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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.

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.

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EFFECTS OF *SESAMUM INDICUM* (SESAME) OIL IN REMINERALIZING OF WHITE SPOT LESIONS INDUCED AFTER BRACKET DEBONDING: AN IN VITRO STUDY

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Abstract.

Background: Potential damage to dental enamel associated with orthodontic treatment especially enamel demineralization or white spot lesions formation are encountered as a common and undesirable complication of fixed orthodontic treatment. **Aims of Study:** Estimation the remineralization potential of paste prepared from *Sesamum indicum* oil in different concentrations and compare with casein phosphopeptide-amorphous calcium fluoride phosphate (CPP-ACFP) paste on artificial enamel caries produced in bracket debonded tooth surface.

Materials and Methods: Fifty-five sound permanent premolars were collected for this study. After mounting, bracket bonding and bracket debonding, the teeth were randomly divided into five groups. Artificial enamel caries was created by immersion of the samples in the demineralization solution. The enamel surface treated as following: Group A (n=11): Baseline (no demineralization and no treatment). Group B (n=11): Control negative (artificial saliva only), Group C (n=11): CPP-ACFP paste, Group D (n=11): 5% *Sesamum indicum* oil (paste1). Group E (n=11): 10% *Sesamum indicum* oil (paste2). Eight samples from each group were subjected to a surface microhardness test (SMH) and three samples from each group were subjected to scanning electron microscope (SEM) with energy dispersive X-ray spectroscopy (EDX) after 30 days of treatment. One-way analysis of variance (ANOVA), and Kruskal-wills tests were used to determine the significant differences between the groups. The statistical outcomes were considered significant at $p < 0.05$. **Results:** (ANOVA) results of SMH revealed a statistically significant difference in surface micro hardness after treatment among the study groups and the greatest mean value of surface microhardness was seen in 5 % *Sesamum indicum* oil (paste1) after the baseline group. Kruskal-wills test outcomes of EDX showed no significant difference after treatment among the treatment groups. SEM observations showed occlusion the craters of enamel rods and well-sealed interprismatic cavities of enamel after treatment. **Conclusion:** The *Sesamum indicum* oil used in this study exhibited potential remineralization in subsurface enamel lesions when compared with CPP-ACFP.

Key words. CPP-ACFP, debonding, demineralization, remineralization, *sesamum indicum* oil.

Introduction.

Dental enamel, the almost mineralized tissue in the human body, builds the protective external layer of a tooth's crown [1]. During orthodontic treatment, a widely trained field in dentistry that aims to correct malocclusions and enhance the esthetics and functionality, it has an inherent potential for causing defects to enamel in the course of bonding and debonding procedures such as enamel cracking during de-bracketing procedure or enamel damage by grinding residual adhesive through the clean-up procedures or interproximal enamel stripping and may induce white spot lesions, enamel wear and discoloration [2]. White spot lesion (WSL), illustrated clinically, as opaque white zones on the tooth surface produced by loss of minerals beneath the outermost enamel protective layer, can be an unfortunate consequence of orthodontic treatment; while prevention of these unsought lesions is the objective of each orthodontist; the prevalence of WSLs after orthodontic treatment has been reported to be 5 to 97% [3].

The minimal invasive dentistry model, incipient carious enamel lesion must be treated with non-invasive strategies of remineralization. For that purpose, dentists use topical gels, mouthwashes, varnishes, and dentifrices containing fluoride to treat WSLs [4]. Nowadays, various non-fluoride remineralization systems are available, and casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) is one of the gold standard of medical treatment for early carious lesions of enamel which is categorized as bioavailable calcium phosphate remineralizing agent [5].

Casein phosphopeptide-amorphous calcium phosphate, a bioactive agent that based on dairy products, which is made of milk protein casein. CPP-ACP that combine with fluoride (900 ppm) forms a casein phosphopeptide-amorphous calcium fluoride phosphate (CPP-ACFP) complex. CPP can stabilize the high concentrations of calcium, phosphate and fluoride ions and can remineralize enamel subsurface lesions, the major product formed when remineralisation is undertaken with CPP-ACFP is fluorapatite, which is highly resistant to acid dissolution [6]. Natural products have several applications in medical and dental practice [7,8] such as in tooth movement [9], improving of orthodontic adhesive properties [10,11], in addition to remineralization system by natural agents that have proposed due to its biocompatible, available with longer shelf life, cost-effective and wide safety margin [4]. Recently, several herbal creams have been introduced to dental practice, and many toothpastes, dental gels, mouthwashes, and related products have been formulated and evaluated for caries management and control [12].

Sesamum indicum (Sesame) oil is selected for the present study due to its already proven health benefits and easy availability in the household, *Sesamum indicum* often known as "seed of immortality", and has been considered as a gift of nature [13]. Also designated as the "queen of oilseeds" due to their higher contents of oil, protein, minerals as phosphorous, and calcium [14]. However, the available data regarding the effect of *Sesamum indicum* on enamel surface is infinitesimal.

Aims of the Study.

The aims of this study are to evaluate the effects of *Sesamum indicum* oil incorporated in a paste formula on the demineralized

enamel after debonding, considering the minimal evidence about the potential effect of *Sesamum indicum* oil on WSLs. Also, to compare the *Sesamum indicum* oil effect with CPP-ACFP.

The Null Hypothesis.

The null hypothesis was tested that there are no statistically significant differences in the SMH and SEM-EDX of the enamel that artificially demineralized among the treatment group.

Materials and Methods.

This *in vitro* study was undertaken at College of Dentistry, University of Mosul from March to June 2024 (Ethical approval no. UoM. Den 23/63. November 15, 2023).

The materials used for this study was CPP-ACFP (GC America Inc. / USA) and *Sesamum indicum* oil (Sigma-Aldrich, Mexico). A total of 55 permanent premolar teeth were carefully chosen from patients due to orthodontic reasons and were arbitrarily divided into five groups, each group (n = 11). The sample size was calculated considering 80 % power and a statistical significance level of 0.05. According to the treatment of enamel surface, samples divided as following: Group A: Baseline group (no treatment carried out).; Group B: Control negative group (the samples were subjected to demineralization solution only); Group C: demineralized samples followed by application of CPP-ACFP paste; Group D: demineralized samples followed by application of 5 % *Sesamum indicum* (paste 1); and Group E: demineralized samples followed by application of 10 % *Sesamum indicum* (paste 2). All the samples were stored in artificial saliva at room temperature and after 30 days, 8 samples were subjected to surface microhardness using Vicker's microhardness tester (SMH) and 3 samples for Scanning electron microscopy-energy dispersive X-ray analysis (SEM-EDX).

The collected teeth were rinsed with tap water thoroughly and cleaned to remove the remaining tissue debris and blood by using soft toothbrush. These teeth were collected and inspected visually checked using an LED light for examination and evaluation the buccal surfaces of teeth to ensure that the selected teeth undergoing the inclusion criteria as follow: The teeth should be free from dental caries, white spot lesions, discoloration, fluorosis, enamel developmental abnormalities or disorders, hypoplasia, evident cracks, fractures as well as restored buccal surfaces. Until use, the samples are stored in 0.1% thymol solution as an antimicrobial agent at room temperature [15].

Sample Preparation.

Plastic rings were employed and filled to about half by dental stone, after setting of the stone, positioning the tooth perpendicular to the ring's base in the center of it by a sticky wax. The ring was fitted on the surveyor's base for parallelism then the ring was filled with cold cure acrylic resin until cemento-enamel junction [16]. And after complete setting of acrylic resin, polishing all the samples with non-fluoridated pumice.

The buccal surface of enamel was etched with 37% phosphoric acid (Maquira, Brazil) for 30 seconds, then washed by water spray for15 seconds, and dried with compressed air for 10 seconds. Premolar standard 0.022 edgewise brackets (Dentaurum, Germany), were bonded with the fluorescent orthodontic adhesive (FIX, Maquira, Brazil) and light-cured (Woodpecker, Jiangsu, China) for 10 seconds on each side (total 40 seconds) [17]. After bonding procedure, all samples were stored in distilled water at room temperature for 24 hour and subsequently the bracket was removed by universal testing machine (GESTER, Fujian, China) [16]. The remaining adhesive was removed from the buccal surface (Figure 1A) using truncated cone rounded-end, carbide bur (Ortho Technology, England) in a high-speed handpiece with water cooling (300,000 rpm) according to the manufacture instruction of the debonding bur, for 20 seconds until no residue remained that can be visible by the fluorescent tracker of the orthodontic adhesive that used, then using a sof-lex polishing disc (Tor VM / Russia) in a low-speed handpiece [17].

Preparation of Artificial Carious Lesions.

The middle third of the buccal surface was protected by adhesive tape (5 × 5mm in size), and the entire surface of each tooth was sheltered by acid-resistant nail paint. The tape was detached, leaving a 5 × 5mm window on the buccal surface. Each tooth was immersed individually in 15 ml of demineralizing solution for 96 hours (Figure 1B). The demineralizing solution consist of 2.2 millimole NaH_2PO_4, 2.2 millimole $CaCl_2$, 0.05 Mole acetic acid with 1 Mole KOH to obtain the pH of 4.4 using a pH meter (PH-009(I) A pen type, China) at 37°C [18]. The demineralizing solution was replaced every 24 h to maintain the pH constant.

***Sesamum indicum* (paste 1) Preparation.**

First, carboxymethyl cellulose (CMC) solution prepared by dissolving 1% (w/v) CMC in hot distilled water, and by using a magnetic stirrer (hot plate and magnetic stirrer; Labnet, Mexico) that employed at 500 rpm with 40 ℃ for 30 min until full dissolution. Concurrently, a 1% (w/v) sodium lauryl sulfate (SLS) dissolved in distilled water in another backer to form SLS aqueous solution. Consequent polymerization was induced by adding SLS solution and 30% (w/v) sorbitol gradually to the CMC solution using magnetic stirrer at 40°C for 15 min and 300 rpm to obtain a homogenic mixture [5]. A 5% (v/v) *Sesamum indicum* oil (Sigma-Aldrich, Mexico) adding to the mixture dropwise, very slowly with continuous stirring. 0.1% (w/v) of methylparaben as preservative and 0.5% (w/v) titanium dioxide used as opacifier were added with stirring gently at room temperature until paste like formation [19]. Finally, filled the prepared paste in a dark and closed plastic container that labeled as 5 % Sesame and stored in refrigerator until used.

***Sesamum indicum* (paste2) Preparation.**

The same procedure of *Sesamum indicum* (paste1) preparation except that 10 % *Sesamum indicum* oil (Sigma-Aldrich, Mexico) was used, and the prepared paste was labeled as 10 % Sesame.

Experimental Paste Application.

The samples of C, D and E groups were treated with experimental paste via painting through the buccal window with a micro brush applicator by CPP-ACFP paste (GC America Inc. / USA), *Sesamum indicum* (paste 1) and *Sesamum indicum* (paste 2) respectively as in (Figure 1C), according to the manufacturer instructions of CPP-ACFP paste (twice daily), left undispensed for 3 min at that time spread in a circular motion over the surface

(a) (b) (c)

Figure 1. *(a) removal of adhesive remanent, (b) sample in demineralizing solution, and (c) sesame paste 1 application.*

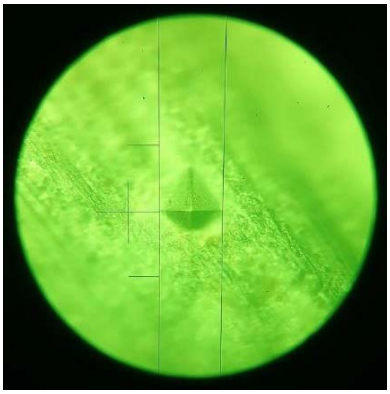


Figure 2. *Microscopic image from a micro hardness optical microscope (×400) viewing the power of micro indentations from the external enamel surface.*

for 1 min and then washed away with deionized water for 30s after 5 min [20].

All the samples in all groups were stored in artificial saliva during (30 days) at 37°C. The composition of artificial saliva according to Taqa et al. (2019) was as follows: 0.4g KCL, 0.4g NaCL, 0.780g $NaH_2PO_4.2H_2O$, 0.795g $CaCL_2.2H_2O$, 0.005g $NaS_9.H_2O$ and 1g urea dissolved in 1L deionized water and adjusted to pH 7 by KOH [21], replaced every 24 h with fresher one to keep pH constant (Figure 1).

Surface Microhardness Test.

Using Vicker's microhardness tester (HVS 1000, Lian gong testing technology Co. Ltd, China). A load of 500g for 15 sec. was applied on the exposed enamel window of the specimens that were constant at the entire study for all the samples [22]. The diamond pyramid indent was measured for length and depth digitally using an optical microscope as shown in (Figure 2), measured on the surface of each specimen at 3 points, and the microhardness mean value was calculated.

SEM and EDX Analysis.

Three specimens from each group were used for this analysis, the samples were decoronated from the mold and 8 mm in height rubber rings poured with cold cure acrylic resin used to hold the coronal portions of the teeth with the labial surface facing upward then dehydrated by ethanol, air dried and gold coated by sputter coater (Quorum, Q300T T, USA). SEM (Zeiss, version 7.01, Germany) investigated the surface morphology of enamel sample with accelerating voltage of 13 kV. The chemical composition of the surface enamel lesion was examined by EDX.

Statistical Analysis.

The SPSS program version 26 software (IBM SPSS Statistics, IBM, Armonk, NY, USA) was used for data analysis, which included:

1. Testing the normality of data distribution using the Shapiro-Wilk test.
2. Descriptive statistics which include mean and standard deviation for each individual variable.
3. Duncan's multiple comparison test combined with one-way analysis of variance (ANOVA).
4. Kruskal- Wallis test.

The significance level set at $p < 0.05$.

Results.

Surface Micro Hardness Results: The mean ± standard deviation of the samples in all groups are shown in Table 1. According to Shapiro-Wilk test, all the data were normally distributed. One-way ANOVA and Duncan's post hoc test multiple comparisons in Table 2 and Table 3 respectively, revealed a significant difference between the base line, control negative and the three treatment groups ($p < 0.05$). The baseline group had the highest surface microhardness mean value, although there was no statistically significant difference between the samples treated with CPP-ACFP paste, *Sesamum indicum* (paste 1) and *Sesamum indicum* (paste 2) but the 5% *Sesamum indicum* (paste 1) had the highest mean value with significant increase difference to the control negative group.

Table 1. *Mean ± standard deviation of SMH.*

Groups	N	Mean ± SD
Base line	8	388.27 ± 62.47
Control negative	8	130.15 ± 39.89
CPP-ACFP	8	211.12 ± 91.13
Sesamum indicum 1	8	215.00 ± 77.75
Sesamum indicum 2	8	142.52 ± 89.25

Table 2. *One-way ANOVA of SMH.*

	Sum of Squares	df	Mean Square	F	p-value
Between Groups	339697.826	4	84924.457	15.267	0 .000*
Within Groups	194692.165	35	5562.633		
Total	534389.991	39			
*Significant at $p < 0.05$					

Table 3. *Duncans post hoc test of SMH.*

Groups	N	Mean
Base line	8	388.27 A
Control negative	8	130.15 C
CPP-ACFP	8	211.12 B
Sesamum indicum 1	8	215.00 B
Sesamum indicum 2	8	142.52 BC
Means in the column with different letter values denote statistically significant differences ($p<0.05$)		

Micro Morphological Observation.

Scanning electron microscope images of an untreated enamel surface (base line group) showed intact, normal, flat without irregularities and low superficial roughness with scratches can be evident at (3000 X) as a result of removal procedure of adhesive remanent which including finishing and polishing process (Figure 3A). SEM of the demineralized enamel (control negative group) at magnification (3000 X) revealed irregular surface with discontinuity, scratches and roughness consequential from the dissolution of the enamel by the demineralizing process in addition to the debonding procedure (Figure 3B). In the enamel surface treated by CPP-ACFP paste, SEM showed the deposition or formation of disaggregated nanoclusters with a globular structure deposit that formed on the enamel surface and occluded the enamel rods, the honeycomb pattern can be observed at high magnification (5000 X) (Figure 3C).

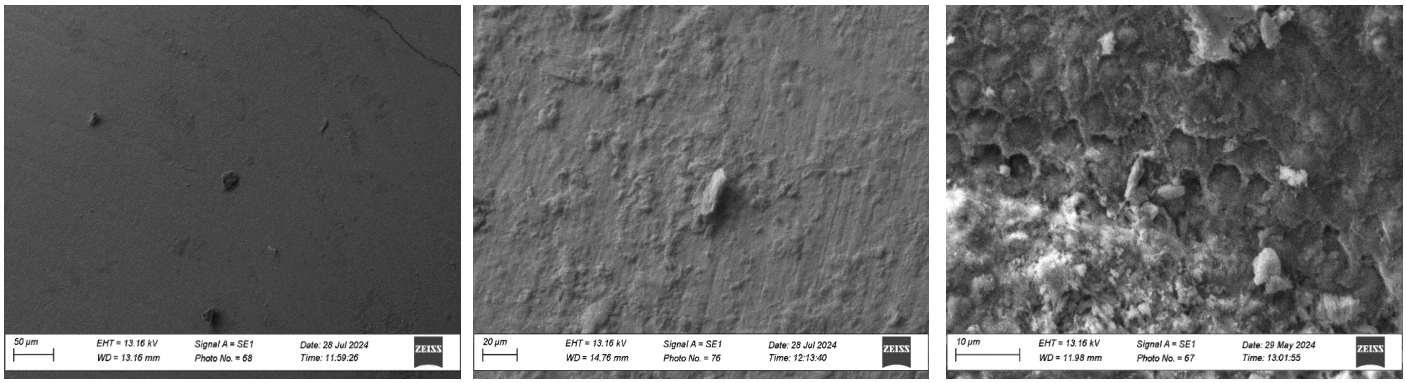
Scanning electron microscope images of enamel surface treated by *Sesamum indicum* (paste 1) revealed amorphous, several white precipitations of inorganic material of different sizes and shapes deposited at the surface forming dense crystals that occluded enamel surface porosities or the craters of enamel rods and sealed interprismatic cavities of enamel rods at high magnification (5000 X). Note that the honeycomb pattern or keyhole pattern cannot be observed, dissimilar to those of the CPP-ACFP that was evident. (Figure 3D). SEM of the enamel surface treated by *Sesamum indicum* (paste 2) revealed flat enamel surface without any defect with less roughness, less irregularities, no craters were seen with more density of enamel surface at magnification (3000 X) (Figure 3 E).

EDX Results.

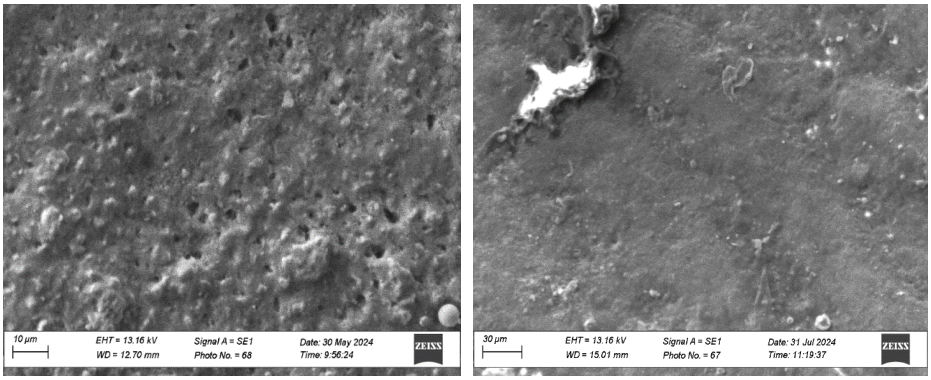
The mean ± SD of the calcium (Ca^{++}), phosphorus (P^{-}) and fluoride (F^{-}) elements in weight percentage in addition to Ca/P ratio of all groups with Kruskal-Wallis test are shown in Table 4. There were no statistically significant differences according to the Kruskal-Wallis test between Ca^{++}, P^{-}, F^{-} elements and Ca/P ratio among the study groups. But CPP-ACPF had the highest mean value of calcium in weight percentage.

Table 4. *Mean ± standard deviation and Kruskal-Wallis test of EDX for all groups.*

Groups	**N**	**Ca^{++}**	**P^{-}**	**F^{-}**	**Ca/ P**
Base line	3	30.86 ± 6.9	18.33 ± 4.4	1.4 ± 0.6	1.69 ± 0.24
Control negative	3	28.96 ± 4.0	17.70 ± 2.	1.2 ± 0.34	1.64 ± 0.18
CPP-ACFP	3	32.03 ± 10.6	16.70 ± 2.5	1.5 ± 0.4	1.88 ± 0.41
Sesamum indicum 1	3	24.90 ± 10.9	15.13 ± 2.2	2.1 ± 1.0	1.58 ± 0.64
Sesamum indicum 2	3	26.06 ± 8.6	15.80 ± 2.0	2.1 ± 1.1	1.61 ± 0.34
Kruskal-Wallis	15	2.267	2.100	2.923	1.060
***p*-value**		0.687	0.717	0.571	0.901
*Significant at $p < 0.05$					



(A) (B) (C)



(D) (E)

Figure 3. *SEM micrographs of: (A) an untreated enamel, (B) a demineralized enamel, (C) an enamel treated by CPP-ACFP, (D) an enamel treated by Sesame paste 1, and (E) an enamel treated by Sesame paste 2.*

Discussion.

Sesamum indicum oil is an aromatic oil extracted from *Sesamum indicum* seeds and is a traditional product from the prime processing of *Sesamum indicum* seeds, which can be used as an edible oil [23]. It has a golden yellow color with pleasant flavor and is reasoned as a main source of energy, contains a high percentage of fatty acids [14]. *Sesamum indicum* oil is rich in unsaturated fatty acids, mainly oleic and linoleic acids and saturated fatty acids such as palmitic and stearic acids [24]. Many in vivo and in vitro studies that conducted on *Sesamum indicum* oil as oil pulling, mouthwash in addition to microbiological studies as well as incorporation of *Sesamum indicum* oil with dental material to improve its properties, but there is no available data about the potential remineralizing capacity of *Sesamum indicum* oil on tooth structure especially the enamel [25,26].

In current study, surface microhardness test (SMH) and Scanning electron microscopy-energy dispersive X-ray analysis (SEM-EDX) were used to assess the enamel remineralization. SMH is the most appropriate and extensively used test to measure the structural integrity and the mechanical properties of the enamel. Vickers microhardness tester is a simple, easy, rapid and nondestructive approach used [27]. SEM is mainly a method for the study of morphology and structure, at a wide range of magnifications, it is sensitive to changes in hard tissue surface characteristics [27]. EDX is a quantitative X-ray micro analytical technique that provides information around the chemical compositions of the targeted part of a specimen, it can denote specific elements in a histogram scheme by the number of amounts [5].

With respect to CPP-ACFP group, many studies showed the CPP-ACFP has an acceptable remineralization effect, and such an outcome has been discoursed formerly in several demineralization remineralization researches [5]. The current study approves with similar preceding researches that concluded the surface microhardness of enamel increased after application of CPP-ACFP [5, 28]. SEM observations revealed the ability of bioavailable minerals to remineralize the lesion, it appears as a nanocluster deposits that occluded the enamel rods, also EDX recorded a higher Ca/P ratio of remineralized lesion than in other study groups which run in accordance with Reynolds (2009) that emphasized the ability of CPP-ACFP nanocomplex to firmly bind to the enamel surface, affording a reservoir of bioavailable calcium and phosphate ions [29].

Regarding *Sesamum indicum* groups, 5% *Sesamum indicum* (paste 1) had the highest value of SMH after base line group with no significant difference with CPP-ACFP and 10 % *Sesamum indicum* (paste 2) but with significant difference to the control negative group. Although, there is a difficulty in direct comparison with previous studies as there are limited data about the use of *Sesamum indicum* oil in cariology studies. Generally, the result is agreed with Aziz (2022) study who assessed the effect of *Sesamum indicum* oil on the surface micro hardness of root dentine. He mentioned that the *Sesamum indicum* oil could be compensated the reduction in minerals due to *Sesamum indicum* rich in calcium and minerals [30].

The results also in agreement with Tanevitch et al. (2020) who evaluated the remineralizing effects of *Sesamum indicum* extract rather than oil on eroded enamel and concluded that the eroded enamel surface subjected to the *Sesamum indicum* solution revealed a greater hardening and less roughness [31]. Another in vitro study established the remineralization efficacy of *Sesamum indicum* seed extraction in a gel formula on the demineralized enamel by Rezvani et al. (2017). They recorded that the *Sesamum indicum* extraction could increase the surface hardness of enamel after exposure to acidic beverage when compared with fluoride gel [32].

The increase in SMH values of samples treated with *Sesamum indicum* group can be attributed to the *Sesamum indicum* rich in calcium and minerals [30]. Or may be qualified to the nature of *Sesamum indicum* oil, as *Sesamum indicum* oil is one of the most popular flavored essential oils [33]. It is very probable that the activity of essential oils cannot be attributed to a specific mechanism but to the presence of a large number of target locations in the cell [34]. So, this may be explaining the potential hardening and micrographs of the samples treated with *Sesamum indicum* oil.

Scanning electron microscope micrographs revealed remarkable morphology variation between groups, samples treated with *Sesamum indicum* (paste 1) showed the deposition of an uneven material on the surface of the demineralized enamel and blocked the pores formed by the loss of minerals and this similar to Tanevitch et al. (2020) outcomes [31].

Energy dispersive X-ray spectroscopy results showed no significant difference among the groups but the Ca/P ratio of samples treated with *Sesamum indicum* oil were less in contrast with other samples of study groups, this may be attributed to the samples heterogeneity, as there are several differences in the chemical content of enamel structure reported by many studies and such differences may be related to tooth age, drug effect and absorbed fluoride content [35].

On the other hand, the oil may act as a diffusion barrier on the enamel surface that prevents the minerals movement and equilibrium that occur between enamel surface and artificial saliva, this can be matched with study by Buchalla et al (2003) who found the samples that pretreated with olive oil before sever demineralization condition revealed a significant reduction of mineral loss, and attributed that to the presence of a film of lipid at the enamel surface may turn as a protective covering and the lipid may increase in the outer most layer of enamel, slowing the diffusion of minerals and acids during carious conditions [36]. According to this concept, we can speak about the *Sesamum indicum* oil may have an anti-erosive effect on the enamel surface and this required further in vitro studies to prove that.

According to Banjar et al. (2017) [37] the minimal inhibitory concentration (MIC) of *Sesamum indicum* oil against streptococcus mutans is 5 % and despite there is no significance differences of the SMH and EDX between 5% *Sesamum indicum* (paste 1) and 10% *Sesamum indicum* (paste 2) in the current study, but 5 % *Sesamum indicum* had the highest mean value of SMH , the reasons for the disparity in SMH between *Sesamum indicum* 1 and *Sesamum indicum* 2 in this study could be due

to the concentration of oil, as the more concentration was less effective which possibly relates to its low polarity and therefore less affinity and less adhesion to the tooth surface [38]. So, we can conclude that 5% concentration of *Sesamum indicum* oil is preferable.

In this study, *Sesamum indicum* oil used in a paste formula other than other formulation such as slurry or emulsion because the paste can be firmly bound to the enamel surface, providing biofilm super saturation with components and maximizing the potential effect with longer contact interval and greater safety in the mouth, whereas in the slurry form or emulsion, had less contact time with the tooth surface that's could be not efficient in addition may be difficult for patients [39].

Limitations of the Study.

Some limitations are encountered during the work of the current study such as reproducibility was not possible in this study as the enamel surface not prepared with abrasive paper for obtaining flat surface because the studied surface was previously involved with debonding procedures in addition to adhesive remnant removal process. Also, the samples in current in vitro study might be differed in their quality in spite of the fact that the same areas of enamel surface are used to have comparable region from different teeth with probable similar chemical properties.

Conclusion.

Although the observed effect of *Sesamum indicum* oil on the enamel surface in comparison with CPP-ACFP was similar in respect with surface microhardness but it could be very early to draw conclusion around the clinical outcome currently. Further investigations and research are required in the future to understand the effect of *Sesamum indicum* oil on the demineralization remineralization dynamics at the enamel tooth surface.

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Conflict of Interest.

All authors have no conflicts of interest.

Authors' Contributions.

The first researcher contributed to acquisition, analysis, and interpretation of data, and drafting of the work, the second researcher contributed to acquisition and interpretation of the data and revising it for important intellectual content and the third researcher contributed to conception, design, analysis of the work, and revising it critically. All authors read and approved the final version of the manuscript.

REFERENCES

1. Beniash E, Stifler C.A, Sun C.-Y, et al. The hidden structure of human enamel. Nat. Commun. 2019;10:4383.
2. Sarafopoulou S, Zafeiriadis A.A, Tsolakis A.I. Enamel defects during orthodontic treatment. Balkan Journal of Dental Medicine. 2018:64-73.
3. Handa A, Chengappa D, Sharma P, et al. Effectiveness of Clinpro Tooth Crème in comparison with MI Varnish with RECALDENT™ for treatment of white spot lesions: a randomized controlled trial. Clin. Oral Investig. 2023;27:1473-1481.
4. Gocmen G.B, Yanikoglu F, Tagtekin D, et al. Effectiveness of some herbals on initial enamel caries lesion. Asian Pac. J. Trop. Biomed. 2016;6:846-850.
5. Hamdi K, Hamama H.H, Motawea A, et al. Remineralization of early enamel lesions with a novel prepared tricalcium silicate paste. Sci. Rep. 2022;12:9926.
6. Bisla I. Review on role of metal salt in the re-mineralization of dental caries. Int. J. Adv. Res. 2020;8:991-1003.
7. Al Hamdany A.K, Al-Khatib A.R, Al-Sadi H.I. Role of olive oil on bone health: An overview. International Medical Journal. 2017;24.
8. Al Hamdany A.K, A Al-Khatib A.R, Al-Sadi H.I. An overview of the beneficial effects of qurecitin on bone. Int. Med. J. 2019;29.
9. Al-Hamdany A.K, A Al-Khatib A.R, Al-Sadi H.I. Influence of olive oil on alveolar bone response during orthodontic retention period: rabbit model study. Acta Odontol. Scand. 2017;75.
10. Al-shihab E.S, Al-khatib A.R, Masudi M. Effects of Zingiber Offcianille Essential Oil on Compressive Strength of Fluorescent Orthodontic Adhesive. Al-Rafidain Dent. J. 2024;24:211-219.
11. Musleh R.T, Al-khatib A.R, Masudi M. Effects of Modifying Orthodontic Adhesive by Thymus Vulgaris and Lavandula Angustifolia Essential Oils on Compressive Strength. Al-Rafidain Dent. J. 2024;24:424-432.
12. Subbiah U, Elango S, Jayesh R. Herbals and green synthesized nanoparticles in dentistry. Elsevier. 2019:617-646.
13. Abdullah Al Qahtani W, Sandeepa N, Khalid Abdullah E, et al. A clinical study comparing the efficacy of SesameOil with desensitizing tooth paste in reducing dentinal hypersensitivity: a randomized controlled trial. Int. J. Dent. 2020;2020:6410102.
14. Yaseen G, Ahmad M, Zafar M, et al. Sesame (Sesamum indicum L.). Elsevier. 2021:253-269.
15. Al-Nuaimi N. H, Gasgoos S. S. Effect of Chicken Eaggshell Paste on Enamel Surface Microhardness and Colour Change of Artificial Carious Lesions Created on Permanently Extracted Teeth. Georgian Med. News. 2023;340:107-112.
16. Yaseen S.N, Taqa A.A, Al-Khatib A.R. The effect of incorporation Nano Cinnamon powder on the shear bond of the orthodontic composite (an in vitro study). J. Oral Biol. Craniofac. Res. 2020;10:128-134.
17. Thys D.G, Martins F.R.P, Cardinal L, et al. In vitro enamel surface roughness analysis of 4 methods for removal of remaining orthodontic adhesive after bracket debonding. Angle Orthod. 2023;93:213-221.
18. ALTINIŞIK H, ERTEN CAN S. Evaluation of the activities of toothpastes with different contents in the prevention of enamel demineralization: An İn vitro study. Curr. Res. Dent. Sci. 2023;33:1.

19. Gonçalves F.M.C, Delbem A.C.B, Gomes L.F, et al. Effect of fluoride, casein phosphopeptide-amorphous calcium phosphate and sodium trimetaphosphate combination treatment on the remineralization of caries lesions: An in vitro study. Arch. Oral Biol. 2021;122:105001.
20. Almarsomy D.H, Al-Khayat F.A, Al-Taee L.A. The preventive/therapeutic effect of CO2 laser and MI Paste Plus® on intact and demineralized enamel against Streptococcus mutans (In Vitro Study). Heliyon. 2023;9:10.
21. Taqa A.A, Al-sarraf H. A. Artificial Saliva Sorption for Three Different Types of Dental Composite Resin (An In Vitro Study). EC Dent. Sci. 2019;18:2339-2344.
22. Qasim A.A. Remineralizing Effect of GC Tooth Mousse versus Acidulated Phosphate Fluoride on the Surface Microhardness of the Demineralized Enamel. Iraqi Dent. J. 2023;45:1-8.
23. Hama J.R. Comparison of fatty acid profile changes between unroasted and roasted brown sesame (Sesamum indicum L.) seeds oil. Int. J. Food Prop. 2017;20:957-967.
24. Sharma L, Saini C.S, Punia S, et al. Sesame (Sesamum indicum) seed. In book: Oilseeds: Health Attributes and Food Applications. 2021:305-330.
25. Saravanan D, Ramkumar S, Vineetha K. Effect of oil pulling with sesame oil on plaque-induced gingivitis: A microbiological study. J. Orofac. Sci. 2013;3:175-180.
26. Aref N.S. Sesame oil (sesamum indicum L.) as a new challenge for reinforcement of conventional glass ionomer cement, could it Be? Int. J. Dent. 2021;2021:5516517.
27. Desai S, Rao D, Panwar S, et al. An in vitro comparative evaluation of casein phosphopeptide-amorphous calcium phosphate fluoride, tricalcium phosphate and grape seed extract on remineralization of artificial caries lesion in primary enamel. J. Clin. Pediatr. Dent. 2022;46:72-80.
28. Bhavsar B, Vijo M, Sharma P, et al. Comparative assessment of enamel remineralisation on the surface microhardness of demineralized enamel-an in vitro study. PeerJ. 2022;10:e14098.
29. Reynolds E. Casein phosphopeptide-amorphous calcium phosphate: the scientific evidence. Adv. Dent. Res. 2009;21:25-29.
30. Aziz N.M. Evaluation the effect of sesame oil on root dentin micro hardness after application of chloroform and orange oil as gutta percha solvents (an in-vitro study). Erbil Dent. J. 2022;5:178-185.
31. Tanevitch A, Durso G, Sambeth J. Treatment of Demineralized Dental Enamel with Sesame Seeds. Microsc. Microanal. 2020;26:195-196.
32. Rezvani M.B, Kamali-Nejad M, Karimi M, et al. Sesame extraction gel as an agent for prevention of dental caries: An in-vitro study. J. oral health oral epidemiol. 2017;6:226-230.
33. Liu W, Yang Z, Shi L, et al. Bioactive β-carbolines harman and norharman in sesame seed oils in China. Molecules. 2022;27:402.
34. Sarac M.B. Essential Oils from Plants. J. Biotechnol. Biomed. Sci. 2018;1:35-43.
35. Salama F, Abdelmegid F, Al-Sharhan M, et al. Effect of remineralizing agents on enamel surface roughness of primary teeth: An in− vitro study. EC Dent. Sci. 2020;19:1-12.
36. Buchalla W, Attin T, Roth P, et al. Influence of olive oil emulsions on dentin demineralization in vitro. Caries Res. 2003;37:100-107.
37. Banjar M.M, Khafaji A.M, Maher Y.A. Antimicrobial activity of hydrogen peroxide, sesame and gum Arabic against Streptococcus mutans. Int. J. of Health Sci. & Res. 2017;7:97-104.
38. Kensche A, Reich M, Hannig M, et al. Lipids in preventive dentistry. Clin Oral Invest. 2013;17:669-685.
39. Khijmatgar S, Reddy U, John S, et al. Is there evidence for Novamin application in remineralization?: a systematic review. J. Oral Biol. Craniofac. Res. 2020;10:87-92.