# The influence of treatments with silicon preparations and organic preparations on the physiological activity of salad and niger seed microgreens when growing in an urban phytotron

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**Abstract.** The article discusses the features of the influence of silicon preparations and organic preparations on the consumer properties of microgreens, salad and niger seed (Guizotia abyssinica (L.f) Cass). The results of physical and chemical analyzes of microgreens are presented and the main aspects of the most effective technology for growing microgreens in an urban phytotron are formed.

## 1 Introduction

In recent decades, humanity has been seriously concerned about solving problems related to sustainable development and environmental sustainability management. In addition, scientists pay great attention to environmental technologies, which should help improve the environmental safety of production and develop science in the field of environmentally oriented technologies.

In 2015, the UN General Assembly developed 17 sustainable development goals (SDGs). It is important to note that the concept of sustainable development goals is based on three significant aspects of human development: social, economic and environmental. To achieve sustainable development goals, it is necessary to take measures that will be aimed at the optimal application and use of various types of saving technologies for the economical use of limited resources. The sustainable development goals include goals such as No. 2 “No hunger”, No. 3 “Good health and well-being”, No. 6 “Clean water and sanitation”, No. 7 “Affordable and clean energy”, No. 12 “Responsible consumption and production”, No. 13 “Combating Climate Change” and No. 17 “Partnerships for Sustainable Development.” All of these goals are directly related to the quality of life and health of the population and resource conservation and ensuring rational models of consumption and production.

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It is important for humanity to act based on sustainable development goals, as this will lead to positive changes in the field of ecology and economy. In this regard, maintaining and developing new environmentally friendly ways of producing foods with high nutrient status is important, as they are a significant contribution to the implementation of Sustainable Development Goals No. 2, 3, 6, 7, 12, 13 and 17.

Microgreens are new products for Russian consumers with a high nutrient status. According to research by Z. Xiao, G.E. Lester and Y. Luo, a plant is considered a microgreen after the appearance of its first true leaf [1-3]. Microgreens (microgreens) are edible shoots of various agricultural crops with a height of 5-12 cm; they differ from traditional crops by more pronounced taste and aromatic characteristics and a higher content of biologically active compounds compared to traditional analogues. As is known, microgreens are several times superior to mature leaves in micronutrient content. Due to the fact that microgreens have a high nutrient status and are a "super food," introducing them into people's diets will help improve the situation of vitamin and nutritional deficiencies in people around the world.

The nutritional value and content of biologically active substances of microgreens are greatly influenced by the type, botanical variety, modes and technology of microgreens production. New biotechnologies for the production of crop products in urban conditions have been developed in the world, where special attention is paid to the possibility of producing environmentally friendly products using a growing system that allows the maximum realization of the genetically inherent maximum level of productivity and nutritional value.

Growing microgreens in cities will make this product more accessible to the mass consumer, and will also allow preserving most of the significant micro- and macronutrients in the product by reducing the path and time from the place of production to the consumer. In world practice, to optimize the production of agricultural crops in urban conditions, growing technologies in closed, isolated automated systems - phytotrons, in which conditions and cultivation regimes can be adjusted over a wide range, have begun to be actively used [4]. These systems allow to maintain the required environmental parameters and make production independent of weather conditions.

Thus, the development of biotechnological approaches to manage the nutritional value of microgreens when grown in an urban phytotrons is relevant for people from all over the world.

## 2 Research Methodology

### 2.1 Conditions for growing microgreens

#### *2.1.1 Conditions for germination of microgreens*

The study was carried out in an urban phytotron ISR-001. Characteristics of the urban-type phytotron (ISR-0.1) for the production of environmentally friendly microgreens: external chamber height 1800 mm, length 1000 mm, width 500 The phytotron has two ventilation systems and four tiers of shelves equipped with fluorescent (white light) and LED lamps (red and blue light). mm. The chamber has 4 tiers of shelves, their internal dimensions are 920 mm * 350 mm. The design of the phytotron allows you to create different temperature and light conditions in it.

Salad and niger seed microgreens were germinated in trays measuring 35 cm x 16 cm. Jute mats measuring 10 cm x 15 cm and 5 mm thick served as a substrate. Before sowing the seeds, the trays were treated with a disinfectant solution and washed with distilled water. Jute mats were thoroughly moistened in water and laid out in trays, three pieces each, at a short distance from each other.

After the first shoots appeared, the microgreens were exposed to light. Microgreens of salad, niger seed and chicory were watered daily with 200 milliliters of water. The temperature on the phytotron shelves ranged from 26 to 28 degrees Celsius during the day and 17-20 at night. The established duration of daylight hours in the phytotron is 16 hours.

### 2.2 Determination of the quantitative content of chlorophyll and carotenoids

Determination of chlorophyll and carotenoids was carried out by spectrophotometry [5].

### 2.3 Determination of quantitative content of phenolic compounds

The quantitative content of phenolic compoundswas measured by the Folin-Ciocalteu method [6].

### 2.4 Determination of total antioxidant activity

The total content of antioxidants was measured using an Expert-006 coulometer [7].

## 3 Results and discussion

### 3.1 Identification of optimal preparations, their concentrations and methods of processing microgreens when grown in an urban phytotron

#### *3.1.1 Identifying the most effective way to process microgreens*

The study was carried out in an urban-type phytotron ISR-001 under the designated environmental conditions. The most effective treatment method was determined when using different concentrations of the preparation 1-ethoxysilatrane (1-ES). The following treatment methods were used: soaking seeds in solution for 2 hours before sowing, foliar treatment on the 5th day of growth, root treatment on the 5th day, soaking and foliar treatment. Three concentrations of the preparation 1-Ethoxysilate were also used:1*10-2; 1*10-3; 1*10-4.

As a result of the study, it was revealed that soaking is the most effective method of processing, giving the best results on the growth and physicochemical parameters of microgreens.

#### *3.1.2 Study of the effect of treatment with various preparations on salad and niger seed microgreens*

To study the effect of various preparations on salad and niger seed microgreens, preparations such as 1-Ethoxysilatran, 1-Germatronol, hydrothermal nanosilica of 10 and 100 nm, obtained from hydrothermal waters of the well of the Mutnovskaya geothermal power plant (Kamchatka) using the ultrafiltration method (GNK-1 and GNK- 2), nanosilica obtained from aqueous solutions of orthosilicic acid by ultrafiltration (NK-3), as well as organic preparations “Nikfan” and “Azotovit”. A comparison of all preparations in various concentrations was carried out to identify the preparation that gives the best result on the physicochemical parameters of microgreens and their indicators of changes in size, germination energy and weight. The treatment was carried out by soaking microgreen seeds in various concentrations of the indicated preparations.

As a result of preliminary processing of the results, it was revealed that the best effect from treating microgreens with preparations 1-ES, 1-EG, GNK-1, GNK-2, NK-3 was observed at their concentration 1*10-3. The optimal concentration for the preparation "Nikfan" was 0.14%, the optimal concentration of the preparation "Azotovit" was 50% (30 ml of the preparation per 30 ml of water).

It was found that treatment with all of these preparations has an equally positive effect on the germination energy and height of salad and niger seed microgreens. There were no significant differences in these indicators. It is important to note that the greatest consumer value in microgreens is their leaves, so it is very important to study the effect of preparations on leaf growth dynamics. As a result of the measurements, it was revealed that the best indicators of changes in leaf growth in niger seed and salad microgreens are present in those samples that were treated with the 1-ES preparation at a concentration of 1*10-3. Also, a good effect on the growth dynamics of niger seed microgreen leaves was observed when it was treated with GNK-2 at a concentration of 1*10-3.

Among other things, an important role in determining the optimal preparations and concentrations for processing microgreens is played by the indicator of the plant's need for mineral nutrition, primarily nitrogen. This indicator was measured by the Nitrogen Tester device. The operating principle of this device is based on calculating the ratio of the absorption values of the light flux in two parts of the spectrum, red and near-infrared. The values vary depending on the amount of light flux absorbed by the chlorophyll of the leaf. The amount of chlorophyll allows you to determine the degree of comfort of the plant and the compliance of the substrate and environmental conditions with its physical needs. The lower this indicator, the greater the plant's need for additional nutrition and fertilizing. The measurement results are presented in Figure 1.

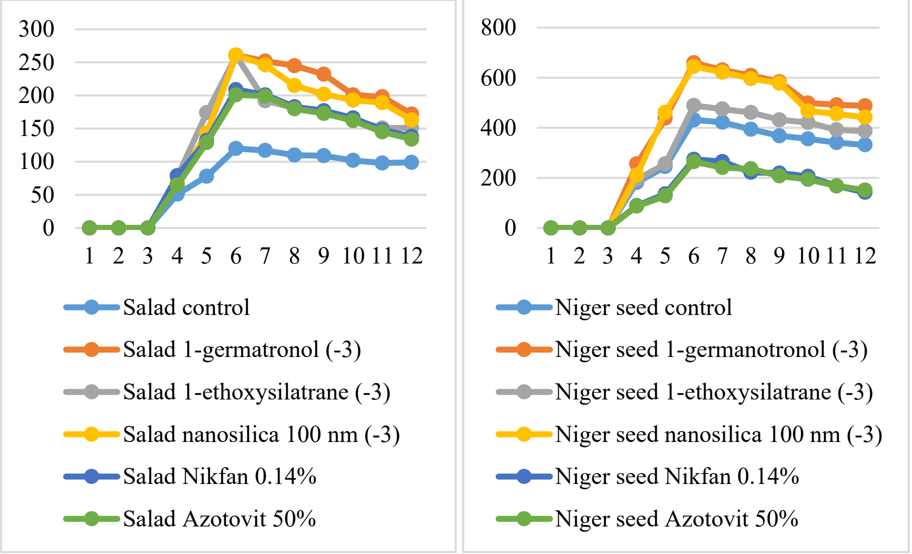


**Fig. 1.** Dynamics of changes in total nitrogen indicators in microgreens of salad (left) and niger seed (right) when treated with various preparations

As a result of the measurements, it was revealed that the best indicators of general condition and the least need for additional mineralization and nutrition when growing niger seed and salad microgreens are present in those samples that were treated with preparations 1-ES, GNK-2 and 1-EG at a concentration of 1*10-3. These data are of great importance, as they confirm the effectiveness of using silicon preparations when growing microgreens. These preparations not only have a positive effect on the growth and development of the plant, but also on its general condition.

When assessing the effectiveness of treatment with microgreen preparations, it is important to pay attention to physical and chemical studies of the samples. The figures show combined diagrams of physical and chemical studies of salad and niger seed microgreens when treated with various preparations.

Figures 2 (salad) and 3 (niger seed) illustrate the total chlorophyll and carotenoid content of microgreens at day 12 after planting and the ratio of chlorophyll a to b. It is important to note that the chlorophyll a:b ratio should be greater than one, which indicates a favorable environment for the plant.

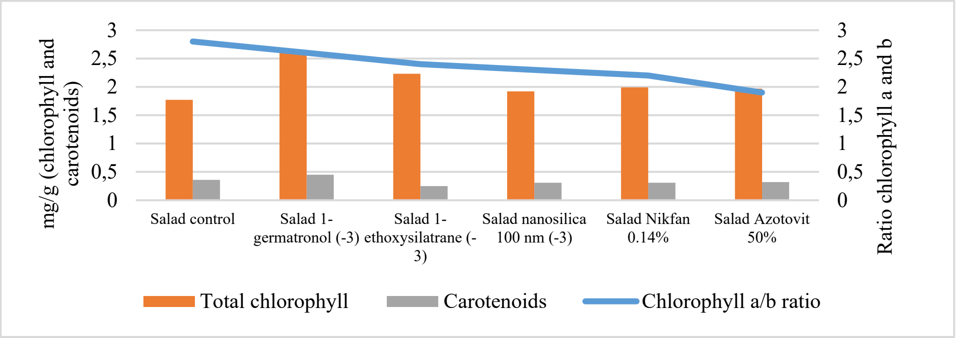


**Fig. 2.** Quantitative indicator of total chlorophyll, carotenoids and chlorophyll a and b ratio in salad microgreens treated with various preparations

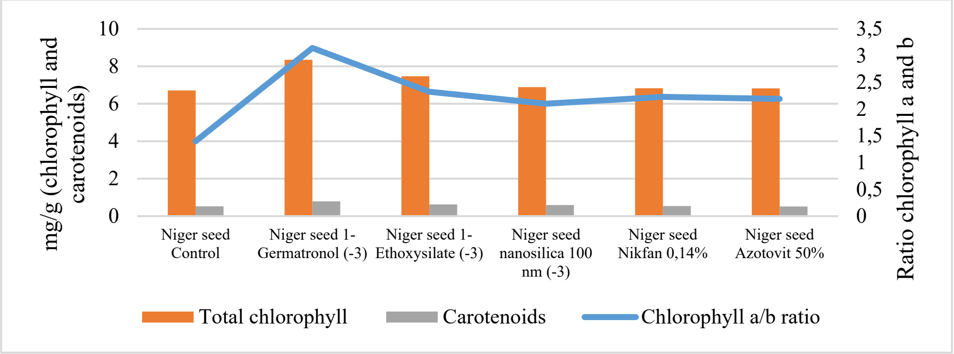


**Fig. 3.** Quantitative indicator of total chlorophyll, carotenoids and the ratio of chlorophyll a and b in niger seed microgreens when treated with various preparations

From the obtained graphs we can conclude that salad and niger seed microgreens, when treated with all preparations, are in a favorable environment, however, in terms of the quantitative content of total chlorophyll and carotenoids, salad and niger seed microgreens treated with 1-EG and 1-ES at a concentration of 1*10 (-3) has higher rates, in contrast to other samples.

Figures 4 (salad) and 5 (niger seed) show combination diagrams illustrating the quantitative content of phenolic compoundsand total antioxidant activity in salad and niger seed microgreens.

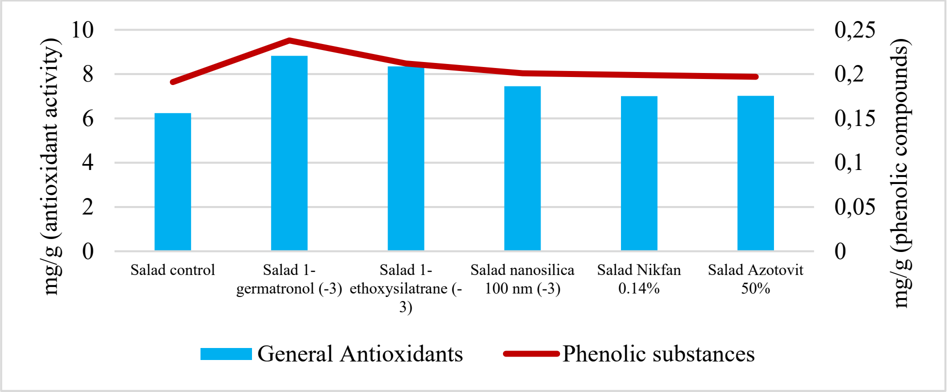


**Fig. 4.** Quantitative indicator of the content of phenolic compoundsand total antioxidant activity in salad microgreens when treated with various preparations

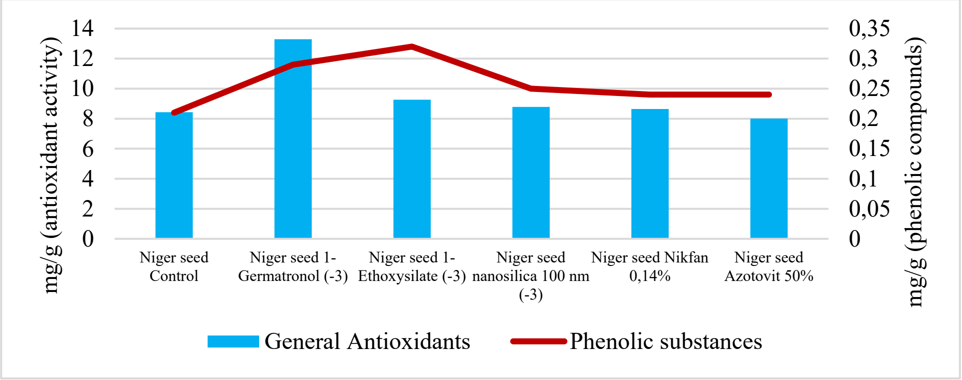


**Fig. 5.** Quantitative indicator of the content of phenolic compoundsand total antioxidant activity in niger seed microgreens when treated with various preparations

As a result, it can be noted that the samples treated with 1-ES and 1-EG preparations at a concentration of $1*10^{-3}$ stand out in terms of the content of phenolic compoundsand general antioxidant activity in salad and niger seed microgreens.

## 4 Conclusions

Thus, plants treated with 1-ES and 1-EG at a concentration of 1*10-3 have the highest rates of physiological activity, according to all physicochemical measurements. This indicates that preparation treatment has a direct connection with meeting the plant's mineral and nutritional needs, which may serve as the basis for further research in this area. It is also important to point out that the best physical and chemical indicators of salad and niger seed microgreens obtained during the study correlate with the results obtained on the Nitrogen Tester device, which indicates the need of plants for additional mineralization and fertilizing. This can facilitate the use of the Nitrogen Tester device as an express method for determining the physiological activity of microgreens.

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