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Research Article

The New Plant Growth Regulators Based On Derivatives Of Oxazole And Oxazolopyrimidine

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Abstract

In our work to study cytokinin-like activity of chemical low molecular weight heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole we used the specific bioassay conducted on the cotyledons isolated from seeds of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea. The activity of derivatives of oxazolopyrimidine and oxazole was compared with the activity of plant hormone cytokinin Kinetin. The specific bioassay on cytokinin-like activity showed that among derivatives of oxazolopyrimidine and oxazole, used at the concentration 10-9M in water solution, the highest activity on the growth of biomass of cotyledons isolated from seed of muscat pumpkin demonstrated the compounds: the compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-d]pyrimidin-7(6H)-one, which contains phenyl substituent at the 5th position of pyrimidine fragment, the compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-d]pyrimidine, which contains amino group at the 7th position of pyrimidine fragment, and the compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile, which contains tolyl substituent at the 2nd position of oxazole. It is obvious that cytokinin-like activity on the growth of the biomass of cotyledons isolated from seed of muscat pumpkin of derivatives of oxazolopyrimidine may depend on substituents at the 5th and 7th positions of pyrimidine fragment, while as activity of compounds, derivatives of oxazole may depend on substituents at the 2th position of oxazole. The obtained results confirmed the cytokinin-like effect of derivatives of oxazolopyrimidine and oxazole on plant cell elongation, division, and differentiation that are the basic processes of plant growth. The practical application of derivatives of oxazolopyrimidine and oxazole as new plant growth regulators was proposed.

Keywords: Cucurbita moschata Duch. et Poir., cytokinin-like activity, Kinetin, oxazolopyrimidine, oxazole, plant growth regulators

Introduction:

Plant hormones cytokinins take an important part in control of embryo patterning, seed germination, de-etiolation, cell cycle control and protein synthesis, chloroplast differentiation, overcoming of apical dominance, releasing of lateral buds from dormancy, flower and fruit development, delaying of leaf senescence, plant-pathogen interactions, and in vitro morphogenesis in plants [1-5]. In recent years the considerable attention is focused on study of plant growth regulating activity of different classes of low-molecular weight heterocyclic compounds, some of them, belonging to derivatives of oxazolopyrimidine and oxazole, have already found practical application in the agriculture as effective substitutes of plant hormones, herbicides, and antimicrobial agents [6-9].

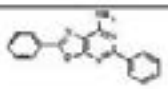
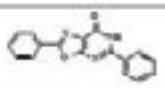
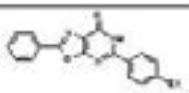
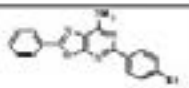
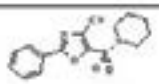
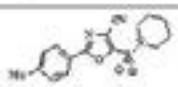
Today the new classes of the plant growth regulating substances are elaborated on the base of chemical low molecular weight five and six-membered heterocyclic compounds synthesized in the Institute of Bioorganic Chemistry and Petrochemistry of National Academy of Sciences of Ukraine. Our numerous researchers showed that different classes of chemical low molecular weight heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole revealed a high stimulating auxin-like and cytokinin-like effect on seed germination and vegetative growth of various agricultural crops [10-14].

The main task of present work was study of the cytokinin-like activities of new chemical low molecular weight heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole using specific bioassay on the isolated organs of pumpkin plants.

Materials and methods:

In our work to study cytokinin-like activity of chemical heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole we used specific bioassay conducted on the cotyledons (i.e. food-storage organs) isolated from seeds of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea. As is known, this bioassay is based on key role of cytokinins in regulation of cell division in isolated plant organs, which leads to an increase in their biomass [1, 15]. The activity of chemical heterocyclic compounds was compared with the activity of plant hormone cytokinin Kinetin. The chemical structure, chemical name and molecular mass (MM) of plant hormone cytokinin Kinetin (N-(2-Furylmethyl)-7H-purin-6-amine), and tested chemical heterocyclic compounds, derivatives of oxazolopyrimidine (compounds № 1-4) and oxazole (compounds № 5 and 6) are shown in the Table 1.

Table 1. Chemical structure of plant hormone cytokinin and chemical heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole

№	Chemical structure of compound	Chemical name and relative molecular mass of compound
Kinetin		[illegible] MM 215.21
1		[illegible] MM 288.31
2		[illegible] MM 289.30
3		[illegible] MM 317.33
4		[illegible] MM 316.37
5		[illegible] MM 317.37
6		[illegible] MM 331.40

To study cytokinin-like activity of chemical low molecular weight heterocyclic compounds, seeds of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea were sterilized in 1 % KMnO4 solution for 3 min and 96 % ethanol solution for 1 min and washed three times in the sterilized distilled water. After this procedure seeds were placed in the cuvettes (each containing 20-25 seeds) on the filter paper moistened with distilled water. Then seeds were placed in the thermostat for their germination in darkness at the temperature 25°C during 96 hours. The 4th-day-old pumpkin seedlings were separated from cotyledons using sterile scalpel. The isolated cotyledons were weighted and placed in the cuvettes (each containing 20 seeds) on the filter paper moistened with distilled water (control) or with water solution of chemical heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole used at the concentration 10-9M, or with water solution of plant hormone cytokinin - Kinetin used at the same concentration 10-9M. Then isolated cotyledons were placed in the plant growth chamber in which they were grown during16 days at above mentioned conditions. To determine indices of growth of biomass (g) of cotyledons isolated from seeds of pumpkin, they were washed with sterilized distilled water and weighted. All experiments were performed in three replicates. Statistical analysis of the data was performed using dispersive Student's-t test with the level of significance at P≤0.05, the values are mean ± SD [16].

Results and Discussion:

The obtained results showed that according to the indices of growth of biomass of cotyledons isolated from seeds of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea during 16 days all tested chemical compounds, derivatives of oxazolopyrimidine and oxazole used at the concentration 10-9M showed the expressive cytokinin-like activity, which was similar or higher of the activity of plant hormone cytokinin Kinetin used at the same concentration 10-9M.

The obtained data of the statistical analysis of indices of growth of biomass of isolated cotyledons of pumpkin showed that the highest cytokinin-like activity revealed the compounds, derivatives of oxazolopyrimidine: the compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-d] pyrimidin-7(6H)-one and compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-d]pyrimidine, as well as the compound, derivative of oxazole: the compound №6 - 2- tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile (Figure 1).

Among the compounds, derivatives of oxazolopyrimidine the compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-d] pyrimidine, which contains amino group at the 7th position of pyrimidine fragment, showed the highest cytokinin-like activity; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №4 were higher at the 40% and 19% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown either on the distilled water (control) or on the 10-9M water solution of cytokinin Kinetin, respectively (Figure 1).

The high cytokinin-like activity demonstrated also the compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4- d]pyrimidin-7(6H)-one, which contains phenyl substituent at the 5th position of pyrimidine fragment; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №2 were higher at the 38% and 17% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown either on the distilled water (control) or on the 10-9M water solution of cytokinin Kinetin, respectively (Figure 1).

The lower cytokinin-like activity showed the compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo [5,4-d]pyrimidin-7(6H)-one, which contains 4-ethylphenyl substituent at the 5th position and oxygen at the 7th position of pyrimidine fragment; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №3 were higher at the 28% and 9% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown either on the distilled water (control) or on the 10-9M water solution of cytokinin Kinetin, respectively (Figure 1).

The lower cytokinin-like activity showed also the compound №1 - 7-amino-2,5-diphenyl[1,3] oxazolo[5,4-d]pyrimidine, which contains phenyl substituent at the 5th position and amino group at the 7th position of pyrimidine fragment; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №1 were higher at the 22% and 4% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown either on the distilled water (control) or on the 10-9M water solution of cytokinin Kinetin, respectively (Figure 1).

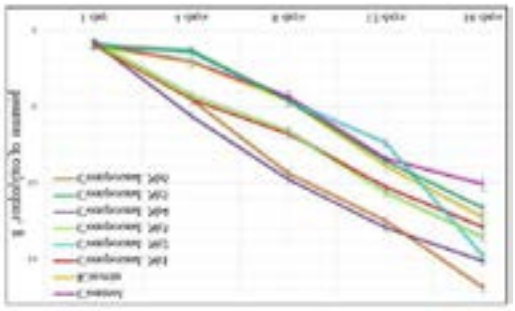


Figure 1.The cytokinin-like effect of chemical heterocyclic compounds, derivatives of oxazolopyrimidine (compound №1 - 7-amino-2,5-diphenyl[1,3]oxazolo[5,4-d]pyrimidine, compound №2 - 2,5- diphenyl[1,3]

oxazolo[5,4-d]pyrimidin-7(6H)-one, compound №3 - 5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4- d]pyrimidin-7(6H)-one, compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-d]pyrimidine), and derivatives of oxazole (compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile and compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile)), and plant hormone cytokinin Kinetin (N-(2-Furylmethyl)-7H-purin-6-amine) on the growth of the biomass of cotyledons isolated from seeds of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea (the biomass was weighted with the interval of each 4 day)

Among the compounds, derivatives of oxazole the compound №6 – 2-tolyl-5-(piperidin-1-ylsulfonyl)- 1,3-oxazole-4-carbonitrile, which contains tolyl substituent at the 2th position of oxazole, showed the highest cytokinin-like activity; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №6 were higher at the 54% and 31% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown either on the distilled water (control) or on the 10-9M water solution of cytokinin Kinetin, respectively (Figure 1).

At the same time the compound №5 - 2-phenyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile that contains phenyl substituent at the 2th position of oxazole revealed lower cytokinin-like activity; the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the 10-9M water solution of compound №5 were higher at the 23% of the indices of growth of biomass of the isolated cotyledons of pumpkin grown on the distilled water (control) (Figure 1).

Conclusion:

Thus, the specific bioassay on cytokinin-like activity showed that among heterocyclic compounds, derivatives of oxazolopyrimidine and oxazole the highest activity on the growth of biomass of cotyledons isolated from seed of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea demonstrated the compounds: the compound №2 - 2,5-diphenyl[1,3]oxazolo[5,4-d]pyrimidin-7(6H)-one, which contains phenyl substituent at the 5th position of pyrimidine fragment, the compound №4 - 7-amino-5-(4-ethylphenyl)-2-phenyl[1,3]oxazolo[5,4-d] pyrimidine, which contains amino group at the 7th position of pyrimidine fragment, and the compound №6 - 2-tolyl-5-(piperidin-1-ylsulfonyl)-1,3-oxazole-4-carbonitrile, which contains tolyl substituent at the 2th position of oxazole. It is obvious that cytokinin-like activity on the growth of the biomass of cotyledons isolated from seed of muscat pumpkin (Cucurbita moschata Duch. et Poir.) cultivar Gilea of chemical compounds, derivatives of oxazolopyrimidine may depend on substituents at the 5th and 7th positions of pyrimidine fragment, while as activity of compounds, derivatives of oxazole may depend on substituents at the 2th position of oxazole.

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