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Eco-Friendly Natural Preservatives for Extending the Postharvest Longevity of Cut Flowers

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Abstract: -

Cut flowers are highly valued in the global floriculture industry for their aesthetic and economic importance. However, their postharvest longevity is limited due to physiological deterioration, microbial contamination, water stress, and ethylene sensitivity. Conventional chemical preservatives, though effective, often raise concerns regarding environmental safety, human health, and sustainability. Artificial preservatives (silver nitrate, silver thiosulfate, nano-silver, hydroxy quinoline, thiabendazole, and aluminum compounds) have been used commercially in vases to preserve cut flowers' quality and longevity. However, these preservatives are costly and may linger in the environment, posing serious health risks and polluting the ecosystem. Thus, the cut flower industry looks for inexpensive, safer, and environmentally responsible substitutes. In this regard, natural preservatives (NPs), such as essential oils (EOs) and plant extracts (PEs), present a viable and sustainable substitute for synthetic preservatives in the vase. The potential NPs and their function in improving the quality and vase life of cut flowers are highlighted in this review. We examined the possible problems related to these preservatives as well as how they work to prevent microbial growth, lower ethylene generation, and improve water absorption. In order to improve the vase life of cut flowers in a sustainable manner, we carried out a systematic analysis of the literature, summarized the most popular EOs and PEs, their ideal dosages, efficacy, and combinations, and came to a conclusion.

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Introduction:

Floriculture is a major global industry that boosts the economies of many nations. The cut flower industry is a major player in the global floriculture industry and has grown significantly in both domestic and foreign markets. The floriculture industry is present in more than 145 countries worldwide, with Western nations including the Netherlands, the United States, Colombia, and Italy being the top producers.Two Farmers in developing nations have also turned to the commercial production of cut flowers, and this industry has been steadily expanding. Cut flowers are prized for beautification, social and cultural ceremonies, and expressing love, gratitude, and emotion on a variety of occasions, from a person's birth to their death. They can also be used to welcome and bid farewell to people, enhance the beauty of homes, and be used in social events like weddings and funerals. Postharvest deterioration of cut flowers occurs rapidly due to several physiological and biochemical processes. Once flowers are detached from the parent plant, they lose their natural supply of water and nutrients. This leads to reduced water uptake, stem blockage caused by microbial growth, depletion of carbohydrate reserves, increased ethylene production, and oxidative stress. These factors collectively result in wilting, petal discoloration, bent neck, and premature senescence.

Traditionally, chemical preservatives containing silver nitrate, silver thiosulfate, sucrose, and synthetic biocides have been used to prolong vase life. Although effective, these chemicals may have toxic effects on the environment and human health. Increasing environmental awareness and consumer preference for sustainable products have encouraged researchers to explore eco-friendly natural preservatives as alternatives. Natural preservatives are biodegradable, non-toxic, and often possess antimicrobial and antioxidant properties that enhance flower longevity without causing ecological harm.

For supply chains around the world, ensuring the quality of cut flowers from harvest to vase is a major concern. Value chain participants (growers, distributors, retailers, and consumers) have utilized various floral preservatives at various stages. To lessen flower loss and extend the vase life of cut flowers, chemical preservatives such as silver thiosulfate, silver nitrate, aluminum sulfate, hydroxy quinoline sulfate, hydrogen gas, thiabendazole, and aluminum compounds have been employed extensively. Nevertheless, the floriculture sector has not yet made commercial use of natural preservatives (NPs), such as plant extracts (PEs) and essential oils

(EOs). Because of their possible unsustainability and long-term impacts on the environment and human health, the use of synthetic preservatives raises concerns. Furthermore, the global consumption of synthetic chemicals may be impacted by the European Union's effort to cut chemical usage by 50% by 2030. In this regard, NPs present viable and long-term solutions for prolonging the vase life of cut flowers. Reduced chemical residues in the environment, compatibility with eco-labeling and export standards, enhanced worker and customer safety, and preservation of postharvest quality under commercial handling conditions are just a few of the practical ramifications of applying NPs.

Utilization of floral preservatives

Cut flower vase life varies depending on species, variety, growing environment, preharvest management strategies, harvesting procedures, and postharvest handling techniques (including preservatives). Among these factors, proper floral preservative application is vital for maintaining flower quality and extending vase life. Preservative solutions include sugar, salts, acids, biocides, germicides, and growth regulators. To extend the vase life of cut flowers, sugar-based treatments and disinfectants are commonly used. Sucrose is a key ingredient in vase solutions, which also include biocides, germicides, ethylene inhibitors, and organic acids. Floral preservatives have multiple benefits, including reducing transpiration and senescence, inhibiting ethylene production, increasing water uptake, improving petal color, promoting bud and flower opening, and preventing bacterial growth. Cut flowers are typically treated with three types of preservative solutions: bud-opening, pulsing, and holding. These solutions assist extend vase life. Preservative solutions often contain synthetic biocides or germicides to prevent hazardous bacteria and extend vase life for cut flowers.

The performance of NPs is heavily influenced by the chemistry of the vase water. The electrical conductivity and pH of the vase solution affect water intake, physiological responses of cut flowers, and the stability of NPs in the vase. Acidic vase solutions enhance water intake and inhibit microbial growth, while alkaline or hard water can diminish preservation effectiveness by encouraging mineral deposits in xylem vessels. Although most essential oils are hydrophobic, their effectiveness varies depending on the vase matrix. In water-in-oil emulsions, neutral to low pH and low hardness promote dispersion and stability. Conversely, hard water and high organic loading inhibit solubilization, leading to phase separation and lower bioactivity. However, the impact of vase water chemistry on EO performance in cut flowers is unclear.

Natural Preservatives Used in Cut Flowers

Plant Extracts

Aloe Vera Gel

Aloe vera gel is widely used as a natural preservative due to its antimicrobial and moisture-retaining properties. It contains polysaccharides, vitamins, enzymes, and phenolic compounds that reduce microbial growth and improve water uptake. Studies have shown that aloe vera treatment can extend the vase life of roses and gerberas by maintaining freshness and reducing stem blockage.

Neem Extract

Neem (*Azadirachta indica*) extract possesses strong antimicrobial and antifungal activity. Neem-based solutions help control bacterial contamination in vase water and delay senescence in flowers such as marigold and chrysanthemum.

Moringa Leaf Extract

Moringa leaf extract contains cytokinins, antioxidants, and minerals that delay senescence and improve flower quality. Cytokinins help maintain chlorophyll content and reduce petal wilting.

Obstacles faced by cut flowers in a vase

The shelf life of cut flowers in a vase is significantly impacted by these difficulties. The development and spread of pathogenic microbes near the basal stem end, which causes vascular clogging, is one significant problem. Water absorption and retention are significantly decreased as a result of this obstruction. The cut ends of flower stems can quickly become colonized by microorganisms, which can cause early withering, interruption of water intake, and obstruction of xylem arteries. The main cause of xylem channel blockage, which lowers water's hydraulic conductivity, generates harmful secondary metabolites and ethylene endogenously, and promotes cell wall breakdown, is bacterial development. Cut flowers' vase life is further shortened by water stress brought on by a lack of water. Xylem blockage is also caused by other mechanisms like air embolism and physiological wound healing. Thirty The oxidative stress response and water interactions have an impact on the vase life and quality of cut flowers. Cut flowers experience oxidative stress after harvest, which leads to the generation of reactive oxygen species (ROS), membrane degradation, rapid senescence, and eventually cell death. Oxidative damage results from the ROS's action on membrane lipids, cellular proteins, and nucleic acids. Therefore, limiting oxidative damage and microbial xylem blockage is essential for postponing senescence, preserving floral quality, prolonging the life of flowers in a vase, and guaranteeing their superior quality.

Future Prospects

Advances in biotechnology and nanotechnology may improve the performance of natural preservatives in the future. Nanoemulsions of essential oils, biodegradable packaging materials, and combined treatments using natural compounds could enhance postharvest quality more effectively. Research into synergistic effects among plant extracts, organic acids, and biopolymers may lead to innovative preservative formulations. Consumer demand for sustainable and chemical-free products is expected to drive further adoption of eco-friendly preservation technologies in the floriculture industry. Developing affordable and commercially viable natural preservatives will support environmentally responsible flower production and marketing.

Conclusion

Eco-friendly natural preservatives provide promising alternatives to synthetic chemicals for extending the postharvest longevity of cut flowers. Plant extracts, essential oils, organic acids, natural sugars, and biopolymers effectively reduce microbial growth, improve water uptake, delay senescence, and maintain flower quality. These natural substances are environmentally safe, biodegradable, and compatible with sustainable floriculture practices. Although challenges related to standardization and commercial application remain, ongoing research continues to enhance their effectiveness and practical use. The integration of natural preservatives into postharvest management strategies can contribute significantly to sustainable ornamental horticulture and reduce the environmental impact of chemical preservatives.

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