FEATURES OF PRIMARY PROCESSING OF CUT PLANT MATERIALS IN ORDER TO PRESERVE MARKETABLE FRESHNESS

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Introduction. Cut flowers are a special type of product for which traditional methods of preservation inherent in agricultural practice are not always suitable. Unlike crop agricultural products, flowers do not have a dormant period, which makes their long-term storage much more difficult. The introduction of modern technologies and methods of preserving cut flowers in industrial floriculture allows to increase production efficiency, minimize losses and provide consumers with flower products.

The influence of light and temperature on the induction of flowering, the transition from vegetative to floral state, flowering in vitro, flower genetics, as well as issues related to pre-harvest conditions were studied in the works of Teixeira da Silva, J.A. and D.T. Nhut D.T.

Williams M.FI. et al. studied the physiology of aging of cut flowers. Flowers are called climacteric or non-climacteric depending on when the ethylene and respiratory peak occurs during petal wilting. In climacteric species, ethylene production, which is induced in response to ethylene, plays a central role in petal senescence, suggesting its involvement in both the initiation and regulation of senescence, while the activity of ACC synthase and ACC oxidase increases dramatically before senescence begins, which does not occur in nonclimacteric species

Van Doom, W.G. and P. Cruz in their research drew attention to the fact that in the petals of cut flowers that undergo aging, the protein content decreases, the activity of proteases increases, the fluidity of lipids in the membranes decreases and the respiration rate increases. It was found that petal aging is accompanied by morphological, biochemical and biophysical deterioration. In aging carnation flowers, a climacteric increase in ethylene production is observed, and exposure of carnation flowers to exogenous ethylene induces petal curling, triggers ethylene synthesis, and induces chemical and physical changes in the lipids of microsomal membranes of aging petals.

Williams et al. (1995) found that in chrysanthemum, which is not a climatic plant, ethylene does not play a role in flower senescence, with only minor changes in protein content and the ratio of major polypeptides (Williams et al., 1995), which explains the long life of chrysanthemum after harvest. Conditions that inhibit the action of, for example, silver salts, sodium benzoate or boric acid, or ethylene synthesis, for example, by supplying a-amino-oxyacetic acid (AOA), extend the life of carnations in the vase; an invertase inhibitor, which is apparently synthesized in the wilting petals of a number of flowers (morning glory, alstroemeria, carnation, dahlia, gladiolus, petunia, and rose), affects petal aging by blocking the hydrolysis of sucrose to glucose and fructose in aging tissues, which may control the translocation of sucrose from wilting petals to other organs of the flower [.

Rose petal shedding is not affected by water status, as long as the plants do not reach a low water potential at the beginning of their vase life, and are not inhibited by low light intensity and are not dependent on the Pr/Pfr ratio.

Among the Ukrainian studies, Sorokina S.V., Akmen V.O., Letun T.I. devoted their works to the study of storage conditions for preserving the decorative effect of cut roses, noting that the most effective method of storing cut roses is the use of a regulated gas environment in combination with the recommended wet cold storage. Such storage allows to reduce losses by 2-3 times.

An important aspect of the floristic business is a careful attitude to environmental protection. The issue of studying the environmental safety of packaging materials, floral foam, aerosol sprays to make plants look more attractive during sale is devoted to the works of Dontsova V.V., Lebedenets V.T. and Sapozhnyk D.I., Butko M.P. and Solomakha I.V.

Ahmad Iftikhar, Dole J.M., Clarke E.M.R. and Blazic F.A. (2014). investigated the effect of floral foam (Oasis®) with conventional and organic preservatives to determine the optimal treatment for extending the life of cut roses (Rosa × hybrida L.) cultivars 'Freedom' and 'Charlotte'. Overall, floral foam resulted in similar or reduced lifespan in cut roses 'Freedom' and 'Charlotte' placed in pots and had no effect on aging symptoms in either cultivar. 'Freedom' showed more browning of petals and rot, as well as reduced bud opening compared to 'Charlotte'. Vase solutions containing one of the two conventional preservatives resulted in longer vase life for both cultivars than stems in deionized (DI) water. Flower foam saturated with DI water resulted in greater changes in vase solution pH in both varieties. Among the preservatives tested, conventional products such as Floralife Premium Rose Food or Chrysal Rose Vase (each 10 ml/L) extended the life of the arrangement by 5.5 or 3.9 days, respectively; while organic products such as Vita Flora or Vita One Step (each 0.53 ml/L) resulted in statistically similar vase life (9.3 days or 8.3 days, respectively) as stems in DI water (7.5 days), regardless of the use of floral foam. These results indicate that floral foam should not be used when treating cut rose stems after harvest. In addition, conventional preservatives were more effective than organic preservatives.

The current Ukrainian flower market is capable of providing consumers with almost 80% of its own production**.** Ukrainian flower growers are able to produce up to 100 million roses. An important obstacle to filling the domestic market and reaching export capacities is overcoming the barrier of storage time by optimizing storage conditions.

The study of storage conditions for preserving the decorativeness of cut roses is devoted to the work of Sorokina S.V., Akmen V.O., Letun T.I., who noted that the most effective method of storing cut roses is the use of a regulated gas environment in combination with the recommended storage in a wet cold way. Such storage allows to reduce losses by 2-3 times.

The use of optimal flower handling procedures (increased sanitation and innovative preservation using inexpensive and environmentally friendly products) will result in better appearance and longer life of cut flowers, foliage and plants in vases and arrangements. Long-lasting quality flowers mean less wastage in the processing cycle. Ultimately, this means more enjoyment and more satisfaction for the consumer. Understanding the biophysical and genetic mechanisms that control the physiological processes in both flower parts and leaves will allow for the development of new, transgenic varieties with longer cut flower life and better post-harvest characteristics (persistent color, aroma, shape).

The study of ways to extend the life and preserve the decorative properties of cut flowers is inextricably linked to understanding the mechanisms of their aging and wilting. After cutting, the flower-bearing shoot finds itself in conditions that lead to a violation of the water balance. Separated from the root system, the stem with leaves and a flower continues to actively evaporate moisture, especially at high temperatures, but cannot compensate for its loss. The cut site on the shoot is a damaged area that, together with air bubbles, clogs the conducting vessels, making it difficult for water to enter even after immersion in the liquid. An additional factor in the blockage of blood vessels is the active development of putrefactive microorganisms in the aqueous solution.

In addition, after cutting, sap is released from the plant's vessels, resulting in compounds harmful to the flower. Tap water contains calcium, magnesium, fluoride and other elements, the concentration of which can negatively affect cut flowers. All the basic life processes continue to take place in their tissues, but their direction differs from the processes in plants that remain with the root system. After cutting off, the flower shoot loses the ability to receive not only water and nutrients, but also important biological compounds such as hormones, vitamins, and enzymes. Their lack leads to metabolic disorders, the prevalence of decay processes, accelerated aging and wilting of flowers.

The first mentions of using chemicals to extend the life and preserve the quality of cut flowers appeared in the early 20th century in Western Europe and the United States. At that time, flower growers, both scientists and practitioners, were actively researching the effect of various chemical compounds on the duration of preservation of decorative properties of plants. They tested a wide range of substances in an effort to find an effective means to reduce the wilting rate and extend the life of cut flowers.

Among the compounds used, solutions of boric and nitric acids, potassium permanganate and nitrate, sucrose, and aspirin yielded positive results. Their use to increase the freshness of such flower crops as carnation, chrysanthemum, poppy, aster, phlox, and others was particularly notable. However, despite certain successes, all these methods were found to be ineffective for mass use.

In the 1930s, a special nutrient solution for cut flowers was developed in the Netherlands, the main component of which was glucose with the addition of a small amount of mineral salts. It was assumed that this composition would help compensate for the lack of nutrients and prolong the freshness of the plants. However, like many other methods, this solution was not widely used in practice. The main reasons for this were insufficient scientific substantiation of the research, as well as the fact that the tests were mainly on open-pollinated crops, which gradually lost their importance in modern industrial floriculture.

Thus, although the first attempts to use chemicals to extend the life of cut flowers yielded some results, they did not lead to the creation of a universal effective method that could be widely used in industrial floriculture. This was the impetus for further research, which subsequently contributed to the development of more effective technologies and methods for preserving cut plants.

Relatively recently, after flower scientists discovered the main causes of wilting of cut flowers, they began to actively use chemicals and their mixtures to extend their freshness. The individual components of these compounds to a certain extent provide the functions of physiologically active substances, affecting the life processes of plants. Conventionally, these substances are divided into three main groups: substances that slow down metabolic processes - inhibitors and retardants; substances that stimulate metabolic processes and maintain plant viability - plant growth stimulants, physiologically active substances; substances that prevent the development of putrefactive microorganisms - antibiotics, antiseptics, preservatives, etc.

The first group necessarily includes such compounds as maleic acid hydrazide (MHA), chlorocholine chloride, tour (CCC) and its salts, dimethyl succinic acid hydrazide (alar), abscisic and fusaric acids, coumarin, thiouracil, etc. They inhibit the activity of metabolic processes, which allows to extend the freshness of the cut flower.

The second group includes growth stimulants known as cytokinins. One of the most effective representatives of this group is kinetin. In addition, purine and pyrimidine compounds play an important role in maintaining the vitality of flowers, and then they become part of nucleic acids. The treatment of cut flowers with such substances slows down the aging of the tissue, prevents the breakdown of chlorophyll, proteins and organic acids, while activating the synthesis processes in plant cells.

Auxins, such as heteroauxin and gibberellin, are naturally occurring compounds that stimulate cell growth and elongation in plants. without them, other synthetic growth regulators, such as anaphthyllucic acid and 2,4-D derivatives, which do not occur naturally but in small concentrations can have a positive effect on the preservation of the decorative quality of cut flowers.

Organic acids, such as succinic, malic, and citric acids, as well as vitamins, such as ascorbic acid (vitamin C), in combination with other substances, support plant metabolism. Some polyphenols and quinolines are also physiologically active compounds. For example, quinoline derivatives, including 8-oxyquinoline citrate (QC) and 8-oxyquinolinecalcium phosphate (QQP), help regulate water metabolism, reduce vascular occlusion, and slow down the aging process. HC is also noted for its ability to inhibit the development of pathogenic microorganisms.

For the preservation of cut flowers, their ability to absorb nutrient solutions is of great importance, which is significantly increased by the introduction of potassium, sodium, boron, aluminum, etc. into the solution. However, the main energy or nutrient materials for cut flowers are various sugars (sucrose, glucose, fructose, etc.). Many scientists point out that sugars− are a source of energy for maintaining plant life at a certain level - they have a positive effect on the stability of cut flowers, stimulate respiration, reduce evaporation and ethylene emission.

One of the ways to prolong the freshness of cut flowers is to use antimicrobial substances in nutrient solutions, which make up the third group. Studies confirm the effectiveness of compounds such as silver nitrate, salicylic and boric acids, thymol, resorcinol, and potassium permanganate,

To preserve the decorative effect of cut flowers, it is necessary to use all these groups of compounds in combination, observing the optimal combinations and concentrations depending on the type of plant and other factors.

Today, the flower market offers a variety of nutrient mixtures for lengthening cut flowers. The composition and formulation of nutrient mixtures may vary, but the principle of their creation has much in common. Such mixtures must contain carbohydrates (sugars), growth regulators, disinfectants, and substances that promote the transport of nutrients to plants and reduce water hardness.

The concentration of sugars can vary from 1 to 6% (10-60 g/l). Flowers cut in the dense bud phase require more sugars to continue their developmental processes. While for fully opened buds, the concentration can be reduced, after which their growth is completed and metabolic processes slow down.

The formulations of many effective foreign products for preserving cut flowers, such as Chrysal (Netherlands), Flower Food (Canada), Fresh Flower (Germany), Smithers Oasis, Floralife® (USA) and others, are patented and not disclosed. At the same time, various nutrient solutions are used in Ukraine, developed by scientific and research institutions, including Buton, Buton-2, Vitant, Nora, Bouquet. They are suitable for a wide range of cut flowers and have available, safe, and inexpensive ingredients. Studies have shown that Buton and Buton-2 are particularly effective for preserving carnations and roses.

Many domestic and foreign products have a complex formulation, contain expensive and hard-to-find components, and sometimes even toxic substances that can color solutions in undesirable shades or give them an unpleasant odor.

Materials and methods of research. The purpose of the study was to investigate the effect of drugs on the life expectancy of rose and chrysanthemum cuttings using floral foam. The two most popular species were chosen as the material for the study - rose bush and Indian chrysanthemum, which are characterized by multi-flowered shoots.

Indian chrysanthemum (spray) Kennedy White is a variety with small flowers of pale pink color. The flowers have a diameter of 4-5 cm. From 3 to 7 buds are formed on one branch. Shoots up to 70 cm high are sold in florist shops. It is considered one of the most resistant to wilting.

Shrub rose (spray) Snow World® is a peony-like variety characterized by particularly lush flowering. The flowers appear in clusters of 5-20 pieces. The flowers are 5-7 cm in diameter, the petals are delicate, collected in dense buds. The variety is odorless and almost does not form thorns. Cut flowers retain their freshness for a long time, so they are often used to create bouquet compositions.

The research was carried out on cut chrysanthemum and rose stems formed in the form of a stationary floral arrangement based on floral foam. These species and varieties were selected based on the results of a survey of florist shop sellers as the most popular among consumers. To extend the shelf life of cut flowers, we used the most popular preservatives among florists: "Flora Active (dextrose, ammonium sulfate and citric acid), Floral Preservative (carbohydrates, vegetable organic acids, trace elements, phytohormones, water), Chrysal Flower Boost (composition is classified by the manufacturer), Forte (sucrose hydrochloride, alum, boric acid, perfume). The samples were purchased from a flower shop that received the flowers fresh and stored in a professional floristic refrigerator at 4-5 °C for one day. By agreement, the seller did not perform any additional processing of the samples.

The technique of primary processing of flowers, which we carried out at the beginning of the experiment, consisted of renewing the cut with a florist's knife, removing excess leaves from the stem to a height of 15 cm. After purchase, the cut flowers were placed in clean glass vessels with a solution of the preparations. The water used was ordinary tap water to simulate the buyer's home conditions. The water temperature for the experiment was within the recommended range (+12-15 ^{o}C). A pure tap water solution was chosen as a control.

The preparations were dissolved in water in accordance with the recommendations of the manufacturers indicated on the packages: "Flora Active (5 ml per 1 liter of water), Floral Preservative (10 ml per 1 liter of water), Chrysal Flower Boost (5 g of the preparation per 500 ml of water), Forte (15 g per 1.5 liters of water). Floral foam briquettes were kept in the same solutions until they were completely wet. The changes were photographed at intervals of 1-3 days from the date of composition. Changes in the characteristics were recorded according to such parameters as petal color, petal shape, peduncle turgor, leaf turgor, and overall decorativeness was assessed. The results of the study of the preservation of flower decorativeness were based on a scoring system (Table 1).

Results. Floral industry workers and ordinary buyers of floral arrangements are well acquainted with the green, moisture-absorbing blocks used to form floral arrangements − with floral foam. It first entered the flower market in the 50s of the 19th century in the United States of America. It is a by-product of Smithers-Oasis, which accidentally turned out to be useful for packaging and design by modern florists. Not only does it absorb and hold water up to 50 times its weight, but it can also support the stem of a flower or leaf in the right position and allow water to flow to the stem. As a packaging option, it makes it easier to transport flower arrangements by holding the stems in place and preventing water from spilling. These features of floral foam have allowed floral design to move in unusual directions as the arrangement process has become easier and faster, and has allowed for more complex designs. Prior to the invention of floral foam, florists made their arrangements directly in vases or pots of water, using wire or metal pins to secure the stems in the desired position.

By origin, floral foam is a type of foam whose structure is similar to that of a plant stem (Fig. 1), which, according to scientists, is the basis for successful water exchange between them.

Table 1. Scale of preservation of decorative qualities of cut flowers (after K. Lutfullina et al, 2023)

Sign.	**Evaluation points**
Color of the petal	5 - rich, intense, corresponds to the description of the variety; 4 - darkening along the edges of 10% of the petal area; 3 - darkening along the edges of 20% of the petal area; 2 - strong darkening along the edges of 50% of the petal area; 1 - darkening of more than 50% of the petal area
Petal shape	5 - the shape corresponds to the description of the variety; 4 - slight loss of turgor in some petals; 3 - change in shape of all petals, loss of turgor; 2 - twisting the petals to the center; 1 - compression of the petals to the center as much as possible
Turgor of the peduncle	5 - the basket is directed upwards; 3 - there is an inclination of the peduncle; 1 - the basket is directed downward
Condition of the stem	5 - the stem is green, elastic, filled with moisture 3 - darkening appears, begins to lose moisture 1 - drying of the stem, color change to a darker color, the beginning of decay
General decorative effect	5 - rich color of the petals without flaws, the peduncle is directed vertically upwards, the leaves are green, juicy; 4 - slight loss of turgor, darkening on some petals (25%), elastic leaves; 3 - the beginning of petal necrosis, loss of turgor, peduncle bending, leaves 50%; 2 - massive necrosis, severely twisted petals, severe loss of turgor - 75%; 1 - loss of color brightness, strong twisting of petals, peduncle is lowered down, leaves with dry ends twisted - 100%.

The most valuable feature of the marketability of cut flowers is the duration of the inflorescence's decorative effect. We have analyzed the shelf life and dynamics of changes in the state of inflorescences during storage in different solutions. The results of the observations are shown in Table 2.

It should be noted that under the studied storage conditions, both species showed the same inflorescence reactions. The manifestations of the stages of change in decorativeness occurred simultaneously in both the shrub rose and the Indian chrysanthemum. We have presented the average observation periods.

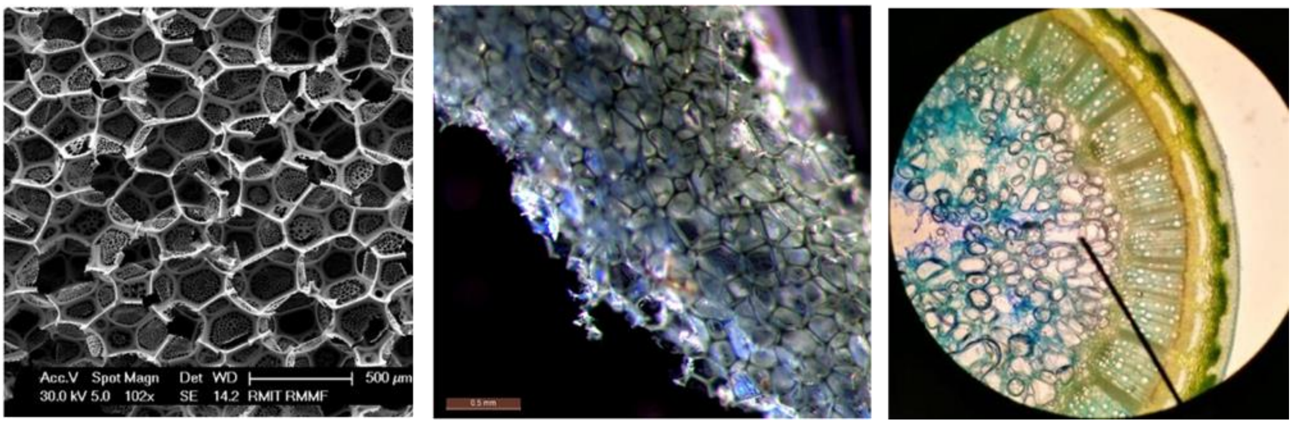

Fig. 1. *The structure of floral foam (1, 2 photos) and a section of a rose stem under a microscope*

The compositions were formed on April 19. They were stored at room temperature away from direct sunlight. The room humidity was standard. No additional treatments were used for the compositions.

Table 2. Average values of the life expectancy of inflorescences of the studied species in the composition on different solutions

Option.	Date of composition filing	Inflorescence stage				Duration. decorativeness, days
		lowering of the petals	curling of petals	loss of color, shape and turgor	darkening, drying out	
Control	19.04	21.04	23.04	27.04	29.04	11
Flora asset	19.04	25.04	29.04	03.05	06.05	17
Floral preservative	19.04	23.04	25.04	27.04	30.04	12
Chrysal Flower boost	19.04	27.04	02.05	06.05	10.05	26
Fleur Eau	19.04	25.04	29.04	02.05	04.05	17

The first signs of petal shape changes began to appear on the control on the third day of storage, when using Floral Preservative on the 5th day. Flora active and Fleur Eau slowed the onset of petal curling to 7 days, and Chrysal Flower boost - to 9 days.

A pronounced loss of decorativeness of inflorescences was observed in the control and soaking in "Floral Preservative", which was 9 days from the date of composition. The darkening and drying of more than 75% of the petal and inflorescence area in these variants was recorded on day 11-12. For the other preparations, the duration of decorativeness was determined to be 17 days for Flora active and Fleur Eau. The use of Chrysal Flower boost made it possible to use the compositions for up to 26 days with a slight loss of overall decorativeness (Fig. 2).

Fig. 2. *Dynamics of decrease in decorative effect of flower arrangements at different*

The results of the observations showed that the rose had an average score of 5 points in terms of color and petal shape in the first five days. Starting from the seventh day, signs of darkening of the petals began to appear, and on the 11th day, darkening of the petals became characteristic of compositions in all solutions, except for "Floral Preservative". The compositions treated with this preparation had a darkening of 50% of the petals, which was evaluated at 2 points.

On the 14th day of observations, the composition formed using "Floral Preservative" received a score of 1, because under its action, mold appeared on the stems and floral foam, which had a very pronounced unpleasant odor. All the other solutions received a total score of 3 points. By day 17, the flowers had completely lost their presentation. Chrysal Flower boost turned out to be the best preparation for preserving cut rose bush peduncles, because it was under its action that the flowers retained their decorative and marketable appearance for the longest time.

The Indian chrysanthemum had an average decorative score of 5 points in the first 7 days based on color and petal shape. Starting from the 11th day, wilting of the petals was observed. On the 14th day, the composition received 1 point for the use of "Floral Preservative", mold appeared on the stems and floral foam and an unpleasant odor was felt.

By day 17, the flowers had completely lost their characteristic varietal color, strong curling of the petals was observed, the peduncles drooped, the edges of the leaf blades dried up and curled on almost 100% of the leaves. The stems became dark in color with signs of decay.

The best preparations for preserving the decorative effect of a composition with chrysanthemum were Chrysal Flower boost, Flora active, and Fleur Eau (Fig. 3).

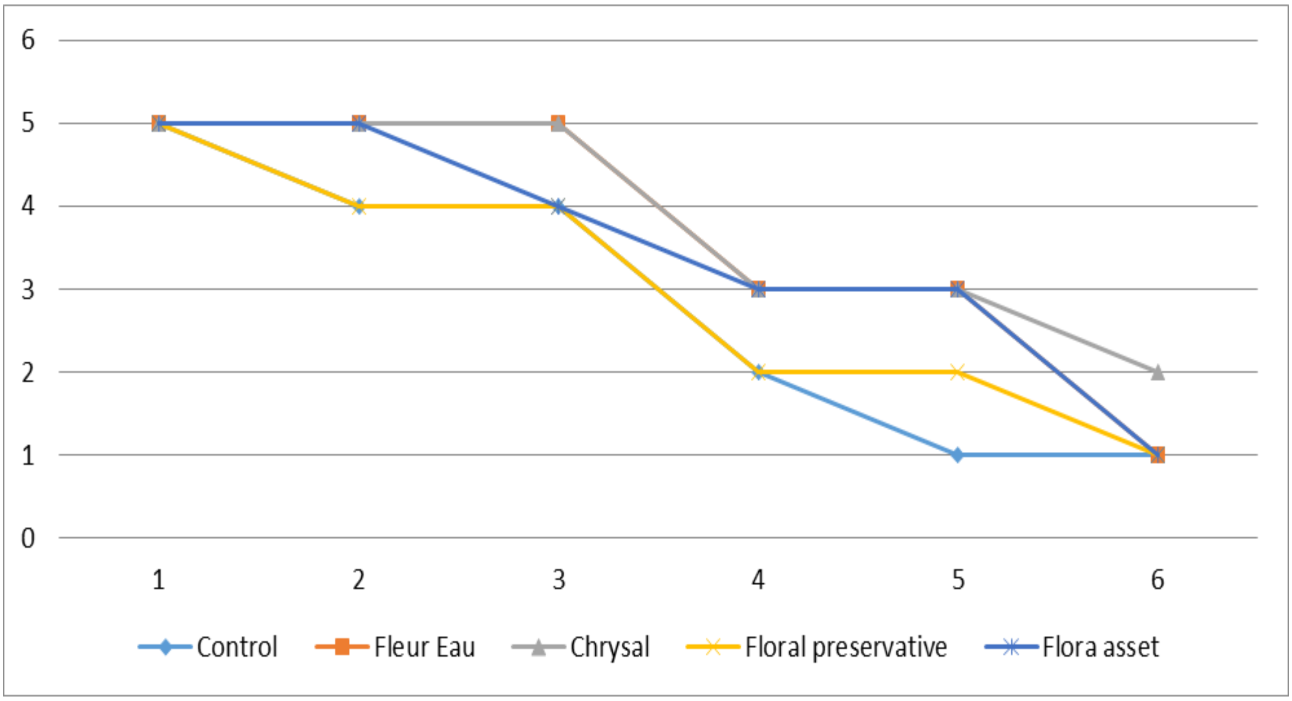

Fig. 3. *Evaluation of the state of turgor of peduncle and stem of rose and chrysanthemum during storage in different preparations, points*

So, in general, we can conclude that the use of preparations to prolong the life of cut flowers has a certain positive effect in the first stages of storage. Soaking a floral sponge in a substrate allows you to preserve the decorative effect of a flower arrangement for 12-26 days, but the first signs of spoilage are observed on day 4-7, regardless of the preparation. The general appearance of flowers at the end of the observations is shown in Fig. 4.

The findings will be of interest to florists and buyers to extend the life and decorativeness of flowers after purchase. Similar research involves a more detailed study of the effect of floral foam on the preservation of cut flowers.

Fig. 4. *Condition of inflorescences of Indian chrysanthemum and rose bush under different storage conditions*

Conclusions. It was found that Chrysal Flower boost was the best among the studied preparations recommended for prolonging the life of flowers after cutting for Indian chrysanthemum and rose bush. The turgor of the peduncle and the condition of the chrysanthemum and rose stem in the first 7 days on the rating scale are 5 points, on the 11th day the darkening of the stem became noticeable, on the 14th day the stem and peduncle acquired signs of darkening (3 points). "Floral preservative" contributed to the formation of mold on the surface of the floral foam, which gave off an unpleasant odor, and the stems began to rot. The use of preparations to prolong the life of cut flowers has a certain positive effect in the early stages of storage. Soaking the floral foam in the substrate allows you to preserve the decorative effect of the flower arrangement for 12-26 days, but the first signs of wilting are observed already on day 4-7, regardless of the use of additional preparations.

REFERENCES

1. Solomakha I., Zhabynska K., Shevchenko K. (2016). Efficiency of appliing of nutrient solution for wet storage of cut carnations remontant. Technical sciences and technologies. №3 (5). S. 210-216
2. Sorokina S.V. (2016). Commodity science of flowers. Kharkiv: KHDUHT. 243 s.
3. Chemistry for cut flowers [Electronic resource]. Available from https://decorize.com.ua/himia-dla-srezannyh-cvetov-podkormka-13264/
4. Yasinskaya A. Cut flowers need care. Electronic resource]. Available from https://zelene.net/interests/pubs/rosliny/poradi-fahivciv-23/zrizani-kviti-potrebuyut-doglyadu.html
5. Ahmad, I., Dole, J. M., Clark, E. M. R., & Blazich, F. A. (2014). Floral foam and/or conventional or organic preservatives affect the vase-life and quality of cut rose (Rosa x hybrida L.) stems. The Journal of Horticultural Science & Biotechnology, 89(1), 41-46. https://doi.org/10.1080/14620316.2014.11513046
6. Begri, F., Hadavi, E., & Nabigol, A. (2014). Positive interaction of ethanol with malic acid in postharvest physiology of cut spray carnation 'white natila'. Journal of Horticultural Research, 22(2), 19-30. https://doi.org/10.2478/johr-2014-0018
7. Chopde N., Dzhadxav Dzh. G., Bxande M. X. (2015). Reakciya kalenduly` na gustotu rastenij dlya proizvodstva srezanny`x czvetov. Arxiv rastenij. 15 (2). 657-660.

8. Dontsova T., Demchenko N. (2004). Green beauty is life: plans and prospects", *Flowers of Ukraine* ["Zelena krasa - ce zhyttja: plany ta perspektyvy", *Kvity Ukrai'ny*]. №. 2, pp. 50-53.
9. Floriculture: Principles and Species by John M. Dole, Harold F. Wilkins. 2005. S 240-268
10. He, S., Joyce, D. C., & Irving, D. E. (2006). Water competition between inflorescences and leaves in cut flowering stems of Grevillea 'Crimson Yul-lo'. The Journal of Horticultural Science & Biotechnology, 81(5), 891-897. https://doi.org/10.1080/14620 316.2006.11512155
11. Junqueira, A. H., & Peetz, M. (2008). Inner market for the products of the Brazilian floriculture: characteristics, trends and recent socio-economic importance. Revista Brasileira de Horticultura Ornamental, 14(1), 37-52. https://ornamentalhorticulture. emnuvens.com.br/rbho/article/viewFile/230/158
12. Junqueira, A. H., & Peetz, M. (2011). Socioeconomic overview of floriculture in Brazil. Revista Brasileira de Horticultura Ornamental, 17(2), 101-108. https://doi.org/10.14295/rbho.v17i2.704
13. Kazaz, S., Kılıç, T., & Şahin, E. G. (2020). Extending the shelf life of cut hydrangea flowers in a vase using preservative solutions. Acta Scientiarum Polonorum, Hortorum Cultus. 19(4), 95-103. https://doi.org/10.24326/asphc.2020.4.9
14. Macnish, A. J., Jiang, C. Z., Negre-Zakharov, F., & Reid, M. S. (2010). Physiological and molecular changes during opening and senescence of Nicotiana mutabilis flowers. Plant Science, 179(3), 267-272. https://doi.org/10.1016/j.plantsci.2010.05.011
15. Nagami X., Sue`naga T., Nakazaki M. (2017). Vozdejstvie pesticidov i sub``ektivny`e simptomy` fermerov, vy`rashhivayushhix srezanny`e czvety`. Journal of rural medicine. 12 (1), 7-11. https://doi.org/10.2185/jrm.2922
16. Negrelle, R., & Anacleto, A. (2012). Bromeliads wild harvesting in State of Paraná. Ciênc. Rural, 42(6), 981-986. https://doi. org/10.1590/S0103-84782012000600005
17. Negrelle, R., & Muraro, D. (2006). Phenological and reproductive aspects of Vriesea incurvata Gaudich (Bromeliaceae). Acta Scientiarum Biological Sciences, 28(2), 95-102. https://doi. org/10.4025/actascibiolsci.v28i2.1011
18. Nguen T. K., i Lim Dzh.X. (2021). Prodlevayut li e`kologicheski chisty`e czvetochny`e konservanty` srok sluzhby` vazy` luchshe, chem ximicheskie rastvory`. Sadovodstvo. MDPI. 2021. https://doi.org/10.3390/ horticulturae 7100415
19. Pattaravayo, R., Ketsa, S., & Van Doorn, W. G. (2013). Sucrose feeding of Cut Dendrobium inflorescences promotes bud opening, inhibits abscission of open flowers, and delays tepal senescence. Postharvest Biology and Technology, 77, 7-10. https://doi.org/10.1016/j.postharvbio.2012.09.014
20. Perik, R. R. J., Razé, D., Ferrante, A., & Van Doorn, W. G. (2014). Stem bending in cut Gerbera jamesonii flowers: Effects of a pulse treatment with sucrose and calcium ions. Postharvest Biology and Technology, 98, 7-13. https://doi.org/10.1016/j. postharvbio.2014.06.008
21. Pietro, J., Mattiuz, B. H., Mattiuz, C. F., & Rodrigues, T. J. (2012). Keeping quality of cut roses cv. Vega in holding solutions. Hortic Bras, 30(1), 64-70. https://doi.org/10.1590/S0102- 05362012000100011
22. Posleuborochnoe kachestvo srezannykh czvetov cinnii, vy`rashhivaemyh pri raznykh urov-nyakh orosheniya i v raznye periody vegetacii. Journal of Selous Chemical Research, 9 (1), 303. https://doi.org/10.5296/jas.v9i1.17996
23. Postharvest Handling and Storage of Cut Flowers, Florist Greens and Potted Plants" by Robert A. Larson. Larson - 2004. [Electronic resource]. Available from https://www.researchgate.net/publication/277732502_Optimizing_Postharvest_Life_of_Cut_Renaissance_Red'
24. Postharvest Physiology and Storage of Tropical and Subtropical Fruits" by Elhadi M. Yahia 2009. [Electronic resource]. Available from
25. Pulido, E., Cuquel, F. L., & Negrelle, R. R. B. (2017). Behavior and postharvest evaluation criteria of Vriesea incurvata Gaudich (Bromeliadaceae) floral scapes. Ornamental Horticulture, 23 (3), 263-269. https://doi.org/10.14295/oh.v23i3.1106
26. Rafdi, H. H. M., Joyce, D. C., Lisle, A., Li, X., Irving, D. E., & Gupta, M. (2014). A retrospective study of vase life determinants for cut Acacia holosericea foliage. Scientia Horticulturae, 180(17), 254-261. https://doi.org/10.1016/j.scienta.2014.10.020
27. Reid, M., & Jiang, C. (2012). Postharvest biology and technology of cut flowers and potted plants. In J. Janek (Eds.), Horticultural reviews (pp. 1-54). Hoboken, John Wiley & Sons. https://doi. org/10.1002/9781118351871.ch1
28. Rubel, F., & Kottek, M. (2010). Observed and projected climate shifts 1901-2100 depicted by world maps of the KöppenGeiger climate classification. Meteorologische Zeitschrift, 19(2), 135-141. https://doi.org/10.1127/0941-2948/2010/0430
29. Sharova O. V., Kurkin V. A. (2007). Flavonoidy` czvetkov kalenduly` lekarstvennoj // Ximiya rastitel`nogo sy`r`ya. (1). 65-68.
30. Tognon, G. B., Amaral, W., Bolzan, R. P., & Cuquel, F. L. (2015). Aesthetic characterization and postharvest performance of Chromolaena laevigata. Acta Horticulturae, 1060, 141-146. https:// doi.org/10.17660/ActaHortic.2015.1060.19
31. Van Doorn, W. G. (1996). Water relations of cut flowers. Horticultural Reviews, 18, 1-85. https://doi.org/10.1002/9780470650608.ch1

32. Verlinden, S., & Vicente García, J. (2004). Sucrose loading decreases ethylene responsiveness in carnation (Dianthus caryophyllus cv. White Sim) petals. Postharvest Biology and Technology, 31(3), 305-312. https://doi.org/10.1016/j. postharvbio.2003.09.010
33. Vexnival S.S., i E`bbi Lord. (2019). Srok godnosti srezanny`x czvetov v vaze - vliyayu-shhie faktory`, metabolizm i organicheskij sostav. Mezhdunarodnyj zhurnal sadovodstva. 3 (6). https://doi.org/10.15406/hij.2019.03.00142
34. Woltering, E. J., Sisler, E. C., Frello, S., & Sriskandarajah, S. (2006). Controlling ethylene responses in flowers at the receptor level. Biotechnology Advances, 24(4), 368-381. https:// doi.org/10.1016/j.biotechadv.2006.01.007
35. Wu, L. Y., Xiao, H., Zhao, W. J., Sun, P., & Lin, J. K. (2016). Effect of green tea extract powder on the vase-life of fresh-cut rose (Rosa hybrida L.) 'Carola' stems. The Journal of Horticultural Science & Biotechnology, 91(3), 279-284. https://doi.org/10.108 0/14620316.2016.1155316
36. Dontsova I. V., Lebedynets V. T, Sapozhnyk D. I. (2024). FRESH CUT FLOWERS: IDENTIFICATION, QUALITY COMPONENTS AND EXPERTISES Herald of Lviv University of Trade and Economics. Technical Sciences. № 37, 19-26. DOI: https://doi.org/10.32782/2522-1221-2024-37-03
37. Ahmad, Iftikhar, Dole, J. M., Clark, E. M. R., & Blazich, F. A. (2014). Floral foam and/or conventional or organic preservatives affect the vase-life and quality of cut rose (Rosa × hybrida L.) stems. The Journal of Horticultural Science and Biotechnology, 89(1), 41-46. https://doi.org/10.1080/14620316.2014.11513046
38. Dole, J. M., Viloria, Z., Fanelli, F. L., & Fonteno, W. (2009). Postharvest Evaluation of Cut Dahlia, Linaria, Lupine, Poppy, Rudbeckia, Trachelium, and Zinnia. *HortTechnology*, *19*(3), 593-600. https://doi.org/10.21273/HORTTECH.19.3.593