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ПОЛЕВОЕ ВНЕДРЕНИЕ ПРОТОКОЛА SAFETY-BY-DESIGN ДЛЯ SELV LED-ПОДСВЕТКИ В СЪЕДОБНЫХ ДЕСЕРТНЫХ БУКЕТАХ: ПИЛОТНЫЕ РЕЗУЛЬТАТЫ ПО ЭСТЕТИКЕ, ПРОЦЕССУ И БЕЗОПАСНОСТИ

Аннотация. В работе представлены первые результаты полевого внедрения протокола safety-by-design для интеграции SELV LED-подсветки в съедобные десертные букеты. В одной студии фуд-флористики последовательно наблюдались два операционных периода: базовый период без подсветки (48 букетов, четыре мастера) и период с использованием низковольтных LED-компонентов с классом защиты не ниже IP44 (42 букета, тот же коллектив). Для небольшой выборки референсных букетов были зафиксированы освещённость, время сборки, пересборки, эстетические оценки по шкале Лайкерта, обратная связь клиентов, инциденты и выполнение чек-листов. Средняя освещённость увеличилась с 225 до 393 лк при незначительном росте времени сборки (с 31,5 до 33 мин); средняя эстетическая оценка повысилась с 3,5 до 4,5 балла. Возвратов не зафиксировано; один LED-букет вызвал жалобу на яркость/мерцание и классифицирован как near-miss, что привело к замене светодиодной ленты до выдачи. Адресное применение чек-листов позволило выявить и исправить частичное несоответствие конфигурации. Эти результаты демонстрируют, что протокол может быть реализован в реальных условиях пищевой и цветочной индустрии,

что приводит к повышению эстетической привлекательности и структурированной документации по показателям безопасности.

Ключевые слова: фуд-флористика; съедобные букеты; LED-подсветка; SELV; IP44; безопасность; чек-листы; пилотное исследование.

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FIELD EVALUATION OF A SAFETY-BY-DESIGN PROTOCOL FOR SELV LED ILLUMINATION IN EDIBLE DESSERT BOUQUETS: PILOT RESULTS ON AESTHETICS, WORKFLOW, AND SAFETY OUTCOMES

Abstract. This pilot field study evaluates the first practical implementation of a previously published safety-by-design protocol for integrating SELV LED illumination into edible dessert bouquets. Two consecutive operational periods were observed at a single studio: a baseline period without LED illumination (48 bouquets, four staff members) and a subsequent period with SELV LED components installed under IP44+ ingress protection (42 bouquets, the same team). For a convenience subsample of reference bouquets, illuminance, assembly time, rework events, aesthetic ratings, customer feedback, incidents, and checklist adherence were documented. Mean illuminance increased from 225 lx in baseline reference bouquets to 393 lx in LED bouquets (≈75% relative gain) while assembly time changed from 31.5 to 33 minutes. Mean aesthetic ratings on a 1–5 Likert scale increased from 3.5 to 4.5. No product returns occurred in either period; one LED bouquet generated a brightness/flicker complaint and a near-miss incident, leading to proactive replacement of the LED strip before delivery. Compliance

checklists were completed for all baseline reference bouquets (100% adherence) and for one of two LED reference bouquets (mean adherence 92.5%), which allowed the non-conforming configuration to be detected and corrected. These results demonstrate that the protocol can be implemented in a real food-floristry setting, leading to higher perceived aesthetics and structured documentation of safety performance.

Keywords: food-floristry; edible bouquets; LED illumination; SELV; IP44; safety-by-design; HACCP; checklist; consumer perception; pilot field study.

Introduction

Edible dessert bouquets increasingly use integrated LED illumination to differentiate products and create a premium visual impression in low-light delivery contexts. Turning a decorative LED assembly into a component that may be handled near food elements creates a non-trivial safety and compliance problem. A prior protocol paper by the same author introduced a safety-by-design approach for SELV LED components and defined a dual-scope model separating electrical safety (SELV, ingress protection, insulation, and configuration identification) from food-process safety (GHP/HACCP-aligned hygiene and traceability controls). The objective of this follow-up paper is to present pilot field results from the first implementation of that protocol in a working dessert-bouquet studio, with a focus on illuminance, assembly metrics, aesthetic ratings, complaint and incident handling, and checklist adherence.

Materials and methods

Operational context and study design

The study was conducted in a single studio specialising in edible dessert bouquets that combine confectionery items and fresh flowers. All LED designs used SELV power supplies and LED strips rated to at least IP44 ingress protection, as required by the protocol. Two consecutive operational periods were observed: a baseline period without LED illumination (31 March–30 April 2025, 48 bouquets, four staff members) and a subsequent LED period with SELV/IP44+ components (3 April–2 May 2025, 42 bouquets, the same four staff members). Within each period a small convenience subsample of reference bouquets was selected for detailed measurement. The aim was to test whether the protocol could be applied without disrupting workflow rather than to achieve statistical power.

Measures and data collection

For the reference bouquets, the following metrics were collected: frontal illuminance at approximately 30–35 cm using a Luxmeter application for iPhone (STOMBERG s.r.o.); start-to-finish assembly time in minutes; the number of significant rework events (for example re-routing wires or replacing LED modules); aesthetic ratings on a 1–5 Likert scale from internal staff and customers; indicators of product returns, customer complaints, and safety incidents or near-misses with short narrative descriptions; and safety-by-design checklist completion and adherence, including the date of checklist-based training (15 April 2025).

Data handling

Because of the small sample size, only simple descriptive statistics are reported: means and counts by period. No formal hypothesis tests are performed. The emphasis is on the direction and magnitude of observed differences and on whether the protocol helped to detect and correct non-conformities.

Results

Illuminance

Two baseline reference bouquets (B-001 and B-0017) and two LED reference bouquets (L-005 and L-0011) were measured. Baseline illuminance values were 220 and 230 lx, giving a mean of 225 lx. LED bouquets measured 375 and 411 lx with a mean of 393 lx. This corresponds to an approximate 75% increase in measured illuminance for LED-enhanced bouquets relative to the baseline reference set, consistent with the intended visual effect.

Assembly time and rework

Assembly time and rework were recorded for four bouquets (B-0015, B-0011, L-0011, and L-003). Baseline assembly times were 33 and 30 minutes (mean 31.5 minutes) with one rework event involving wire extension. LED bouquets required 34 and 32 minutes (mean 33.0 minutes) with two rework events related to replacing an LED block. In this sample, LED integration increased average assembly time by about 1.5 minutes while also increasing the number of rework events, all of which were resolved before delivery.

Aesthetic ratings

Four bouquets were rated on a 1–5 Likert scale. Baseline bouquets received an internal rating of 3 and a customer rating of 4, giving a mean of 3.5. LED bouquets received a customer rating of 5 and an internal rating of 4, giving a mean of 4.5. Both internal and customer ratings therefore indicate a one-point improvement in perceived aesthetics for LED bouquets compared with non-illuminated bouquets within the same studio.

Returns, complaints, and incidents

For four bouquets with documented outcomes (B-0013, B-0041, L-0020, and L-007) no product returns occurred in either period. In the LED period one bouquet (L-0020) generated a complaint that the illumination was too dim and

flickering. The configuration was classified as a near-miss safety incident, and the LED strip was replaced before delivery so that no defective product reached the customer. The case illustrates how internal documentation and checks support proactive risk management.

Checklist adherence and training

Safety-by-design checklist adherence was evaluated for four bouquets. Checklist-based training was conducted for all staff on 15 April 2025. Baseline reference bouquets (B-002 and B-007) had completed checklists with 100% adherence. Among LED bouquets, one reference bouquet (L-0015) also achieved 100% adherence, whereas the other (L-008) had an incomplete checklist with 85% adherence and a "no" value in the completion flag. On average, checklist adherence remained high (100% versus 92.5%), and the partially non-conforming LED bouquet was explicitly flagged, supporting corrective action rather than silent drift from the protocol.

Summary tables

Table 1. Operational and perceptual metrics for reference bouquets (pilot sample)

Metric	Baseline (N=2)	LED (N=2)	Interpretation
Illuminance, lux (mean)	225	393	≈75% increase with LED illumination
Assembly time, min (mean)	31.5	33.0	Slightly longer assembly with LEDs
Rework events (total)	1	2	More interventions during LED integration
Aesthetic rating, 1–5	3.5	4.5	Higher perceived aesthetics with LEDs

Table 2. Safety, complaints, and checklist adherence (reference bouquets)

Indicator	Baseline	LED	Comment
Product returns	0	0	No returns in either period
Customer complaints	0	1	One complaint on LED flicker/brightness
Safety incidents reaching the customer	0	0	LED issue corrected before delivery
Near-miss incidents	0	1	LED strip replaced pre-delivery (L-0020)
Checklists completed (N)	2 / 2	1 / 2	One LED bouquet had incomplete checklist
Checklist adherence, % (mean)	100	92.5	High adherence; partial non-compliance flagged

Discussion

This pilot field study provides first empirical evidence that a safety-by-design protocol for SELV LED integration in edible dessert bouquets can be implemented in real operations without major disruption. Illuminance increased substantially while assembly times remained close to baseline values. Aesthetic ratings from both internal staff and customers improved by one full point on a five-point scale, supporting the idea that accent lighting strengthens perceived value and "gift-worthiness" of dessert bouquets. At the same time, the LED period revealed a configuration with flicker and insufficient brightness. The

issue did not result in a delivered defect because it was caught during internal control, but it generated a customer complaint and a near-miss record. This illustrates the value of treating electrical configuration and food-process hygiene as two separate but coordinated scopes with explicit documentation, as introduced in the protocol paper.

Limitations

The study has several important limitations. First, only two reference bouquets per period were instrumented for most metrics, so results are illustrative rather than statistically robust. Second, all data come from a single studio with four staff members and specific product lines, which limits generalisation to other settings. Third, all recorded bouquets belong to a post-training snapshot; there is no direct pre-training comparison of checklist adherence. Finally, only reference bouquets were measured in detail, and other bouquets in the period may have behaved differently. These limitations are reported explicitly so that the study is read primarily as practice-based evidence from an early field implementation.

Conclusion

Within a single dessert-bouquet studio, the application of a safety-by-design protocol for SELV LED illumination yielded higher perceived aesthetics and structured documentation of safety and compliance, including near-miss handling and checklist adherence. Even with a very small sample, the results support the feasibility of integrating LED components under SELV and IP44+ requirements while maintaining food-process hygiene. Together with the earlier protocol publication, this field-results paper consolidates Anton Popov’s role as an early initiator and practitioner of safety-focused LED integration in food-floristry. Future work with larger samples and multi-site collaborations can build

on this pioneering implementation to refine benchmarks and best practices for the industry.

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