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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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PRODUCTIVITY AND SELENIUM ENRICHMENT OF STEVIA IN HYDROPONIC AND SOIL CULTIVATION SYSTEMS IN THE ARARAT VALLEY

M.A. Babakhanyan[1], V.A. Chavushyan[2], K.V. Simonyan[2], L.M. Ghalachyan[1], L.V.Darbinyan[5], A.G. Ghukasyan[4], Sh.S. Zaqaryan[3], L.E. Hovhannisyan[1].

[1]G.S. Davtyan Institute of Hydroponics Problems NAS RA, Yerevan, Armenia.

[2]Orbeli Institute of Physiology NAS RA, Neuroendocrine Relationships Lab, Yerevan, Armenia.

[3]Institute of Geological Sciences, NAS RA, Yerevan, Armenia.

[4]"Agriculture Scientific Center" SNCO, Yerevan, Armenia.

[5]Orbeli Institute of Physiology NAS RA, Sensorimotor Integration Lab, Yerevan, Armenia.

Abstract.

Hydroponics offers a viable solution for obtaining plant products that are rich in micronutrients and ultramicronutrients, such as selenium. Selenium plays a crucial role in strengthening the body's immune defense and acts as a potent antioxidant. Low levels of selenium have been associated with an increased risk of heart attacks, strokes, and cancer. Stevia rebaudiana Bertoni (SrB), a relatively new crop in plant cultivation, was the focus of the present study. SrB has numerous medicinal and prophylactic properties, and its leaves are rich in macro- and microelements, vitamins, and diterpene glycosides. These diterpene glycosides, when extracted from the plant material, exhibit a sweetness that is 200-300 times greater than that of sugar. The study aimed to investigate the effects of exogenous application of varying amounts of selenium to the nutrient solution and foliar feeding of SrB plants with a selenium aqueous solution. The productivity of SrB and selenium accumulation in the leaves were assessed under both hydroponic and soil cultivation conditions in the Ararat Valley. Comparative analyses were also conducted on biometric and biochemical indicators, as well as the productivity of SrB cultivated using different fillers, including black volcanic slag, red volcanic slag, and gravel, in hydroponic and soil environments. The findings of this research hold practical significance as they serve as a foundation for the development of biotechnological approaches to enhance selenium enrichment in various crops. By applying these strategies, crop cultivation methods can be improved, and the selenium content in plant products can be enhanced. This optimization of crop production techniques can increase the nutritional value and potential health benefits of selenium-enriched plant products.

Key words. Stevia rebaudiana Bertoni, Se, hydroponics, soil.

Introduction.

The development of biotechnologies that enrich plant raw materials with organomineral microelements and ultramicroelements is an important current problem. Hydroponics is a solution that allows for the control of the chemical composition of plant material through a nutrient solution. The ultramicroelement selenium (Se) performs many protective functions in the human body, such as strengthening the immune system, acting as an antioxidant, and helping increase lifespan. However, many studies have shown that 60-80% of the population has an increased incidence of heart attacks, strokes, and cancer due to low Se levels, as their daily intake is often less than optimal. The World Health Organization recommends an average daily intake of 55-70 μg of Se for adults. The lack of Se in food chains, and consequently in the human body, is attributed to the low content of this element in the soil. Therefore, it is necessary to develop measures to increase the Se content in the soil-plant system. One way to address Se deficiency is through the production of Se-enriched crop products. Various countries have accumulated experience in fortifying crops such as parsley, radish, dill, lettuce, garlic, and wheat with Se. The Se content in agricultural crops ranges from 78 to 166 μg/kg, depending on the geochemical conditions. On average, the Se content in plants belonging to different families is up to 100 μg/kg [1-5,6-12,13-20].

We conducted a study to investigate the impact of exogenously adding varying amounts of Se to the nutrient solution and applying Se solution through foliar nutrition on Se accumulation in the leaves of Stevia plants.

The study aimed to enrich the plant material with Se and assess the efficiency of hydroponics and soil cultivation in the Ararat Valley. The research was based on the widespread use of Stevia as a technical crop and considering the significant medical and biological importance of Se.

Materials and methods.

The research was conducted between 2019 and 2022 at the hydroponic Ararat Valley's experimental station of the National Academy of Sciences of the Republic of Armenia. The study involved both soil and hydroponic vegetation vessels, each with an area of $1m^2$ and three replicates. The Ararat Valley is situated at an altitude of approximately 850-900 meters above sea level and experiences a very dry climate, with an average annual temperature of 11.0-11.8°C, a relative humidity of 40%, and an average annual precipitation of 200-300 mm [21]. The surrounding soils of the hydroponic institute are semi-desert, loamy, and carbonate-based, with a humus content of 1.5-2.5%. These soils are rich in phosphorus and potassium. In soil culture, standard agricultural practices were followed, including soil tillage, fertilization, loosening, regular watering, and weed removal. In the hydroponic system, the plants were provided with the nutrient solution recommended by Davtyan (Table 1) [22]. Red and black volcanic slags, along with gravel particles ranging from 3 to 15 mm in diameter, were used as the growing medium. Prior to use, the filler material was disinfected with a 0.05% solution of $KMnO_4$. The experimental crop chosen for the study was Stevia rebaudiana Bertoni (Figure 1-2).

__Table 1.__ The nutrient solution recommended by Davtyan consisted of various essential nutrients necessary for plant growth and development, with their respective concentrations in g/m³ of water.

Amount of nutrients	**The beginning of the vegetation period**	**Vegetative growth period**	**Fertility period**
N-80-200	80	175	200
KNO_3	580	580	580
NH_4NO_3	-	170	170
$(NH_4)_2SO_4$	-	175	175
$CO(NH_2)_2$	-	-	56
P-45-65	45	65	65
H_3PO_4	170	250	250
K- 310-350	310	310	350
K_2SO_4	170	170	170
S-100-150	100	150	150
Ca -150	150	150	150
$CaSO_4{\cdot}2H_2O$	640	640	640
Mg- 30-50	30	40	50
$MgSO_4{\cdot}7H_2O$	300	400	500
Microelements			
$FeCl_3{\cdot}6H_2O$ or $Fe_2(SO_4)_3{\cdot}9H_2O$	5-10		
H_3BO_3	0.2		
$KMnO_4$ or $MnSO_4{\cdot}4H_2O$	1-2		
$ZnCl_2$ or $ZnSO_4{\cdot}7H_2O$	0.4-0.8		
$CuSO_4{\cdot}5H_2O$	0.2		
Na_2MoO_4	0.2		
$CoCl_2{\cdot}6H_2O$ or $Co(NO_3)_2{\cdot}6\,H_2O$	0.1		
KI	0.2-1.0		

__Figure 1.__ SrB cutting (a) (b), general appearance at the beginning of vegetation (c, d),) general appearance at the end of vegetation of growth in soil and hydroponics.

__Figure 2.__ Overall appearance of SrB in soil (a), in hydroponics (b), and in various biospecimens (c).

Stevia rebaudiana Bertoni (SrB) is one of the youngest agricultural crops in modern plant breeding and was introduced to Armenia in 2009 as a new technical crop. It is a perennial herb native to South and Central America, as well as northern Mexico. SrB possesses numerous healing and preventive properties. The leaves of SrB are abundant in vitamins (A, E, C, beta-carotene, etc.), macro- and micro-elements, as well as diterpene glycosides such as stevioside, rebaudiosides A, B, C, D, E, steviolbioside, and dulcoside A. Notably, the dry leaves of SrB are 10-15 times sweeter than sugar, and the diterpene glycosides isolated from the plant material are 200-300 times sweeter than sugar [14,19,23].

Several biochemical analyses were conducted on vegetation in the study. The vitamin C content in the vegetable raw material was determined using the method described by Yermakov [24]. The organic acids were analyzed using the "Water Separations Modul 2695" (USA) according to Shomod-Nelson [25,26]. The protein nitrogen content was determined using the Kjeldahl method [27,28]. The analysis of extractives and tannins was conducted according to the pharmacopoeia [29]. The quantification of photosynthetic pigments followed the method developed by Vetstein [30,31]. Carotene content was determined according to the method described by Sapozhnikov [32], while flavonoids were analyzed using the method outlined by Georgievsky [33].

Sampling, sample pretreatment, and determination of Se concentrations in the soil and plant samples were carried out following the state standard method EASC-19413-89. This method relies on the reaction between selenite ions and 2,3-diaminonaphthalene in an acidic environment, leading to the formation of 4,5-benzopiazoselenol [34,35]. Selenite ions were utilized in the form of Se. The obtained data were subjected to statistical analysis using Excel and following the guidelines outlined by Dospechov [36].

Results and Discussion.

It is well known that Se accumulation in plants is influenced by various factors, including the plant species, Se content in the soil, soil properties (such as soil type, acidity, humus content, total Se supply, and interactions with other mineral elements), chemical form of Se, method of Se introduction (such as spraying plants with Se solution or soaking seeds), precipitation, and environmental temperature [2-3,8-11,15]. The bioaccumulation coefficient (BAC) is a measure of the ratio of Se content in plants to Se content in soil. According to the literature, the typical range of BAC for Se is from 0.2 to 0.6. For example, when the black soil had insufficient Se content (Se = 100 μg/kg), corn and sunflower plants accumulated Se at levels of 107 μg/kg and 104 μg/kg, respectively, resulting in BAC values of 1.07 and 1.04, respectively 1 . Despite the semi-desert irrigated gray soils surrounding HPI having a low Se content (Se = 40 μg/kg), the BAC values ranged from 1.3 to

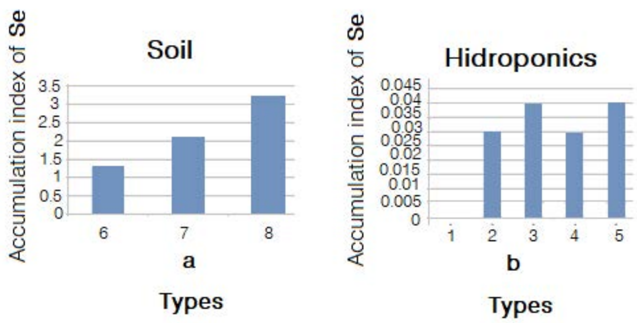

__Figure 3.__ Effect of Se on the accumulation coefficient of Se in the soil-plant system (a), and in the nutrient-plant system (b).

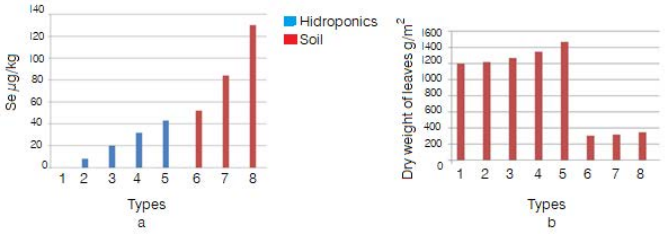

Figure 4. *Effect of Se on Se accumulation (a) and yield (b) in SrB leaves in hydroponics and soil.*

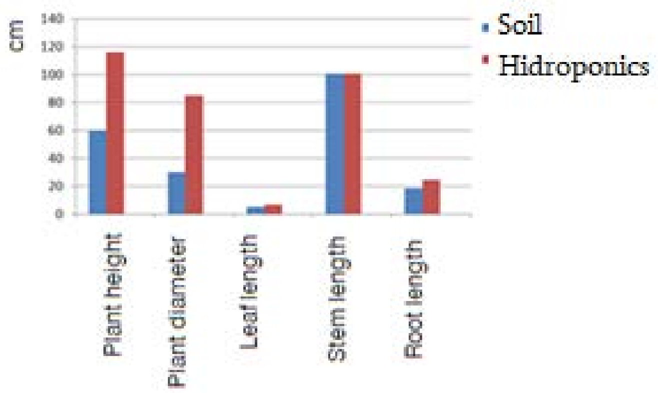

Figure 5. *Leaf biometrics of SrB in hydroponics and soil.*

Table 2. *Scheme of the experiment.*

Option N	Option description
1.	control- digestion without Se addition
2.	nutrient solution + 0,25 mg/L Se
3.	nutrient solution + 0,5 mg/L Se
4.	nutrient solution + 1,0 mg/L Se
5.	nutrient solution + 1,0 mg/L Se +extra-root nutrition of plants with 0.001% Se solution
6.	control - soil without Se addition, Se=40 µg/kg
7.	soil - extra-root nutrition of plants with 0.0005% Se solution
8.	soil - extra-root nutrition of plants with 0.001% Se solution

Table 3. *Effect of Se on the content of diterpene glycosides in SrB under hydroponic conditions, (%).*

Variant	Stevioside	Rebaudioside A	Rebaudioside B	Rebaudioside C	Dulco-side A
1	13,4	3,6	0,07	0,09	0,9
5	15,8	3,9	0,09	0,12	1,1

3.2, indicating Se enrichment (Figure 3a).

By employing foliar feeding of plants with Se solutions in both hydroponic and soil cultivation systems, as well as the exogenous addition of Se to the shoot nutrient solution, the accumulation of Se in plant leaves can be enhanced. In hydroponics, the Se accumulation ranges from 8 to 43 µg/kg, while in soil cultivation, it ranges from 52 to 130 µg/kg (Figure 4a). Furthermore, foliar feeding of plants in the soil with a 0.001% solution of Se leads to a 2.5-fold increase in Se accumulation in leaves compared to the control (variant 6). Similarly, in the case of foliar feeding of plants with a 0.001% solution of Se in hydroponics (variant 5), Se accumulation in leaves increases by 1.3 times.

The addition of 1.0 mg/L Se to the nutrient solution in hydroponics resulted in a 12% increase in yield compared to the control (Figure 4b). Additionally, foliar feeding of plants with a 0.001% Se solution (variant 5) led to a 22% higher yield. Table 3 provides data indicating that Se also had a positive impact on the content of diterpene glycosides in Stevia rebaudiana. When 1.0 mg/L Se was present in the hydroponic nutrient solution or when plants received extra-root nutrition with a 0.001% Se solution, the content of stevioside increased by 18%, rebaudioside A by 8%, rebaudioside B by 28%, rebaudioside C by 33%, and dulcoside A by 22%.

Hydroponic systems have been shown to outperform soil-based systems in terms of various biological and biochemical efficiency indicators. This superiority can be attributed to the regulation of certain environmental abiotic factors in hydroponics, which leads to improved nutrition and water-air balance in plants, resulting in higher biological efficiency. Consequently, hydroponic plants have exhibited better performance than soil plants in several aspects, including plant height (1.9), diameter (2.8), leaf and root length (1.4) (Fig. 5), as well as dry weight of leaves (3.9 times) (options 1 and 6) (Fig. 2 b). Furthermore, hydroponic plants showed higher levels of extractive substances, proteins, stevioside, nitrogen (Fig. 6 a), carotene, vitamin C, and chlorophyll content (a+b) (1.1-1.2) (Fig. 6 b). The only parameters in which hydroponic plants were inferior to soil plants were the content of tannins (1.4 times) and flavonoids (1.1 times) (Fig. 6 a).

The levels of organic acids in Stevia rebaudiana (SrB) leaves did not significantly differ under different cultivation conditions. Both hydroponic and soil cultivation resulted in a similar decreasing order of organic acid content: malic acid > sorbic acid > ascorbic acid > citric acid > genic acid > fumaric acid. However, in the case of soil cultivation, SrB leaves exhibited a lower content of malic acid (1.3 times), while showing higher levels of ascorbic acid, tartaric acid, citric acid, and fumaric acid (1.8; 2.6; 1.4; 17; 3.3 times) compared to hydroponically grown plants.

The application of different fillers (black, red volcanic slag, boulder) in hydroponic cultivation of SrB revealed that SrB exhibited superior biometric characteristics (plant height: 1.6-1.8; diameter: 1.8-2.3; leaf length: 3.2-3.7; stem length: 1.7-3.3; root length: 1.2-1.3 times) (Fig. 8a) and higher efficiency (dry weight of leaf, stem, root: 1.9-3.1; 2.9-4.3; 1.9-3.1 times) (Fig. 8b) compared to SrB cultivated in soil.

Moreover, black volcanic slag yielded the best results in terms of SrB's biometric performance indices.

Conclusion.

Stevia rebaudiana (SrB) grown in hydroponics has been shown to exhibit superiority in terms of yield, extractive substances, proteins, stevioside, and malic acid content compared to plants grown in soil. Hydroponic systems have been shown to outperform soil-based systems in terms of various biological and biochemical efficiency indicators, providing high crop yield and high-quality products, even in areas with adverse

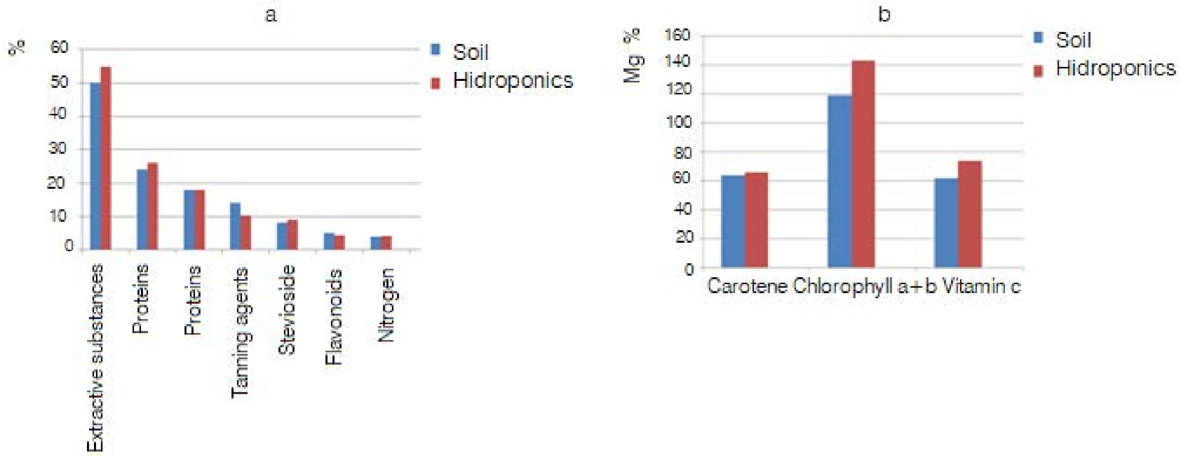

Figure 6. *Biochemical indices of SrB leaves in hydroponics and soil.*

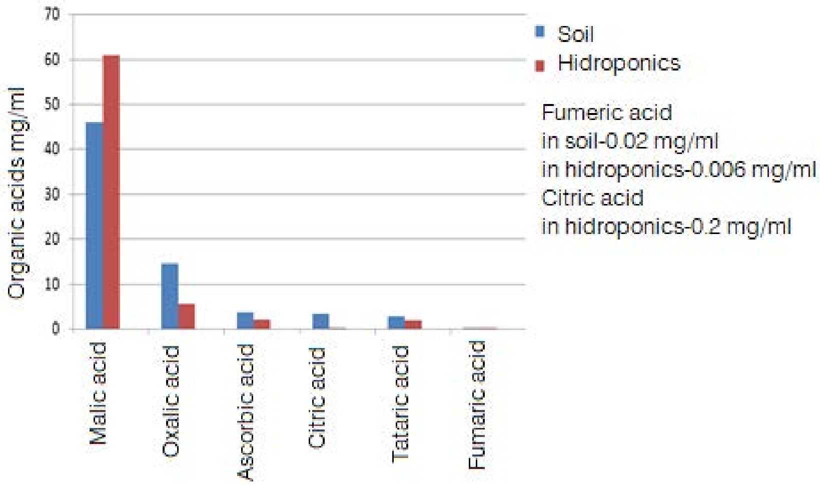

Figure 7. *Organic acid content of SrB leaves in hydroponics and soil.*

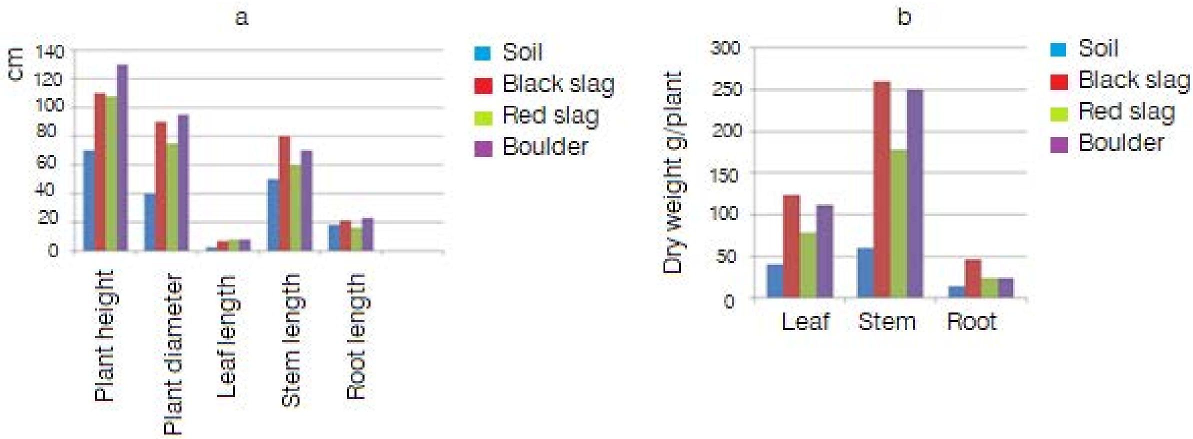

Figure 8. *Leaf biomass (a) and dry weight (b) of SrB in different fillers in hydroponics and soil.*

growing conditions. Hydroponic systems allow flexibility and intensification, providing high crop yield and high-quality products, even in areas with adverse growing conditions. The addition of exogenous Se to the hydroponic nutrient solution results in an increase in Se content in the SrB plant material. The highest Se content in SrB plant material was observed in hydroponics and soil when plants were foliar-fed with a 0.001% solution of Se, supplemented with 1 mg/L Se in the nutrient solution, and when the soil contained 40 µg/kg of Se. The introduction of 1.0 mg/L Se in the nutrient solution and foliar feeding of plants with a 0.001% Se solution resulted in a 22% additional yield compared to the control.

Based on the provided search results, here are some practical suggestions for enriching Stevia rebaudiana (SrB) plant material with selenium and improving its efficiency:

1. Hydroponic cultivation: To ensure high efficiency and enrich the plant material with Se, it is recommended to prefer the hydroponic method of cultivation. Maintain a nutrient solution with a concentration of 1 mg/L Se and provide additional foliar feeding of plants with a 0.001% Se solution. Black volcanic slag can be used as a filler in hydroponic systems, as it has been shown to yield the best results in terms of SrB's biometric performance indices.

2. Soil cultivation: To enrich the plant material with Se in soil cultures of SrB, it is suggested to apply exfoliating foliar feeding of plants with a 0.001% solution of Se.

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Продуктивность и обогащение селеном медовой травы в условиях гидропоники и почвы в Араратской долине

М.А.Бабаханян[1],В.А.Чавушян[2], К.В.Симонян[2], Л.М.Калачян[1], Л.В.Дарбинян[5],А.Г.Гукасян[4],Ш.С. Закарян[3], Л.Э.Оганесян[1]

Гидропоника дает возможность решить проблему получения растительных продуктов, богатых микроэлементами и ультрамикроэлементами. Ультрамикроэлемент Se (селен) укрепляет иммунную защиту организма, является сильным антиоксидантом. Установлено, что увеличение частоты инфарктов, инсультов и онкологических заболеваний у 60-80% населения связано с низким содержанием селена.Объектом исследований служила Stevia rebaudiana Bertoni (SrB) – самая молодая культурав растениеводстве. В Армению интродуцирована в 2009 г., обладает многими лечебными и профилактическими свойствами. Листья SrB богаты макро- и микроэлементами, витаминами (A, E, C, бета-каротином и др.), дитерпеновыми гликозидами (стевиозид, ребаудиозиды A, B, C, D, E, стевиолбиозид и дулкозид-А). Дитерпеновые гликозиды, выделенные из растительного сырья, в 200-300 раз слаще сахара.Исследовано влияние экзогенного внесения различных количеств Se в питательный раствор и внекорневой подкормки растений водным раствором Se на продуктивность SrB и накопление Se в листьях в условиях гидропоники и почвы в Араратской долине. Также были проведены сравнительные исследования по биометрическим, биохимическим показателям и по продуктивности SrB, культивируемого в различных наполнителях (черный, красный вулканический шлак, гравий) в условиях гидропоники и почвы. Полученные данные имеют практическое значение, так как могут быть положены в основу разработки биотехнологии обогащения сельскохозяйственных культур селеном.

Ключевые слова: медовая трава, Se, гидропоника, почва.