium (Sigma-Aldrich, St. Louis, MO, USA) and treated with 1, 3, 5, 10, 20, 30, or 40 mg/mL *H. cordata* extract at 37°C for 24 h.

***H. cordata* extract:**

H. cordata was purchased from Cheongmyeong Herbs Company(Chungju, Korea). *H. cordata* was finely ground and mixed with 70% ethanol following shaking at 60 °C for 24 h. The supernatant was filtered, and then *H. cordata* solution was concentrated using a rotary vacuum evaporator (N-1300E.V.S.; EYELA, Tokyo, Japan). The concentrated *H. cordata* extract was freeze-dried at -80°C via lyophilization (FD, Ilshin Lab, Yangju, Korea) and diluted in dimethyl sulfoxide to obtain a powder.

Colony forming unit assay:

An *S. mutans* suspension (1×10^6 cells/mL) was mixed with 1, 3, 5, 10, 20, 30, and 40 mg/mL of *H. cordata* extract in a 1:1 ratio. Subsequently, 1000 µL of the mixed solution was spread onto 100-millimeter plates and incubated at 37°C for 24 h. After treatment with the *H. cordata* extract, the colonies were washed with phosphate-buffered saline and counted via observation with the naked eye. Each group was distinguished based on the morphological features of *S. mutans* colonies. The number of colony-forming units (CFUs) was converted into logarithms and analyzed. Experiments were repeated thrice to determine the reproducibility of the measurements.

Disk diffusion assay:

An *S. mutans* suspension was prepared and spread onto BHI medium, and 10-millimeter paper discs were soaked in 1, 3, 5,

10, and 20 mg/mL solutions of *H. cordata* extract. The plate was incubated at 37°C for 24 h. After treatment, the size of the growth inhibition zone for each paper disc was measured using a Vernier caliper. The experiments were repeated thrice to determine the reproducibility of the measurements.

Statistical analysis:

Statistical analyses of log CFU/mL values were conducted using IBM SPSS (version 20.0; SPSS, Chicago, IL, USA). Changes in the log CFU/mL values in all groups were investigated using a one-way analysis of variance complemented by Tukey's test ($p < 0.05$).

Results.

Compared with the control group, the cell viability of *S. mutans* treated with *H. cordata* extract decreased in a dose-dependent manner (Figure 1a). The log CFU/mL values were decreased after treatment with 1 to 40 mg/mL of *H. cordata* extract (Figure 1b). In the present study, colony formation of *S. mutans* was inhibited at a concentration of 3 mg/mL of *H. cordata* extract, and significant growth inhibition occurred at a concentration of 10 mg/mL.

To confirm the susceptibility of *S. mutans* to *H. cordata* extract, paper disks soaked in *H. cordata* extract were placed on plates containing *S. mutans* growth. Each paper disk was treated with 1, 3, 5, 10, or 20 mg/mL *H. cordata* extract for 24 h. The diameter of the growth inhibition zone was 11 mm at a concentration of 20 mg/mL (Figure 2). Our results suggested that *H. cordata* exhibited effective antibacterial activity against *S. mutans*.

Discussion.

Dental caries are a harmful factor affecting human oral health. An important stage in dental caries involves the formation of biofilms by pathogenic bacterial colonies on the tooth surface. Dental biofilms consist of *S. mutans*, *Streptococcus salivarius, Streptococcus mitis, Streptococcus sanguinis, Actinomyces spp*., and *Lactobacillus spp*. Among these, *S. mutans* is strongly associated with dental caries. During the initial phase of dental biofilm development, *S. mutans* adheres to the tooth surface; this binding represents the first stage of dental plaque formation. Chlorhexidine, phenolic compounds, and delmopinol are effective antimicrobial agents. However, many of these substances cause side effects [2]. Recently, several studies have reported that natural plant extracts exert antibacterial effects against oral microorganisms such as *S. mutans*, *S. sobrinus*, and *Porphyromonas gingivalis* [13-15]. *H. cordata* contains various chemical constituents including alkaloids, flavonoids, volatile oils, and phenolic acids. Flavonoids and volatile oils are the crucial active components [9]. The antibacterial effects of flavonoids against *S. mutans* have been extensively studied for a long time. The flavonoid baicalein suppresses biofilm formation by inhibiting the growth of *S. mutans* and *C. albicans*. In addition, enamel hardness has been protected after baicalein treatment [16]. Further, xanthorrhizol isolated from *Curcuma xanthorrhiza Roxb*. shows rapid antibacterial activity against *S. mutans* [17]. Another study reported that honey has anti-caries effects. Naturally derived substances, such as herbal medicines, are consistently used as research materials owing to their

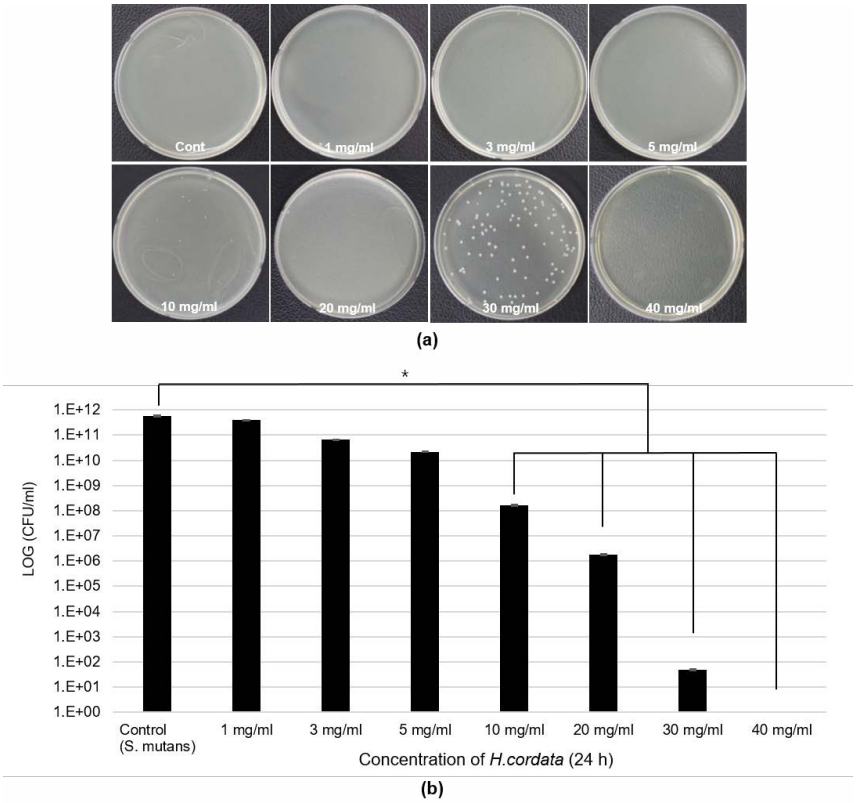

Figure 1. *Number of CFUs of Streptococcus mutans after Houttuynia cordata treatment. (a) CFUs of S. mutans suspension incubated with 0, 1, 3, 5, 10, 20, 30, and 40 mg/mL H. cordata. (b) The mean and standard deviation of the log CFU/mL values of each group. * $p < 0.05$ versus control. CFU, colony-forming unit.*

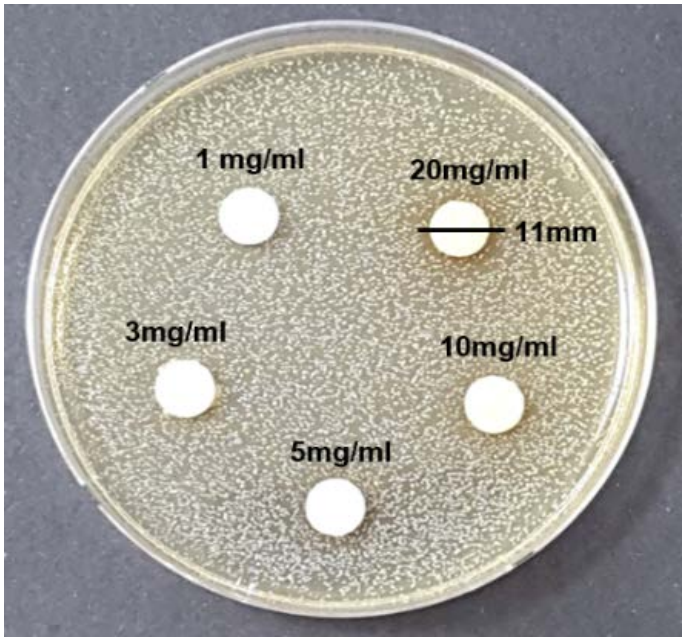

Figure 2. *Disk diffusion assay of Streptococcus mutans. Each paper disk was impregnated with 1, 3, 5, 10, or 20 mg/mL of Houttuynia cordata extract and placed on the agar plate. The diameter of growth inhibition zone was measured after 24 h. Representative data from three independent experiments are shown.*

relatively fewer side effects. Many studies have focused on the antitumor effects of natural substances; however, research on dental caries and bacterial diseases remains insufficient. In the present study, to confirm the antibacterial effect of *H. cordata* extract, *S. mutans* was incubated with an *H. cordata* extract. Regarding our results on the decrease in cell concentration after treatment, Jiangang et al. found that the minimal inhibitory concentrations against *S. aureus* are 25 mg/mL [18]. In a previous study, *H. cordata* has been found to show antibacterial activity against *Escherichia coli* at a concentration of 250 mg/mL [19]. In comparison, we confirmed that *H. cordata* exhibits an antibacterial effect at a lower concentration on *S. mutans* than on *E. coli*. In addition, based on the disk diffusion assay results, a previous study indicated that the effect may vary depending on the components of the material from which *H. cordata* is extracted. Breast cancer cell lines were previously exposed to a crude extract of *H. cordata* (hexane, dichloromethane, ethyl acetate, and methanol fractions), and the cytotoxic effects of *H. cordata* against the breast cancer cells have been found to depend on the extractant used during extraction [20].

To date, many substances have been studied to treat or prevent dental caries, and there are almost no studies on the antibacterial activity of *H. cordata* against *S. mutans*. However, one limitation of this study was that it was limited to data related to cell survival. Therefore, further research should be conducted to elucidate the antibacterial mechanisms of *H. cordata* extract.

Conclusion.

This study showed for the first time that *H. cordata* extract exhibited antibacterial activity against *S. mutans*. Significant growth inhibition was confirmed when using 10 to 40 mg/mL concentrations of *H. cordata* extract. The largest growth inhibition zone was obtained after treatment with 20 mg/mL. Thus, our study provides basic research data on the potential of *H. cordata* as a preventive and therapeutic agent against dental caries.

REFERENCES

1. Dai LL, Mei ML, Chu CH, et al. Antibacterial effect of a new bioactive glass on cariogenic bacteria. Archives of Oral Biology. 2020;117:104833.
2. Krzysciak W, Jurczak A, Koscielniak D, et al. The virulence of Streptococcus mutans and the ability to form biofilms. European Journal of Clinical Microbiology & Infectious Diseases. 2014;33:499-515.
3. Grigalauskiene R, Slabsinskiene E, Vasiliauskiene I. Biological approach of dental caries management. Stomatologija. 2015;17:107-12.
4. Lin YJ, Lin YT. Influence of dental plaque pH on caries status and salivary microflora in children following comprehensive dental care under general anesthesia. Journal of Dental Sciences. 2018;13:8-12.
5. Zhang L, Yuan CY, Tian FC, et al. Antibacterial effect of self-etching adhesive systems on Streptococcus mutans. Beijing Da Xue Xue Bao Yi Xue Ban. 2016;48:57-62.
6. Karpinski TM, Szkaradkiewicz AK. Chlorhexidine–pharmaco-biological activity and application. European Review for Medical and Pharmacological Sciences. 2015;19:1321-6.
7. Slot DE, Berchier CE, Addy M, et al. The efficacy of chlorhexidine dentifrice or gel on plaque, clinical parameters of gingival inflammation and tooth discoloration: a systematic review. International Journal of dental hygiene. 2014;12:25-35.
8. Kaushik M, Reddy P, Sharma R, et al. The Effect of Coconut Oil pulling on Streptococcus mutans Count in Saliva in Comparison with Chlorhexidine Mouthwash. Journal of Contemporary Dental Practice. 2016;17:38-41.
9. Wu Z, Deng X, Hu Q, et al. Houttuynia cordata Thunb: An Ethnopharmacological Review. Frontiers in Pharmacology. 2021;12:714694.
10. Sekita Y, Murakami K, Yumoto H, et al. Preventive Effects of Houttuynia cordata Extract for Oral Infectious Diseases. Biomed Research International. 2016;2016:2581876.
11. Rafiq S, Hao H, Ijaz M, et al. Pharmacological Effects of Houttuynia cordata Thunb (*H. cordata*): A Comprehensive Review. Pharmaceuticals (Basel). 2022;15:1079.
12. Satthakarn S, Chung WO, Promsong A, et al. Houttuynia cordata modulates oral innate immune mediators: potential role of herbal plant on oral health. Oral Diseases. 2015;21:512-8.
13. Choi YS, Lee JS, Lee HG. Nanoencapsulation of Grapefruit Seed Extract and Cinnamon Oil for Oral Health: Preparation, In Vitro, and Clinical Antimicrobial Activities. Journal of Agricultural and Food Chemistry. 2023;71:5646-54.
14. Kazemipoor M, Fadaei Tehrani P, Zandi H, et al. Chemical composition and antibacterial activity of Berberis vulgaris (barberry) against bacteria associated with caries. Clinical and Experimental Dental Research. 2021;7:601-8.
15. Babaeekhou L, Ghane M. Antimicrobial activity of ginger on cariogenic bacteria: molecular networking and molecular docking analyses. Journal of Biomolecular Structure and Dynamics. 2021;39:2164-75.

16. Chen H, Xie S, Gao J, et al. Flavonoid Baicalein Suppresses Oral Biofilms and Protects Enamel Hardness to Combat Dental Caries. International Journal of Molecular Sciences. 2022;23:10593.
17. Khalid GS, Hamrah MH, Ghafary ES, et al. Antibacterial and Antimicrobial Effects of Xanthorrhizol in the Prevention of Dental Caries: A Systematic Review. Drug Design, Development and Therapy. 2021;15:1149-56.
18. Jiangang Fu LD, Zhang Lin, Hongmei Lu. Houttuynia cordata Thunb: A Review of Phytochemistry and Pharmacology and Quality Control. Chinese Medicine. 2013;4:123.
19. Li J, Rehman MU, Zhang H, et al. Antibacterial effect of the water extract of Houttuynia cordata water extract against multi-drug resistant Escherichia coli. Southeast Asian Journal of Tropical Medicine and Public Health. 2017;48:1260-66.
20. Inthi P, Pandith H, Kongtawelert P, et al. Anti-cancer Effect and Active Phytochemicals of Houttuynia cordata Thunb. against Human Breast Cancer Cells. Asian Pacific Journal of Cancer Prevention. 2023;24:1265-74.