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ВЛИЯНИЕ РАЗЛИЧНЫХ СОСТАВОВ ПИТАТЕЛЬНОЙ СРЕДЫ НА РАЗВИТИЕ МИКРОРАСТЕНИЙ КАРТОФЕЛЯ СОРТА СОЛНЕЧНЫЙ

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Представлены результаты исследования влияния питательных сред различного состава на рост оздоровленных микрорастений картофеля сорта Солнечный, выращиваемых в лабораторных условиях *in vitro*. Изучено шесть составов питательной среды: стандартная среда по прописи Мурасиге-Скуга, модифицированная для микрочеренкования (контроль), модифицированная среда Мурасиге-Скуга со сниженным содержанием минеральных компонентов (до 1/2 и 1/3), модифицированная среда Мурасиге-Скуга с повышенным содержанием агар-агара (10 г/л), модифицированная среда Мурасиге-Скуга с пониженным содержанием агар-агара (4 г/л), среда Мурасиге-Скуга, модифицированная с добавлением 3 мг/л гиберреллиновой кислоты и 1 мг/л индолилуксусной кислоты. Учтены параметры растений: длина растения, наличие корня, число междоузлий, общая масса растения, масса листьев, масса корней, площадь поверхности листовой пластины. Применение сред со сниженным содержанием минеральных компонентов привело к увеличению длины растений на 28–30%, массы побега на 25% за счет массы листьев на 18%, массы стебля на 31%, суммарной площади поверхности листовых пластин на 12%. На среде с 1/3 минеральных компонентов отмечено увеличение массы корневой системы на 20%. На среде с повышенным содержанием агар-агара зарегистрировано уменьшение длины растений на 6%, уменьшение массы побега на 12% за счет уменьшения массы стебля на 15%. Растения на среде с пониженным содержанием агар-агара отличались большей массой корневой системы на 10%, побега на 17% за счет увеличения массы листьев на 27% и суммарной площади поверхности листовых пластин на 22%. При добавлении в среду регуляторов роста (гиберреллиновой и индолилуксусной кислоты) отмечено увеличение высоты растений на 70%, уменьшение массы корневой системы на 50% и листьев на 46%, увеличение массы стебля на 23%. Суммарная площадь поверхности листьев была ниже контрольных значений на 28%. Для ускоренного микроразмножения оздоровленных растений и подготовки растений для пересаживания на аэрогидропонные установки с целью получения миниклубней оптимальными являются модифицированные питательные среды со сниженным количеством минеральных компонентов 1/2 и 1/3 и со сниженным содержанием агар-агара.

Ключевые слова: картофель, состав питательной среды, клональное микроразмножение, регуляторы роста

THE EFFECTS OF DIFFERENT COMPOSITIONS OF GROWTH MEDIA ON THE DEVELOPMENT OF MICROPLANTS OF THE SOLNECHNY POTATO VARIETY

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The results of studying the effect of nutrient media of various compositions on the growth of improved micro-plants of potatoes of the Solnechny variety grown under laboratory conditions in

vitro are presented. Six compositions of the nutrient medium were studied: standard Murashige-Skuga medium modified for micropropagation (considered as a control), modified Murashige-Skuga medium with a reduced content of mineral components (up to 1/2 and up to 1/3), modified Murashige-Skuga medium with an increased content of agar-agar (10 g/l), modified Murashige-Skuga medium with a reduced content of agar-agar (4 g/l), Murashige-Skuga medium modified with the addition of 3 mg/L giberrellinic acid and 1 mg/L indoliacetic acid. The following parameters of cultivated plants were taken into account: plant length, root presence, number of internodes, total plant mass, leaf mass, root mass, leaf plate surface area. The use of modified nutrient media with a reduced content of mineral components led to an increase in plant length (by 28-30%), stem mass (by 25%) due to leaf mass (by 18%) and stem mass (by 31%) and the total surface area of leaf plates (by 12%). In the variant using a medium with 1/3 mineral components an increase in the mass of the root system was observed (by 20%). When growing plants on a modified nutrient medium with a high content of agar-agar, a decrease in the length of plants (by 6%), a decrease in the mass of the scion (by 12%) due to a decrease in the mass of the stem (by 15%) was observed. Plants grown on a modified nutrient medium with a reduced content of agar-agar were distinguished by a larger mass of the root system (by 10%), scion (by 17%) (due to an increase in leaf mass (by 27%), as well as the total surface area of leaf plates (by 22%). When growth regulators (giberrellin and indoliacetic acid) were added to the modified nutrient medium, a significant increase in plant height (by 70%), a decrease in the mass of the root system (by 50%) and leaves (by 46%), and an increase in the mass of the stem (by 23%) were observed. The total leaf surface area was 28% lower than the control values. For accelerated micropropagation of improved potato plants of the Solnechny variety and preparation of plants for transplanting to aerohydroponic systems in order to produce mini-tubers, the following modified nutrient media are optimal options: with a reduced number of mineral components (1/2 and 1/3) and with a reduced content of agar-agar.

Keywords: potatoes, nutrient medium composition, clonal micropropagation, growth regulators

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INTRODUCTION

The potato is one of the most important crops in agricultural production in Russia and around the world. According to FAO, potatoes are grown in 180 countries [1]. One of the main factors affecting the yield of this crop is high susceptibility to viral, bacterial and fungal diseases. The use of clonal micropropagation method can solve the problem of obtaining healthy planting material free from viral, fungal and bacterial infection, and increase the yield of this crop [2-4]. Compared to traditional methods, micropropagation has the following advantages: obtaining genetically homogeneous planting material, high multiplication rate, reducing the time of the breeding process, the possibility of cultivation of hard-to-reproduce plants by traditional methods [1,2] [5].

One of the important factors influencing the process of plant micropropagation under

[1]Dorofeeva V.Y., Medvedeva Y.V., Karnachuk R.A. Selective light and productivity of potato plants under in vitro and hydroponic cultivation. Actual problems of potato growing: materials of the All-Russian Scientific-Practical Conference with international participation (Tomsk, April 10-13, 2018). Tomsk, 2018. pp. 215-218.

[2]Fedorova Y.N., Fedorova L.N. The combined effect of nutrient medium and light on the formation of microgrowths in vitro. Traditions and innovations in the development of agriculture: materials of international scientific and practical conference (Velikie Luki, 17-19 April 2019). Velikie Luki, 2019. pp. 53-59.

laboratory conditions is the composition of the nutrient medium. Thus, the plant requires 17 chemical elements for complete growth and development [6, 7]. Therefore, it is important to choose the composition of the medium optimal for the growth of plants of a particular variety in seed production of healthy potatoes.

Currently, for microclonal propagation of potato nutrient medium Murashige- Skoog (MS) with various modifications is used. In the work of S.V. Kushnarenko et al. [8] it is shown that when growing potato plants on nutrient medium MS with full mineral part, the tendency to reduce the growth of potato plants is observed, while growing on 1/2 mineral part did not show this effect. In addition, potato plants rooted better on the medium with 1/2 mineral part. In our work we conducted a series of experiments to identify the effect of different concentrations of mineral part in the modified nutrient medium MS on potato microgrowths of the Solnechny variety.

According to the literature data, growing plants on modified nutrient media with a lower content of agar-agar (4 g/l) leads to an increase in the number of internodes because the liquid nutrient medium provides greater mobility of trophic elements. From the economic point of view, growing plants on liquid nutrient media is more profitable since less agar-agar is used to prepare one liter of medium [9, 10].

Researchers are searching for methods to slow down the growth of plants in vitro to reduce the cost of microtransplanting when maintaining the variety in the collection [11-13]. One of such approaches can be the use of modified nutrient media with different contents of agar-agar.

In our work, we conducted a series of experiments to determine the effect of liquid (4 g/l agar-agar) and solid (10 g/l agar-agar) MS nutrient medium on the growth and development of potato plants of the Solnechny variety.

The purpose of the study was to study the effect of different compositions of modified nutrient media on the growth and development of potato plants in the Solnechny variety in vitro under laboratory conditions.

To achieve the goal, the effect of nutrient medium on morphometric indicators (plant height, number of internodes, rhizogenesis, root system weight, shoot weight, leaf weight, stem weight and leaf surface area) of recovered potato microplants of the Solnechny variety was studied and the economic efficiency of using nutrient media of different composition was determined.

MATERIAL AND METHODS

The work was carried out in the Siberian Research Institute of Agriculture and Peat - branch of the Siberian Federal Scientific Center of Agro-BioTechnologies of the Russian Academy of Sciences. The object of the experiment was the healthy maternal microclones of potato Solanum tuberosum L. cultivar Solnechny, obtained from the apical meristems by cultivation on standard nutrient medium MS with modifications. Preparation and cultivation of plants were carried out according to the recommendations[3].

The Solnechny variety is mid-maturing, suitable for processing into potato products. Marketable yields are 21-27 tons per hectare. The tuber is rounded with medium-deep eyes. The skin is smooth yellow. The flesh is yellow. The mass of the commodity tuber is 139-290 g. The starch content is of 14,4-16,0%. The taste is good. Productivity is 85-98%. Storability is 94%. This variety is resistant to the pathogen of potato cancer, weakly affected by the golden potato cyst nematode. It is included in the State Register of the Russian Federation for the West Siberian (10) region.

After isolation of meristem and emergence of complete microplant from the meristem, its microclonal propagation was carried out and

[3]Trofimets L.N., Boyko V.V., Anisimov B.V. et al. Non-viral seed production of potatoes: recommendations. Moscow: Agropromizdat, 1990.

the experiment was established. Microclonal propagation of in vitro potato plants was carried out by microtransplanting in sterile laminar boxes. All microplants were diagnosed by real-time PCR for X-, Y-, M-, L-, S-, A-viruses and potato spindle tuber viroids before setting up the experiment. According to the results of the analysis, all plants used in the work were free from the infectious agents.

Gibberellic acid (GA) and indole acetic acid (IAA) were dissolved in 70% ethyl alcohol or in a small amount (a few drops of 0.5 n) of HCl or KOH. All concentrated solutions of the required elements were labeled and stored in the refrigerator. Six compositions of the modified nutrient medium were studied (see Table 1).

The composition of the modified nutrient medium used as a control was selected on the

Табл. 1. Состав модифицированной питательной среды для выращивания оздоровленных растений картофеля

Table 1. Composition of a Modified Nutrient Medium for Improved Potato Plants

Nutrient medium component	Experiment variant number					
	1	2	3	4	5	6
	MS medium (control), mg/l	MS medium with 1/2 content of mineral components, mg/l	MS medium with 1/3 content of mineral components, mg/l	MS medium with increased content of agar-agar (10 g/l), mg/l	MS medium with reduced agar-agar content (4 g/l), mg/l	Medium with GA and IAA content, mg/l
Macrosalts						
NH_4NO_3	1650	825	550,00	1650	1650	1650
KNO_3	1900	950	633,34	1900	1900	1900
$CaCl_2$ $2H_2O$	440	220	146,67	440	440	440
$MgSO_4$ $4H_2O$	370	185	123,34	370	370	370
KH_2PO_4	170	85	56,67	170	170	170
Microsalts						
H_3BO_3	6,2	3,1	2,07	6,2	6,2	6,2
$MnSO_4$ $4H_2O$	22,3	11,15	7,44	22,3	22,3	22,3
$CoCl_2$ $6H_2O$	0,025	0,0125	0,0084	0,025	0,025	0,025
$ZnSO_4$ $7H_2O$	8,6	4,3	2,87	8,6	8,6	8,6
$CuSO_4$ $5H_2O$	0,025	0,0125	0,0084	0,025	0,025	0,025
Na_2MoO_4 $2H_2O$	0,25	0,125	0,084	0,25	0,25	0,25
KI	0,83	0,415	0,28	0,83	0,83	0,83
Ferric chelate						
Fe_2SO_4 $7H_2O$	27,8	13,9	9,27	27,8	27,8	27,8
Na_2–EDTA $2H_2O$	37,3	18,65	12,44	37,3	37,3	37,3
Vitamins						
Thiamine – HCl	2,5	2,5	2,5	2,5	2,5	0,1
Pyridoxin – HCl	5	5	5	5	5	0,5
АС-К	2,5	2,5	2,5	2,5	2,5	–
Growth regulators						
GA	–	–	–	–		3
IAA	–	–	–	–		1
Saccharose	30000	30000	30000	30000	30000	10000
Agar-agar	7000	7000	7000	10000	4000	7000

basis of data given in the literature, which the authors of this work have been successfully used for several years for cultivation of healthy potato microplants during microtransplanting [14, 15].

In the modified nutrient media 2 and 3 the content of mineral components is reduced in order to identify the influence of the amount of mineral part on the growth and development of potato microplants. Modified nutrient media 4 and 5 are distinguished by increased and decreased content of agar-agar. Adding more agar-agar to the modified nutrient medium leads to a slower growth and development rate of potato microplants, which allows to reduce the cost of micrografting. The use of a modified nutrient medium with a lower content of agar-agar allows for greater mobility of trophic elements and a higher rate of growth and development of microplants. The use of modified nutrient medium 5 is more profitable from an economic point of view and can provide more active plant growth. The modified nutrient medium of the Kemerovo Research Institute of Agriculture (KemNIISKh) [16] was used for the basis of modified nutrient medium 6. Against the background of other media, it stands out due to the presence of growth regulators, composition of vitamins, and low sucrose content. This nutrient medium contributes to an increase in the multiplication factor and plant height.

During the experiment, the cuttings were cultivated at 20-22 °C with a photoperiod (light/dark) of 16/8 h in tubes for 28 days using OSRAM fluorescent lamps (cold daylight, power 36 W, illumination section of 5 thousand lux). Thirty-five plants of each variety were grown on each variant. Repeatability was threefold. During the experiment on the 3rd, 7th, 14th, 21st, 28th days we measured the indices characterizing plant development: plant length, root presence, number of internodes per plant. On the 28th day, we measured the total plant weight, leaf weight, root weight, and surface area of the leaf plate.

The appearance of roots was determined visually at certain intervals. The height was measured with a ruler from the base of the plant to the upper point of growth. The number of internodes was determined by counting them on one microplant. The weight of plants with leaves, the weight of leaves, and the weight of roots were determined by weighing on laboratory scales. Scanned images of leaves were used to determine leaf surface area, which were processed using the program "ImageJ". Statistical processing of the results was performed using the Windows Statistica 8.0 software package. Mann-Whitney test was used to compare the studied values.

RESULTS AND DISCUSSION

The results of the study of different compositions of the modified nutrient medium on the height of plants at different stages of their development are shown in Table 2. The studied compositions of nutrient medium are given in Table 1.

Analysis of the data of Table 2 shows that growing of healthy potato plants of the Solnechny variety on modified nutrient medium MS with 1/2 of mineral components led to an increase in plant height (the difference was 1 cm on the 14th day of growing, 2 cm on the 21st day and 2.52 cm on the 28th day of growing). Using a modified nutrient medium MC with 1/3 mineral components led at first to a decrease in the plant height compared to the control (0,39 cm on the 7th day of growth), but at a later date to an increase in the plant height (plants of experimental variant were higher than the control by 0.6 cm on the 14th day of development, by 2.25 cm on the 21st day and by 2.7 cm on the 28th day). It should be noted that different varieties respond differently to this factor. For example, N.V. Lebedeva[4] notes

[4] Lebedeva N.V. Accelerated multiplication of early potato varieties under in vitro conditions and its use in seed production of the North-West of Russia: Ph.D. in Agricultural Sciences. Velikie Luki, 2015. 186 p.

Табл. 2. Влияние различных составов модифицированной питательной среды на высоту оздоровленных микрорастений сорта Солнечный, см

Table 2. Effects of Different Compositions of the Modified Nutrient Medium on the Height of Improved Microplants of the Solnechny Variety, cm

Experiment option	Cultivation time, days				
	3	7	14	21	28
1	0,17 ± 0,018	1,15 ± 0,06	4,92 ± 0,21	7,38 ± 0,25	8,95 ± 0,27
2	0,20± 0,015**	1,07 ± 0,06	5,92 ± 0,20***	9,38 ± 0,25***	11,47 ± 0,29***
3	0,12 ± 0,009	0,76 ± 0,04***	5,52 ± 0,16**	9,63 ± 0,27***	11,65 ± 0,31***
4	0,13 ± 0,016*	0,87 ± 0,05***	4,89 ± 0,16	7,07 ± 0,27	8,46 ± 0,32*
5	0,13 ± 0,010	1,04 ± 0,05	5,42 ± 0,17*	7,64 ± 0,23	9,13 ± 0,22
6	0,11 ± 0,009**	1,35 ± 0,06**	7,53 ± 0,19***	11,85 ± 0,23***	15,22 ± 0,27***

Here and in Tables 3, 4:

* Differences are significant with $p < 0.05$ compared to control.

** Differences are significant with $p < 0.01$ compared to control.

*** Differences are significant with $p < 0.001$ compared to controls.

a significant negative impact of reducing the mineral part on the growth and development of potato varieties Udacha, Charodey, Zagadka Pitera and Snegir. The plants grown on MS medium with increased content of agar-agar insignificantly lagged behind the control plants in growth (0,04 cm on the 3rd day of growth, 0,28 cm on the 7th day of growth and 0,49 cm on the 28th day of growth). Use of modified MS nutrient medium with reduced content of agar-agar did not cause statistically significant deviations from the control. The only difference appeared on the 14th day of cultivation - the plants were 0.5 cm higher than controls, but no differences were noted on later terms of cultivation. With the modified medium with added GA and IAA, the plants first lagged behind the control (by 0.6 cm on the 3rd day of cultivation), then caught up and exceeded the length of control plants (1.2 cm on the 7th day, 2.61 cm on the 14th day, 4.47 cm on the 21st day and 6.27 cm on the 28th day). The increase in the height of potato microplants by 7.6-24.1% when using the medium of KemNIISKh is also noted by V.P. Khodaeva and V.I. Kulikova [16].

The results of measuring the number of internodes when growing microplants using a modified nutrient medium of different composition are presented in Table 3.

In the variant with the use of modified nutrient medium MS with 1/2 mineral components in the experiment with potato plants of the Solnechny variety an increase in the number of internodes on the 14th and 21st days of growth (0.38 and 0.41 units, respectively) was noted, but on the 28th day of growth reliable differences were not revealed (see Table 3). On the 21st day of cultivation, there was also an increase in the number of internodes in plants grown on medium with the addition of GA and IAA (by 0.29 units). On the 28th day of growth reliable differences were not revealed. Khodaeva V.P. and Kulikova V.I. [16] also indicate that the number of internodes in some cases increased by 30% when using the modified nutrient medium of KemNIISKh. In addition, the studies by E.P. Myakisheva and others [10] show that adding 4 g/l agar-agar to the modified nutrient medium contributes to an increase in the number of internodes. However, no such effect was observed in our work.

The effect of different compositions of the modified nutrient medium on the morphometric parameters of growing plants is shown in Table 4.

Табл. 3. Влияние различных составов модифицированной питательной среды на количество междоузлий оздоровленных микрорастений сорта Солнечный, шт.

Table 3. Effects of Different Compositions of the Modified Nutrient Medium on the Number of Internodes of Improved Microplants of the Solnechny Variety, pcs.

Experiment option	Cultivation time, days			
	7	14	21	28
1	0,75 ± 0,091	3,08 ± 0,121	4,81 ± 0,111	6,57 ± 0,100
2	0,87 ± 0,083	3,46 ± 0,104*	5,22 ± 0,106**	6,78 ± 0,104
3	0,54 ± 0,072	3,11 ± 0,077	4,93 ± 0,090	6,50 ± 0,094
4	0,81 ± 0,084	3,18 ± 0,086	4,75 ± 0,103	6,53 ± 0,110
5	0,81 ± 0,080	3,20 ± 0,087	4,77 ± 0,102	6,62 ± 0,095
6	0,90 ± 0,072	3,27 ± 0,078	5,10 ± 0,099*	6,77 ± 0,107

The analysis of the data presented in Table 4 shows that on the modified MS nutrient medium with 1/2 mineral components the plants had a greater shoot mass due to a slight increase in leaf mass (by 0.02 g, or 18%) and stem mass (by 0.04 g, or 31%). At the same time, the area of leaf plates was also larger (by 0.83 cm^2 or 12%). Plants grown on MS nutrient medium with 1/3 mineral components had the same parameters as those grown on medium with 1/2 mineral components, but were additionally distinguished by an increased root mass (by 0.02 g, or 20%). The plants grown on a modified medium with increased content of agar-agar had a less massive shoot due to a decrease in stem mass (by 0.02 g, or 15%). By contrast, the plants grown on a modified medium with a lower content of agar-agar had a more massive shoot due to an increase in leaf weight (by 0.03 g, or 27%). The total surface area of leaves in the experimental variant was higher than in the control by 1.49 cm^2, or 22.1%. The use of the modified medium with the addition of GAs and IAAs resulted in a significant decrease in the weight of the root system of plants (by 0.05 g, or 50%), a decrease in the weight of leaves (by 0.05 g, or 54.5%) and an increase in the stem weight (by 0.03 g, or 23%). The surface area of leaf plates was reduced by 1.87 cm2, or 27.8%.

The dynamics of rhizogenesis in plants grown on modified nutrient media of different composition is presented in Table 5.

When growing potato microplants of the Solnechny variety on modified MS medium with a

Табл. 4. Влияние различных составов модифицированной питательной среды на морфологические показатели оздоровленных микрорастений сорта Солнечный на 28-е сутки выращивания

Table 4. Effects of Different Compositions of the Modified Nutrient Medium on Morphological Parameters of Improved Microplants of the Solnechny Variety on the 28th Day of Cultivation

Experiment option	Weight, g				Lamina surface area, cm^2
	roots	sprout	leaves	stem	
1	0,10 ± 0,004	0,24 ± 0,008	0,11 ± 0,004	0,13 ± 0,006	6,74 ± 0,206
2	0,11 ± 0,004	0,30 ± 0,01***	0,13 ± 0,004**	0,17 ± 0,007***	7,57 ± 0,199**
3	0,12 ± 0,005*	0,30 ± 0,01***	0,13 ± 0,003***	0,17 ± 0,007***	7,52 ± 0,188**
4	0,09 ± 0,04	0,21 ± 0,01**	0,10 ± 0,003	0,11 ± 0,005**	6,95 ± 0,184
5	0,11 ± 0,04*	0,28 ± 0,01**	0,14 ± 0,005***	0,14 ± 0,005	8,23 ± 0,225***
6	,05 ± 0,04***	0,22 ± 0,01	0,06 ± 0,004***	0,16 ± 0,008***	4,87 ± 0,213***

reduced concentration of mineral components, acceleration of rhizogenesis was recorded (see Table 5). In addition, acceleration of rhizogenesis was also noted in the variant with reduced amount of agar-agar. Addition of GAs and IAAs resulted in slowing down the process of root formation. While stimulating stem growth, this modified nutrient medium simultaneously suppressed root growth due to the high concentration of gibberellin and led to a decrease in the leaf size, which is expressed in their low weight in this variant of the experiment[5].

When calculating the cost-effectiveness of the use of modified nutrient media of different composition, the cost of individual components of the nutrient medium, as well as disposable consumables required in the preparation of the media (during the preparation of nutrient medium MS with the addition of GAs and IAAs for sterilization of these components it is additionally necessary to use cold filtration filters, the cost of which is 246 rubles. 84 cop. per 1 pc. Two filters are needed to prepare 1 liter of medium). The cost of individual components is presented in Table 6. Calculation results are given in Table 7. Prices as of October 22, 2021

Табл. 5. Влияние различных составов модифицированной питательной среды на число микрорастений картофеля сорта Солнечный с появившимися корнями на разных сроках культивирования

Table 5. Effects of Different Compositions of the Modified Nutrient Medium on the Number of Potato Microplants of the Solnechny Variety, with Roots Formed at Different Stages of Cultivation

Experiment option	Cultivation time, days				
	3	7	14	21	28
1 (control)	19	70	105	105	105
2	29	82	104	105	105
3	29	85	104	105	105
4	23	52	105	105	105
5	40	81	105	105	105
6	10	58	105	105	105

Табл. 6. Стоимость компонентов питательной среды

Table 6. The Cost of Components of the Nutrient Medium

Nutrient medium component	Cost per 1 kg, roubles.
NH_4NO_3	468
KNO_3	440
$CaCl_2\ 2H_2O$	400
$MgSO_4\ 4H_2O$	300
KH_2PO_4	479
H_3BO_3	173
$MnSO_4 \cdot 4H_2O$	1157
$CoCl_2 \cdot 6H_2O$	2980
$ZnSO_4\ 7H_2O$	243
$CuSO_4\ 5H_2O$	724
$Na_2MoO_4\ 2H_2O$	3448
KI	5516
$Fe_2SO_4\ 7H_2O$	318
Na_2–EDTA $2H_2O$	700
Thiamine – HCl	41167
Pyridoxin – HCl	466078
IAA	65496
GA	1484306
Saccharose	586
AC-K	2552
Agar-agar	5700

Табл. 7. Стоимость различных вариантов модифицированной питательной среды

Table 7. The Cost of Different Compositions of Modified Nutrient Medium

Nutrient conditions variant	Cost per 1 l, roubles.
Control	61,96
MS medium with 1/2 content of mineral components	60,94
MS medium with 1/3 content of mineral components	60,60
MS medium with increased content of agar-agar (10 g/l)	79,07
MS medium with reduced agar-agar content (4 g/l)	44,87
MS medium with 3 mg/l GA and 1 mg/l IAA	557,97

[5] Timofeeva O.A., Nevmerzhitskaya Yu. Yu. Clonal micropropagation of plants: teaching aid. Kazan: Kazan University. 2012. 56 p.

were used for the calculations.

The most expensive components of modified nutrient media are GAs, IAAs, Thiamine - HCl, and Pyridoxine - HCl (see Table 6).

From the considered three variants of nutrient medium composition are cheaper than the control: nutrient medium with 1/2 mineral components (by 1 p.02 for 1 l), nutrient medium with 1/3 mineral components (by 1 p.36 for 1 l) and nutrient medium with decreased agar-agar content (by 17 p.09 for 1 l) (See Table 7).

CONCLUSION

The use of a modified nutrient medium with a reduced amount of mineral components (1/2 and 1/3 of MS concentration) for growing potato plants of the Solnechny variety led to an increase in the plant height, increased weight of the root system, leaves and stems of plants, as well as an increase in the surface area of leaf plates of the plants. Cultivation of healthy potato plants on modified nutrient medium with an increased content of agar-agar (10 g/l) led to a decrease in the height of plants and stem weight. The use of a modified nutrient medium MS with a lower content of agar-agar (4 g/l) caused an increase in the root weight, leaf weight and total surface area of leaf plates of potato plants of the Solnechny cultivar. In the variant with the modified nutrient medium with the addition of GAs and IAAs, a significant increase in the plant height, as well as a decrease in the weight of the root system, leaves and the total surface of the leaf plates were observed. In addition, in this variant, an increase in the weight of plant stems was recorded.

When calculating the cost of a modified nutrient medium of different compositions, the modified nutrient medium with the addition of GAs and IAAs was found to be the most expensive variant of those studied; the medium with a reduced amount of agar-agar was found to be the least expensive.

For cultivation of healthy microplants of the Solnechny variety for further cuttings to obtain the maximum number of new plants it is advisable to use a modified nutrient media with a reduced number of mineral components (1/2 and 1/3 parts). When growing plants which are being prepared for further transplanting to aerohydroponic plants to obtain minitubers, a modified nutrient media MS with reduced amounts of mineral components (1/2 and 1/3), as well as with reduced content of agar-agar (4 g/l) are recommended.

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