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SYNERGISTIC EFFECTS OF ESSENTIAL OIL (*MENTHA PIPERITA*) AND 8-HYDROXYQUINOLINE SULPHATE ON POSTHARVEST LONGEVITY OF *ASPARAGUS DENSIFLORUS*

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ABSTRACT

This study investigates the synergistic effects of *Mentha piperita* L. essential oil (EO) and 8-hydroxyquinoline sulphate (8-HQS) on the postharvest quality and longevity of asparagus cut greens (*Asparagus densiflorus*). Ten treatments combining varying concentrations of EO (5%, 10% and 20%) and 8-HQS (25, 50 and 75 ppm) were evaluated. The most effective treatment, T_5 (10% EO and 50 ppm 8-HQS), achieved the longest vase life of 18.65 days, significantly outperforming other treatments, including T_1 (20% EO and 75 ppm 8-HQS), which extended vase life to 16.60 days. T_5 also demonstrated superior preservation of physiological and biochemical parameters, including minimal physiological weight loss (41.87%) and maintained chlorophyll content (1.07 mg/cm²). The results highlight the potential of combining natural essential oils with chemical preservatives to enhance the postharvest quality of ornamental greens, offering a sustainable and effective solution for the floriculture industry. This study provides valuable insights into the optimization of preservative concentrations to maximize vase life while minimizing phytotoxic effects.

Keywords : *Mentha piperita*, 8-hydroxyquinoline sulphate, asparagus, vase life, chlorophyll content and antimicrobial efficacy.

Introduction

Indian floriculture is now viewed as a high growth dynamic industry. The liberalization of industrial and trade policies paved the way for development of export-oriented floriculture. Flower consumption growth raises up to 30 per cent per annum and numerous festivals, along with increasing modernization and per capita income make India a floral super power of the future (Gowthami *et al*., 2021). Among floricultural products, cut foliage plays a pivotal role due to its aesthetic value, including its form, colour, and freshness, which enhance floral designs, bouquets, and wreaths (Gowthami *et al*., 2021). Asparagus fern (*Asparagus densiflorus*) is herbaceous tender evergreen perennial belonging to the family liliaceae is widely used as filler foliage in flower arrangements due to its year-round availability and superior vase life. In hanging pots, its delicate branches provide a wild, natural aesthetic. Despite its versatility, asparagus foliage is highly susceptible to mechanical damage, physical stress and postharvest deterioration caused by microbial infections and vascular blockages. The primary cause of quality decline in cut foliage is microbial accumulation in xylem vessels, which leads to occlusion and disrupts water uptake. Secondary causes include air embolisms and physiological responses to stem cutting (Kazemi *et al*., 2011).

To address these challenges, commercial vase solutions often include sugars, germicides, acids, and plant growth regulators to enhance the longevity of cut foliage. (Kumarihami *et al*., 2017). Sugars serve as an energy source, improving water balance and fresh weight retention (Amin, 2017). Germicides such as 8-

hydroxyquinoline sulphate (8-HQS) act as antimicrobial agents, reducing microbial accumulation and preventing vascular blockage (Hajizadeh, *et al*., 2021). However, concerns regarding the toxicity of silver-based compounds, commonly used in vase solutions, have driven the search for alternative preservatives (Ahmad and Dole, 2014). As alternative to silver compounds, essential oils can also be very effective, even at quite low concentrations; a number of studies have reported that some essential oils considerably prolong vase life (Shanan, 2012). Some herbal extracts and essential oil have antimicrobial properties and are used for their impact on prolonging life after harvesting horticultural products. Essential oils (EOs), which have various anti-oxidant, antibacterial or antifungal properties, are organic or natural products from aromatic and medicinal plants (Teissedre and Waterhouse, 2000; Bayat *et al*., 2013), these can be used as the preservative solutions to control bacterial and fungal pathogens (Hegazi and EL-Kot, 2009; Solgi *et al*., 2009; El-Hanafy, 2007). Essential oils lead to an increase in the permeability of bacteria cell due to the in capability of cell membrane to separate the constituents can lead to destabilization of the phospholipid layer of cytoplasmic this damage causes cell inactivation and/or death (Borges *et al*., 2013). The antimicrobial action of monoterpenes suggest that they can easily diffuse into or penetrate through the damaged cell membrane structures of microorganisms. Therefore, essential oils rich in terpenes have been shown to good possess antibacterial (Hojjati and Barzegar, 2017). In general, EOs act to inhibit the growth of bacterial cells and also inhibit the production of toxic bacterial (Burt, 2004). Therefore, the objective of this study was to examine the possible application and postharvest quality effects of combination of plant essential oil (*Mentha piperita* L.) and chemical preservative (8-HQS) as vase solution and optimal doses were determined for extending the vase life of asparagus cut greens.

Materials and Methods

Source of the asparagus shoots and essential oil

Fresh asparagus cut greens were obtained from department of floriculture and mint (*Mentha piperita* L.) essential oil was procured from department of medicinal and aromatic crops, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India.

Treatment details

The experiment involved ten treatments with three levels (5, 10 and 20%) of mint (*Mentha piperita* L.) essential oil (EO), three levels (25, 50 and 75 ppm) of 8-hydroxyquinoline sulphate (8-HQS) and tap water was served as the control (Table 1). A 2% sucrose solution was maintained constant across all treatments. Fresh asparagus shoots, trimmed to a length of 50 cm, were immersed in 250 ml conical flasks containing the treatment solutions.

Postharvest characters

Vase life (days)

Asparagus shoots were discarded when one third of the foliage was brown or wilted. This stage was considered to be the end of potential useful longevity of the shoot (Safeena, 2013).

Loss of shoot fresh weight percentage (%) (LSFW)

It was determined at the fading stage as the formula (Safeena, 2013).

$$\text{LSFW}\,(\%) = \frac{\text{Initial fresh weight - Final fresh weight}}{\text{Initial fresh weight}} \times 100$$

Relative fresh weight (%) (RFW)

Fresh weight of the shoots was determined just before the immersion of the shoots into the solutions and collected every two days until the vase life of the shoots was terminated. The fresh weight of each shoot was expressed relative to the initial weight to represent the water status of the shoot (Hashemabadi *et al*., 2012).

Relative fresh weight (RFW) = $W_t/W_0 \times 100$

W_t – Weight of the shoot (g) at different intervals

W_0 – Initial fresh weight of the same shoot (g)

Final water uptake (g)

It was calculated at the end of the experiment as the following formula (Koraddi and Devendrappa, 2011).

Water uptake (g) = the amount of solution at the beginning of the experiment - the amount of the solution remaining at the end of the experiment.

Physiological loss in weight (%) (PLW)

The physiological loss in weight (PLW) of whole cut greens was calculated the mean of replicated trials using the formula (Koraddi and Devendrappa, 2011).

$$\text{PLW}\,(\%) = \frac{\text{Initial weight - Final weight}}{\text{Initial weight}} \times 100$$

Chlorophyll content (mg/cm^2)

Chlorophyll content of cut greens measured by using SPAD – 520 plus instrument. Measurements are taken by simply inserting a leaf and closing the measuring head. It is not necessary to cut the leaf, so

the same leaf can be measured throughout the experiment (Ling *et al*., 2011).

Vase solution uptake rate (%) (VSU)

VSU was calculated using the formula below

$$\text{VSU rate} = \frac{\left([(St-1)-St]\times 100\right)}{\text{IFW of stem}}$$

Where (St) is the weight of the vase solution (g) at 2, 4, 6, 8 days, (St-1) is weight of the vase solution (g) on the previous day and (IFW) is the initial fresh weight (g).

Experimental layout and statistical analysis

The experimental layout was a completely randomized design (CRD). It consists of ten treatments with three replicates each replicate contains three shoots. Analysis was done using Web Agri. Stat. Package 2 developed by ICAR research complex, Goa. Interpretation of the data was carried out in accordance with (Panse and Sukhatme, 1985). The level of significance used in 'F' test was 1% level ($P<0.01$). Critical difference values were calculated wherever 'F' test was significance.

Results and Discussion

Vase life (days)

The extended vase life of asparagus shoots was observed in T_5 (18.65) and T_9 (16.73) can be attributed to the optimal balance between antimicrobial efficacy and compatibility with plant tissues. Moderate EO and 8-HQS concentrations may have minimized phytotoxic effects while maintaining sufficient microbial inhibition. Conversely, the slightly lower vase life in T_1 (16.60) may reflect the impact of higher essential oil concentration causing mild stress on plant tissues (fig. 1). This trend aligns with studies emphasizing the importance of optimizing preservative concentrations for maximizing vase life (Singh *et al*., 2022).

Loss of shoot fresh weight % (LSFW)

T_1 resulted in the lowest LSFW (39.93%) suggests that the preservative solution was effective in maintaining shoot hydration and turgidity by preventing vascular blockage through antimicrobial action (Fig. 1). The control's high LSFW (51.65%) underscores the detrimental effects of untreated microbial proliferation on water balance (Gani *et al*., 2018).

Water uptake (g)

The enhanced water uptake was observed in T_1 (76.34 ml) versus the control (36.50 ml) due to the strong antimicrobial action by essential oil, which preserved xylem vessel functionality and minimized microbial blockages. Moderate water uptake in T_5 and T_9 reflects their ability to balance antimicrobial efficacy and tissue health (fig. 2). In contrast, the control's reduced water uptake highlights the impact of untreated microbial growth in compromising vascular conductivity (Gururani *et al*., 2023).

Relative fresh weight % (RFW)

The Relative Fresh Weight (RFW) of shoots in T_1 remained higher throughout the experiment, decreasing from (88.77%) on day 2 to (60.07%) on day 8, whereas the control declined to (34.66%) by day 8. This indicates that the treatment effectively delayed senescence and maintained cellular integrity. T_5 and T_9, though slightly lower, performed effectively in maintaining RFW, possibly due to their balance of antimicrobial action and plant tissue compatibility. The control's steep RFW decline indicates rapid dehydration and senescence caused by microbial blockages (El-Sayed *et al*., 2021).

Physiological loss in weight % (PLW)

At the end of the 8th day, the lowest PLW was recorded in T_5 (4.2%) (Table 2), indicates that moderate EO and 8-HQS concentrations can significantly reduce PLW while avoiding potential stress from higher concentrations (Fig. 3). T_1 (4.5%) also performed well, demonstrating minimized water loss and slower metabolic activity due to effective antimicrobial and preservative action. The control's high PLW (7.5%) reflects accelerated senescence and water loss due to untreated microbial proliferation (Adam, 2021).

Chlorophyll content index (CCI) (mg/cm^2)

The highest CCI values were recorded in T_1, with a final value of (1.45) on day 8, followed by T_5 and T_9. The control exhibited the lowest CCI at (0.72). The higher CCI values in T_1, T_5 and T_9 suggest effective preservation of chlorophyll content and delayed senescence (Fig. 4). The antioxidant properties of mint essential oil likely played a significant role in reducing oxidative damage and preserving chlorophyll. The control's lower CCI underscores the impact of oxidative stress and microbial activity on chlorophyll degradation (Babarabie *et al*., 2016).

Vase solution uptake rate % (VSU)

The highest VSU was observed in T_1 and T_5 (28.74%) on day 2 and T_1 (26.48%) on day 4, followed by T_9 (24.92%). The higher VSU rate observed can be attributed to the combined effect of mint essential oil and 8-HQS in preventing xylem blockage caused by microbial proliferation (Fig. 4). Essential oils, known for their strong antimicrobial properties, reduce

bacterial colonization in the vase solution and prevent occlusion of xylem vessels, ensuring continuous water uptake. This is consistent with findings by (Kumarihami *et al*., 2017). The optimal concentration of essential oil (10%) and 8-HQS (50 ppm) in T_5 likely minimized phytotoxicity while providing sufficient microbial inhibition (Kazemi *et al*., 2011). Similarly, the slightly lower VSU rate in T_1 and T_9 compared to T_5 could be explained by the higher and lower concentrations of essential oil, respectively, which may have caused stress to plant tissues or insufficient microbial control (Hajizadeh *et al*., 2021). Conversely, the control (T_{10}) exhibited the lowest VSU throughout the experimental period, with only 12.84% on day 4, highlighting the detrimental effect of microbial proliferation on water uptake.

Conclusion

This study demonstrates that preservative solution combining *Mentha piperita* L. essential oil and 8-Hydroxyquinoline sulphite significantly enhances the postharvest quality of *Asparagus densiflorus* cut foliage. While the optimal treatment combination (10% essential oil + 50 ppm 8-HQS) significantly enhanced vase life, minimized physiological loss in weight and maintained higher relative fresh weight and chlorophyll content compared to the control. Additionally, T_1 (20% essential oil + 25 ppm 8-HQS) also demonstrated notable improvements in postharvest parameters, though a higher essential oil concentration may have induced mild stress on plant tissues. These findings underscore the potential of combining plant-derived essential oils with conventional antimicrobial agents as an effective alternative to synthetic preservatives. The antimicrobial properties of mint essential oil not only inhibited microbial growth but also preserved xylem vessel functionality, ensuring sustained water uptake and reducing vascular blockages. Furthermore, the study emphasizes the importance of optimizing preservative concentrations to balance antimicrobial efficacy and tissue compatibility, thereby preventing phytotoxic effects offering a sustainable and effective approach for postharvest management in floriculture.

Table 1: Effect of different concentration of essential oil and preservative on vase life (days), loss of shoot fresh weight (LSFW) (%), relative fresh weight (%) and final water uptake (g) of asparagus shoots

Treatments			Vase life	LSWF	Relative fresh weight (%)				Final water uptake (g)
	EO (%)	8-HQS (ppm)	(days)	(%)	D_2	D_4	D_6	D_8	
T_1	**20**	**75**	16.60	39.93	88.77	79.91	69.86	60.07	76.34
T_2	**20**	**50**	11.60	46.27	87.35	77.11	65.55	50.71	53.24
T_3	**20**	**25**	8.56	47.89	73.55	67.27	60.36	47.31	46.80
T_4	**10**	**75**	9.09	49.12	77.48	61.59	55.98	39.41	54.61
T_5	**10**	**50**	18.65	41.87	88.49	79.49	67.98	60.47	71.10
T_6	**10**	**25**	11.47	44.32	78.00	70.54	56.27	44.64	66.60
T_7	**5**	**75**	8.67	50.43	71.63	59.74	50.46	40.53	44.50
T_8	**5**	**50**	12.90	47.88	77.27	68.23	62.49	49.35	51.17
T_9	**5**	**25**	16.73	42.65	72.51	63.57	52.63	39.12	64.63
T_{10}	**0**	**0**	7.40	51.65	70.69	61.60	48.34	34.66	36.50
Mean			**12.16**	**45.40**	**78.58**	**68.90**	**58.99**	**46.62**	**56.55**
S.Em ±			0.84	0.67	0.76	0.70	0.54	0.33	0.42
CD@1%			**3.24**	**2.26**	**3.13**	**2.87**	**2.22**	**1.35**	**1.74**

Table 2: Effect of different concentration of essential oil and preservative on physiological loss in weight (%), Chlorophyll content index and vase solution uptake rate of asparagus shoots

Treatments	Physiological loss in weight (%)				Chlorophyll content index (CCI) (mg/cm^2)					Vase solution uptake rate (VSU %)			
	D_2	D_4	D_6	D_8	D_0	D_2	D_4	D_6	D_8	D_2	D_4	D_6	D_8
T_1	1.1	2.1	3.5	4.5	3.15	2.40	2.15	1.80	1.45	28.74	26.48	22.12	18.06
T_2	1.7	3.4	4.6	5.9	2.25	1.42	1.30	1.15	1.00	22.87	18.37	15.68	12.74
T_3	1.5	3	4.8	6.5	1.85	1.95	1.70	1.45	0.90	20.54	15.29	13.42	10.58
T_4	1.3	3.2	3.8	5.0	2.15	1.45	1.30	1.10	0.75	19.42	13.82	11.74	8.96
T_5	1.0	1.8	2.9	4.2	2.55	1.65	1.50	1.15	1.07	28.74	24.92	20.65	17.5
T_6	2.0	3.8	6.1	7.2	1.70	1.60	1.40	1.25	0.80	23.45	20.65	18.42	14.62

T_7	1.4	2.9	4.3	6.0	2.00	1.55	1.35	1.05	0.70	17.80	14.74	12.88	9.84
T_8	1.5	3.0	5.1	6.8	1.85	1.75	1.55	1.30	0.90	21.38	19.38	16.72	13.48
T_9	1.8	3.2	4.9	6.1	1.71	1.90	1.55	1.20	1.05	26.48	24.92	20.92	16.74
T_{10}(Control)	1.1	2.1	4.8	7.5	2.40	2.00	1.75	0.90	0.72	15.92	12.84	10.64	8.56
Mean	**1.44**	**2.85**	**4.48**	**5.97**	**2.16**	**1.77**	**1.56**	**1.24**	**0.93**	**22.83**	**19.97**	**16.92**	**13.91**
S.Em ±	0.05	0.06	0.05	0.03	0.06	0.05	0.06	0.05	0.05	0.62	0.48	0.38	0.26
CD@1%	**0.22**	**0.25**	**0.20**	**0.12**	**0.23**	**0.21**	**0.24**	**0.22**	**0.21**	**2.48**	**1.93**	**1.52**	**1.04**

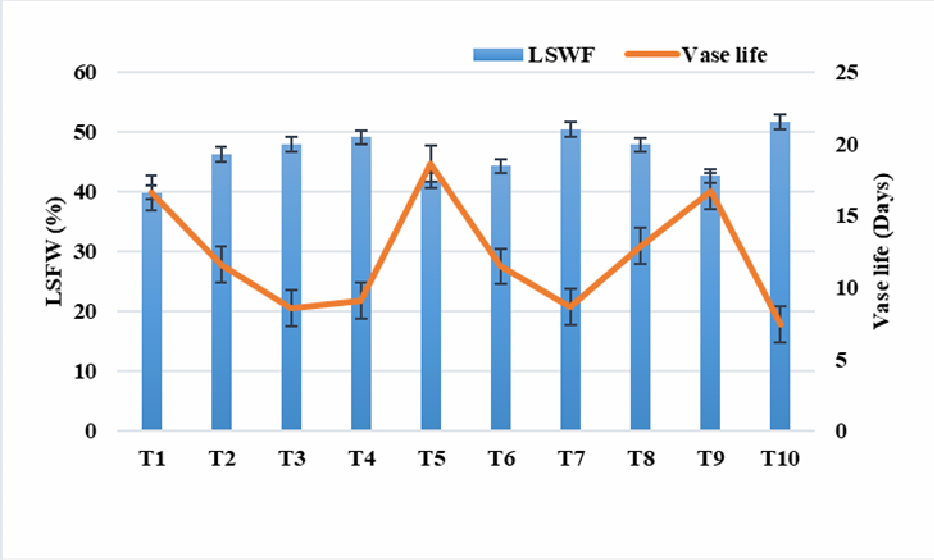

Fig. 1: Vase life and loss of shoot fresh weight (%) of asparagus shoots treated with different concentrations of essential oil and 8-hydroxyquinoline sulphate

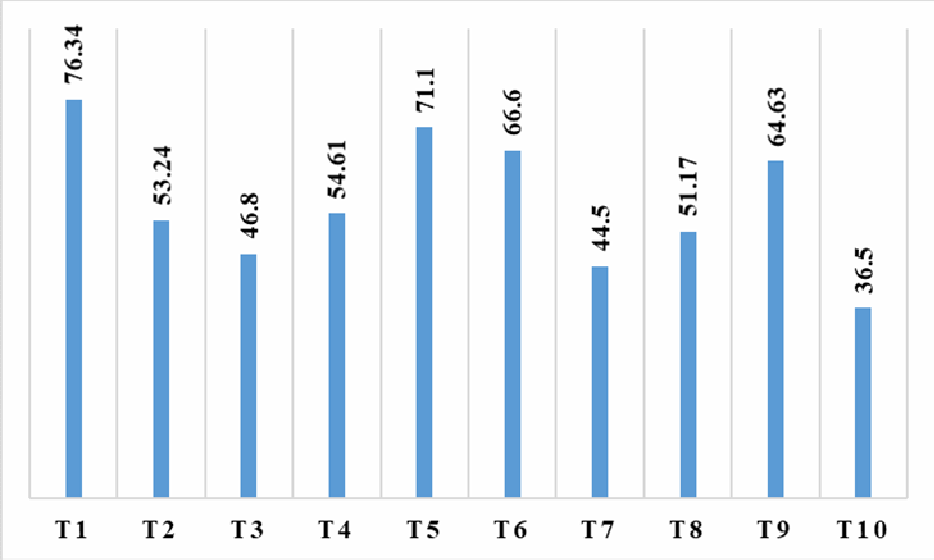

Fig. 2: Water uptake (g) of asparagus shoots under various treatments of essential oil and 8-hydroxyquinoline sulphate

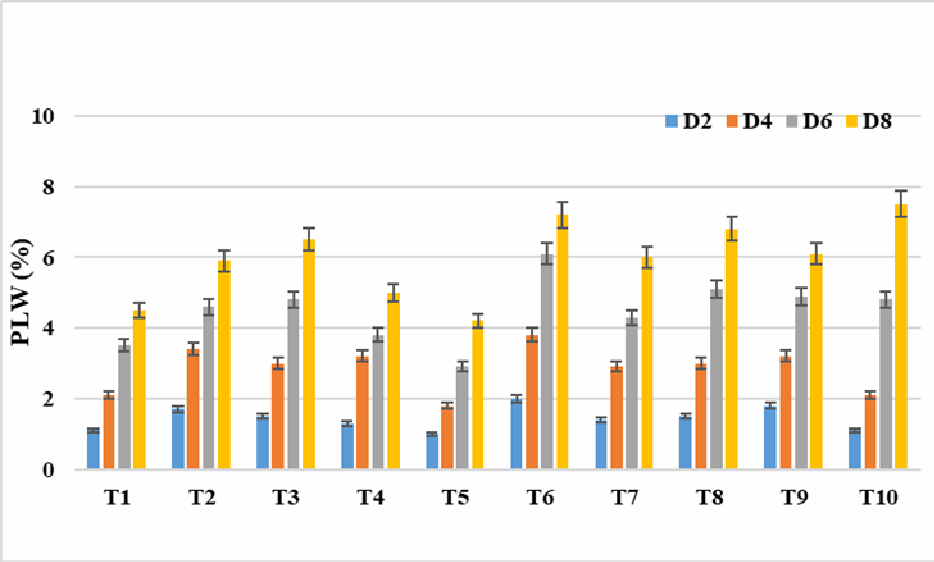

Fig. 3: Physiological loss in weight (PLW) of asparagus shoots with different treatments of essential oil and 8-hydroxyquinoline sulphate

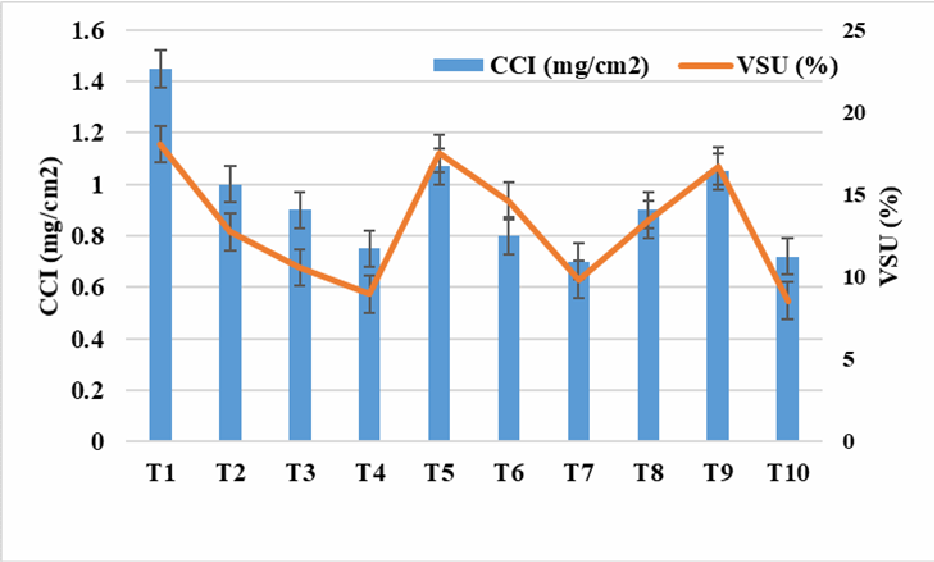

Fig. 4: Chlorophyll content index (CCI) and vase solution uptake rate (VSU %) in asparagus shoots treated with essential oil and 8-hydroxyquinoline sulphate

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