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INTEGRATING SELV LED ACCENT LIGHTING INTO EDIBLE DESSERT BOUQUETS: A SAFETY-BY-DESIGN PROTOCOL AND CONSUMER-PERCEPTION STUDY FOR CONFECTIONERY FOOD-FLORISTRY

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Abstract

Confectionery food-floristry (edible dessert bouquets and related compositions) increasingly competes on visual impact and customer experience, while remaining constrained by safety requirements when electrical components are introduced for accent lighting. This paper proposes a safety-by-design protocol for integrating extra-low-voltage (SELV)[5,9] LED lighting into edible dessert bouquets and outlines a mixed study design to quantify (i) perceived aesthetics, (ii) operational efficiency, and (iii) safety outcomes under explicit electrical and food-safety scopes. This paper formulates testable hypotheses for a planned evaluation: H1 - accent lighting is expected to increase perceived aesthetics; H2 - when a SELV supply and at least IP44[2–4] ingress protection are verified and documented, the incidence of reportable electrical safety incidents is expected to be negligible (and may not be detected) within the predefined observation window; H3 - maker checklist adherence is expected to improve after targeted training. The protocol uses objective and business-relevant metrics (illuminance, assembly time, errors/rebuilds, returns/complaints) plus Likert-scale[6] aesthetic ratings. The framework is intended as an industry standard for emerging LED-enhanced food-floristry and as an evidence basis for documenting original contributions in a cross-disciplinary creative-technical market.

Keywords: confectionery food-floristry; LED accent lighting; SELV; IP rating; IP44; safety-by-design; HACCP; GHP; consumer perception; operations metrics.

1. Introduction

Confectionery food-floristry combines pastry craft, floristic composition principles, packaging engineering, and customer-experience design. As competition increases, visual differentiation becomes a primary lever. LED accent lighting can amplify perceived depth, contrast, and premium feel; however, the introduction of electrical components into products that may include edible items raises safety, compliance, and reputational risks. This paper addresses the practical question: how can LED lighting be introduced in a way that is measurable, repeatable, and auditable - without blurring electrical safety with food safety responsibilities?

This paper contributes: (i) a scope-separated compliance model (electrical safety vs. food-process safety), (ii) a measurement framework aligned with business outcomes and customer perception, and (iii) a training-and-checklist mechanism designed to reduce process variance and error rates.

2. Background and positioning

In practice, most “LED bouquet” implementations are ad-hoc: lighting is added for marketing effect, while documentation of voltage class, enclosure protection, and assembly controls is inconsistent. The absence of standardized checklists limits scalability and increases the risk of defects, customer complaints, and safety incidents. The proposed protocol is designed to be implementable in small creative studios and scalable to multi-maker teams.

3. Research questions and hypotheses

Hypothesis	Operational meaning	Primary measures
H1: Lighting increases perceived aesthetics	LED accent lighting improves visual appeal and premium perception versus a non-LED baseline.	Likert rating (1–5); blind panel comparison; customer post-purchase rating.[6]
H2: Safety incidents are expected to be rare under SELV + IP44 verification	When electrical controls are followed and documented, reportable incidents/near-misses are expected to be rare (and may not be detected) within the planned observation window.[2–5,9]	Incident and near-miss log; defect/safety returns; checklist pass rate.
H3: Checklist adherence is expected to increase after training	Short training + standard checklist reduces variance and improves compliance behaviors.	Pre/post adherence rate per checklist item; error/rebuild count; assembly time.

4. Materials and Methods (protocol)

4.1 Product configurations

Two configurations are compared: (A) baseline bouquets without lighting, and (B) LED-enhanced bouquets using an extra-low-voltage (SELV) supply and verified enclosure ingress protection (minimum IP44).

4.2 Electrical scope (SELV + enclosure protection)

The electrical scope includes voltage class, isolation, cable routing and strain relief, connector integrity, and enclosure protection against ingress. The IP code is defined in IEC 60529[3] and adopted in the GOST 14254-2015[2] standard. SELV[5,9] is used as a safety concept to reduce shock hazard in higher-risk environments.

4.3 Food-safety scope (GHP / HACCP)

Food safety controls remain a separate scope: hygiene, allergen management, cleaning and sanitization of tools and surfaces, prevention of physical contamination, and traceability. Where edible components are present, the protocol uses Good Hygiene Practices (GHP)[1] and the HACCP[1] approach (hazard analysis and critical control points) as organizing principles. The FDA Food Code[7,8] is referenced as a model for retail and food-service handling.

4.4 Study design and sampling

A mixed design is recommended: (i) controlled evaluations (photo-based or in-person) to measure perceived aesthetics under standardized lighting conditions, and (ii) operational tracking across real orders. At minimum, track N1 baseline orders (non-LED) and N2 LED orders before training, then conduct a short training session and track N3 LED orders after training.

4.5 Measurement plan

Metric	Unit/Scale	How measured	Business relevance
Illuminance	lux	Measure at fixed distance/angle (e.g., 30 cm from focal point) in consistent ambient conditions.	Consistency and visual impact control.
Assembly time	minutes	Timer from start of assembly to packaging completion.	Labor cost and throughput.
Errors / rebuilds	count	Record rework events (wiring, placement, packaging defects).	Quality cost and standardization.
Aesthetic rating	Likert 1–5[6]	Customer survey or blind panel rating with standardized criteria.	Conversion, referral, premium pricing.
Returns / complaints	count / %	CRM log; categorize reasons (quality, damage, safety concern).	Reputation and unit economics.
Checklist adherence	%	Per-item completion verified by supervisor/self-audit.	Risk reduction and scalability.

4.6 Analysis plan (minimum)

Compare baseline vs LED for aesthetics (H1) using mean/median differences; if multiple covariates exist (bouquet size, complexity, seasonality), apply regression with controls. Evaluate training effects (H3) with pre/post comparisons of adherence and error rates. Safety outcomes (H2) should be reported transparently as incidence counts and exposure time; avoid absolute claims and specify the observation window.

5. Figures (schematics)

Figure 1. Conceptual model linking LED integration to perception, operations, customer outcomes, and compliance levers.

Figure 1. Conceptual model: LED integration, outcomes, and compliance levers

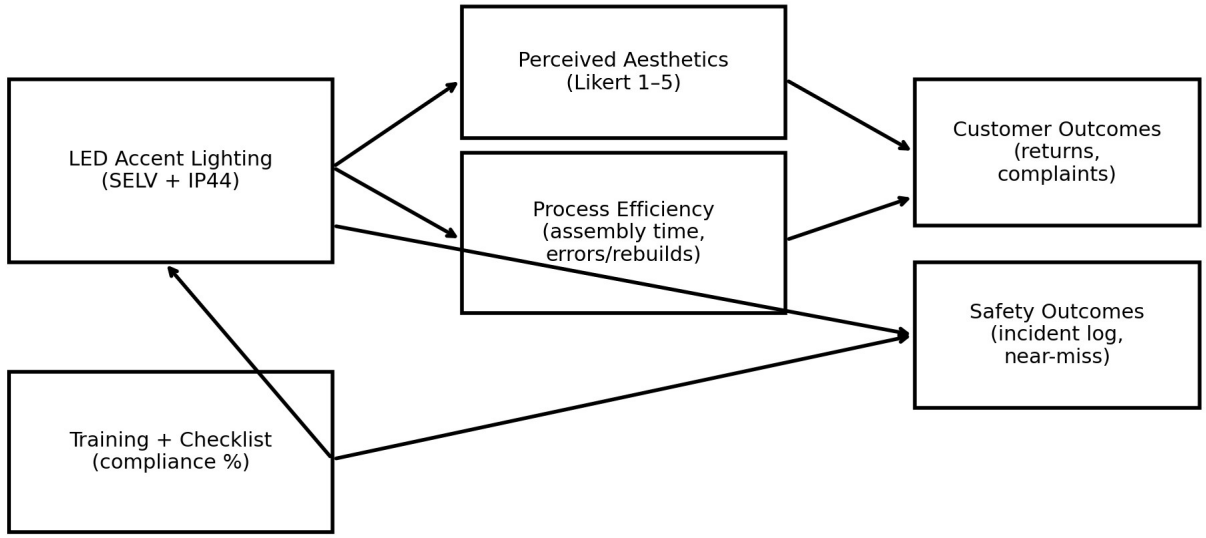


Figure 2. Study design: baseline vs LED intervention, training, and post-training tracking.

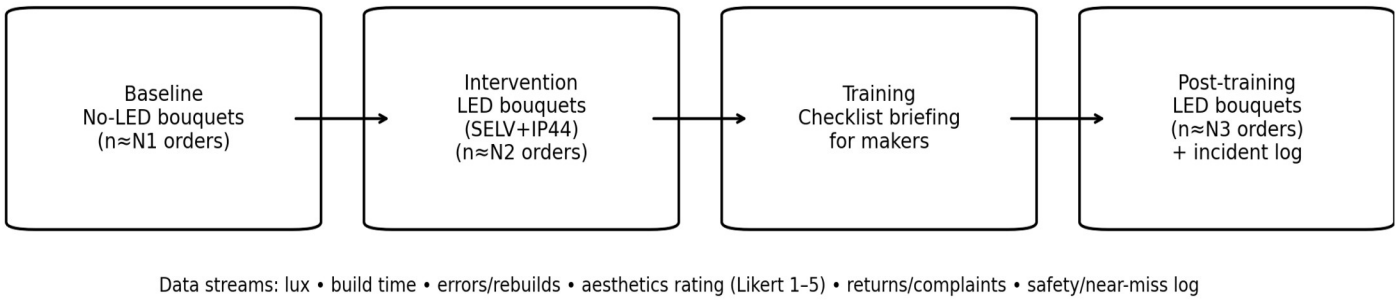


Figure 3. Scope separation: electrical safety controls vs food-safety controls.

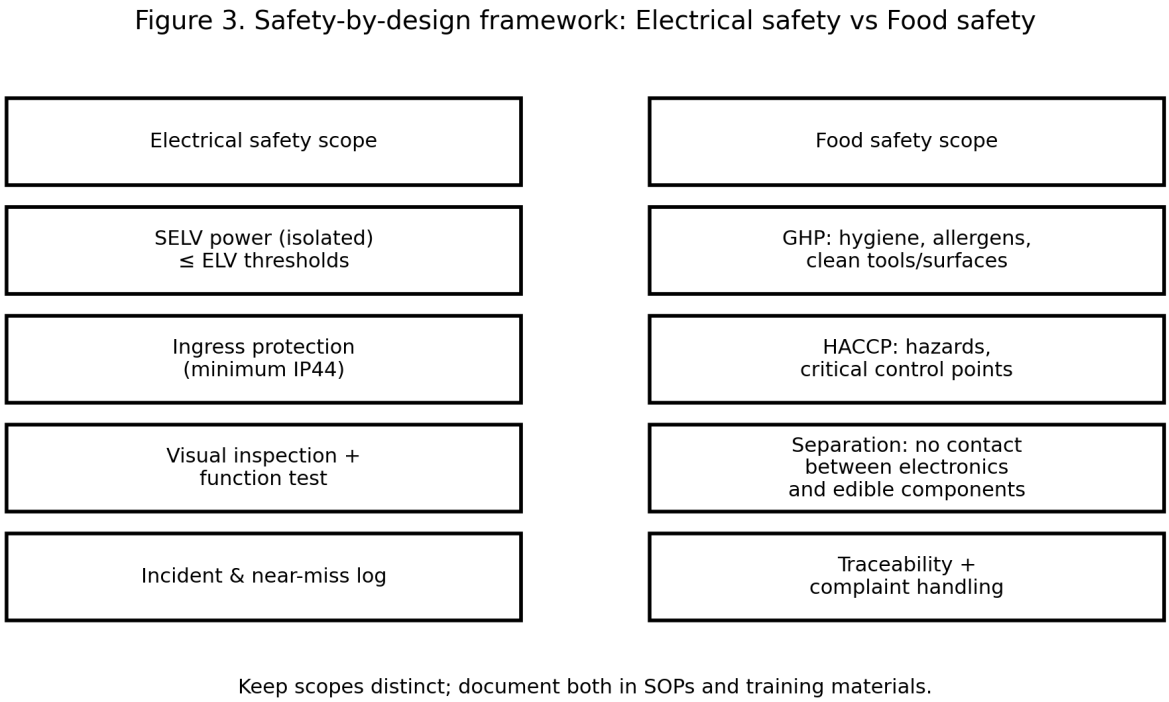
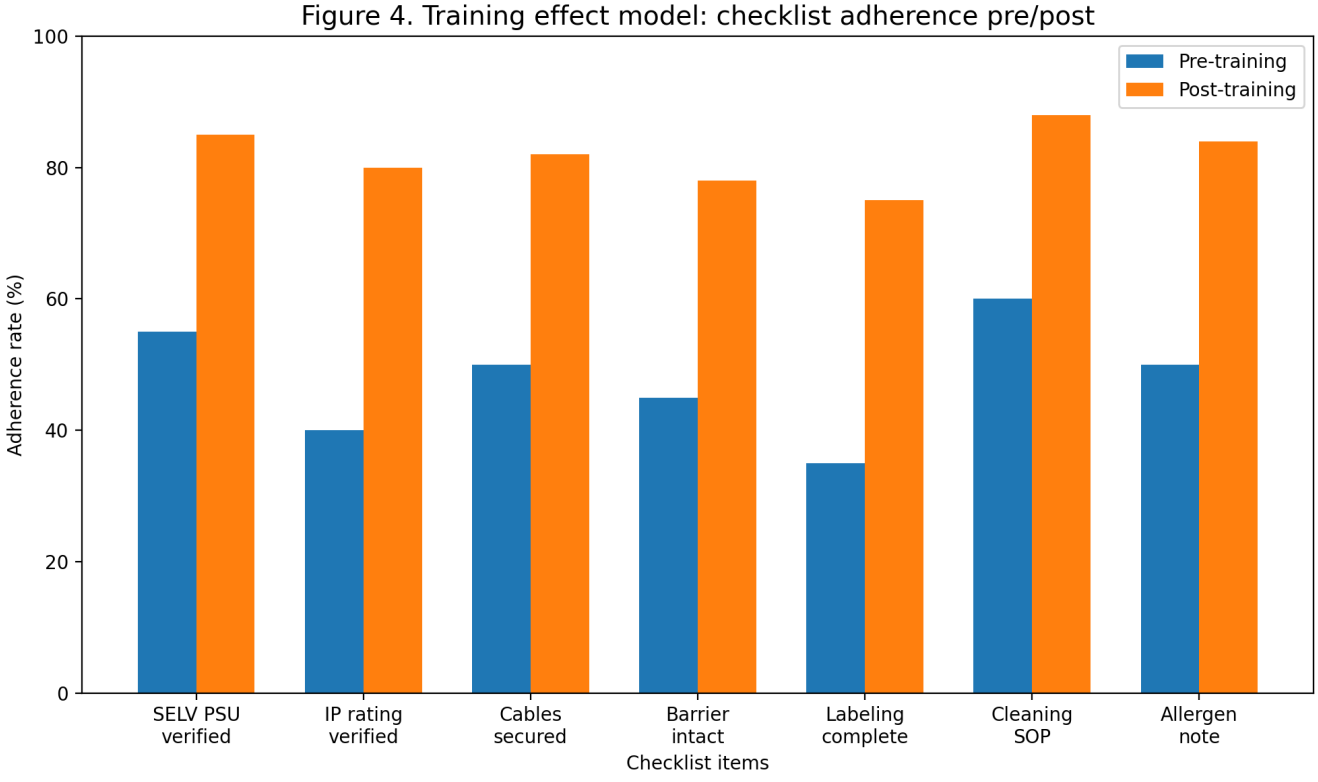


Figure 4. Training effect model: example pre/post checklist adherence profile (illustrative).



6. Documentation pack (what to record on each LED order)

Electrical safety record (order-level):

- Power supply rated as extra-low voltage (SELV) and isolated (model, output voltage, certification marks where applicable).
- IP rating evidence (IP44 minimum): product datasheet screenshot or supplier declaration; photo of label if present.
- Build photos: cable routing, strain relief, insulation/barrier separation from edible components.
- Functional test: light on/off and battery/connector integrity; visual inspection pass/fail.
- Incident / near-miss notes (including zero counts where applicable).

Food-safety record (batch/order-level):

- GHP: clean tools and surfaces; hand hygiene; packaging integrity; temperature/time controls if applicable.
- HACCP-style hazards list (physical/chemical/biological) and key controls relevant to the studio workflow.
- Allergen disclosure policy and labeling; traceability of ingredients and suppliers.
- Complaint handling log with categorization and corrective actions.

7. Discussion and practical implications

If H1 holds, LED accent lighting can justify premium pricing and improve customer satisfaction. If H3 holds, training + checklist adoption improves throughput and reduces rework, enabling scaling beyond a single master. The key strategic contribution is the explicit separation of electrical safety (SELV/IP verification, enclosure integrity, wiring controls) from food safety (GHP/HACCP controls), which makes the workflow auditable and defensible.

The protocol can be published as an industry guideline and updated as studios adopt it, generating evidence of market influence (e.g., references by other studios, training programs, and supplier partnerships).

8. Limitations

Aesthetics ratings are partially subjective and may be influenced by photography, brand perception, and seasonality. Safety incident rates depend on exposure time; rare events require longer observation windows. This paper should be updated with actual sample sizes, confidence intervals, and operational context once data collection completes.

9. Conclusion

LED-enhanced food-floristry can be developed responsibly when the implementation follows a safety-by-design logic and collects verifiable, business-relevant evidence. The proposed protocol provides a structured way to test customer perception, operational efficiency, and safety outcomes while keeping compliance scopes separate and documented.

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