Expenses for producing the winter garlic planting material 
(*allium sativum* L.) *in vitro*

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**Abstract.** The article calculates the costs incurred at different stages of cultivation of winter garlic in an *in vitro* culture. It is shown that when using the developed technique (10,000 plants with a cost of 30.3 rubles per 1 plant), a regenerant can be obtained for 270 days of cultivation.

1. **Introduction**

Currently, the solution of practical problems of breeding is largely determined by the effectiveness of involving modern biotechnological methods that can be successfully used at all stages of the selection process, including the creation of genetic diversity, obtaining stable genetic lines, the identification of genotypes and their reproduction [6].

Sowing campaign garlic (*Allium sativum* L.) is a valuable vegetable and medicinal crop that is widely used in human nutrition and the pharmaceutical industry [2]. Garlic is a vegetatively propagated plant. In this regard, it is subject to numerous viral, bacterial, fungal and other infections that are transmitted to offspring, which leads to lower yields, loss of quality, keeping quality, and often degeneration of varieties [1, 4].

Numerous studies have shown the possibility of obtaining a healthy planting material using *in vitro* technologies. Therefore, improving the planting material of this type of cultivated plant is a necessary condition in contemporary technologies of garlic seed production.

2. **Materials and Methods**

Unripe air bulbs of garlic winter varieties Gladiator served as a research material [5]. All-Russian Scientific Research Institute of Vegetable-Growing – Branch of the Federal State Scientific Institution Federal Research Center for Vegetable-Growing has developed a method for producing the *in vitro* planting material for winter garlic (*Allium sativum* L.) [3]. To calculate the plant production costs according to this method, the following input data were used: (1) wages with a specialist’s charges (40,000 rubles per month), (2) costs of 1 kW / hour (4.66 rubles), (3) an average cost of 1 l nutrient medium (600 rubles).

According to this method, a step sterilization of 7-day-old garlic inflorescences (using 1% potassium permanganate solution at exposure time 15-20 minutes, 70% ethanol solution for 30 seconds and 1.0% sodium hypochlorite solution) takes 20 minutes and allows one to get from 92.6% to 100.0% sterile explants.
3. Results and Discussion
In accordance with the technological process, at the first stage, the isolated inflorescences are placed on a nutrient medium containing macro- and microelements, vitamins and organic compounds according to the recipe N6 [7], as well as kinetin at a concentration of 1.0 mg/l. At this stage, the duration of cultivation averaged 30 days, and the cost of wages with charges and payment of electricity amounted to 1,739.95 rubles (Table 1).

| Table 1. The cost of obtaining 10,000 plants (regenerants) of garlic in vitro. |
|---------------------------------------------------------------|
| Indicators | Cultivation stages | Total costs |
|------------|-------------------|-------------|
|           | Introduction in vitro | Breeding shoots | Rooting and growing shoots in vitro | Adaptation of regenerants to ex vitro conditions and their growing |
| Nutrient medium | N6, kinetin 1 mg/l, sucrose 3% | N6, kinetin 1 mg/l, sucrose 3% | N6, PAA 0.1 mg/l, sucrose 1% | Peat tablets Jiffy 24 mm |
| The duration of cultivation, days | 30 | 30 | 30 | 150 | 270 |
| Expenses: | | | | | |
| including labor, man-hour | 26 | 125.5 | 125.5 | 126 | 402 |
| electricity, rub. | 1216.95 | 4862.46 | 4748.90 | 83280.01 | 94108.32 |
| salary with charges, rub. | 523 | 2522.5 | 2522.5 | 2532.6 | 8080.2 |
| materials, rub. | 81111.48 | 119700 | | | |
| TOTAL | | | | | 303,000 |
| costs, rub. | | | | | |
| Per 1 regenerant, rub. | | | | | 30.3 |

The resulting shoots of garlic are transplanted to a nutrient medium N6, containing sucrose at a concentration of 10 g/l, PAA (0.1 mg/l). After 10-14 days, the roots and additional leaves begin to appear in the garlic regenerants. To adapt to the new gas composition to the air with less humidity and infectious load, holes are made in the lids of the cultivation vessels, which expand as the plants adapt. This period usually lasts 3-7 days. Then, plants with a well-formed root system are removed from the cultivation vessels and planted in peat tablets. Within 10-14 days, the plants are kept in a humid chamber at a temperature of +18...+20°C, and they are opened daily for aeration.

The cost of materials for the entire period of in vitro cultivation is 81,111.48 rubles, or 26.8% of the total costs, and includes the cost of the nutrient medium, consumables, and ethanol.

The stages of obtaining regenerants and their rooting are 30 days each, and the cost of wages with charges and electricity for this period is 14,656.36 rubles, or 4.8% of the total costs.

Using the described techniques provides for 81.5–94.3% of garlic regenerated plants adapted to ex vitro conditions. To produce well developed plants and bulbs, they are grown within 3-4 months. At this stage, costs amount to 205,512.61 rubles, or 67.8% of the total costs.

4. Conclusion
When using the described in vitro technology, the period of obtaining 10,000 winter garlic plants takes 270 days, and the cost of 1 plant (regenerant) is 30.3 rubles.

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