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# Effect of Free and Encapsulated Olive Leaf Extract on the Functional and Quality Characteristics of Cantal-Type Cheese During Refrigerated Storage

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## INTRODUCTION & AIM

The olive tree is a rich source of bioactive compounds, mainly oleuropein and hydroxytyrosol, known for their strong antioxidant and antimicrobial activities. However, their direct use in food products is limited by sensitivity to environmental factors. Encapsulation represents an effective strategy to protect these compounds, improve their stability, and control their release. Incorporating encapsulated olive leaf extract (E-OLE) into dairy matrices, particularly cheese, can enhance their functional and antioxidant properties. This study investigates the impact of E-OLE addition on the quality and functionality of Cantal-type cheese during cold storage.

## METHOD

| Preparation | Storage | Analysis |
|---|---|---|
| →Addition of OLE and EOLE at 0%,1%, 2% and 3%(W/W), with equivalent TPC at each level<br>→ The samples are vacuum-packed in polyethylene plastic bags | Storage at 2°C for 63 days | → Composition<br>→ pH<br>→ Microbiology<br>→ Color<br>→ Texture & rheology<br>→ Antioxidant activity |

## RESULTS & DISCUSSION

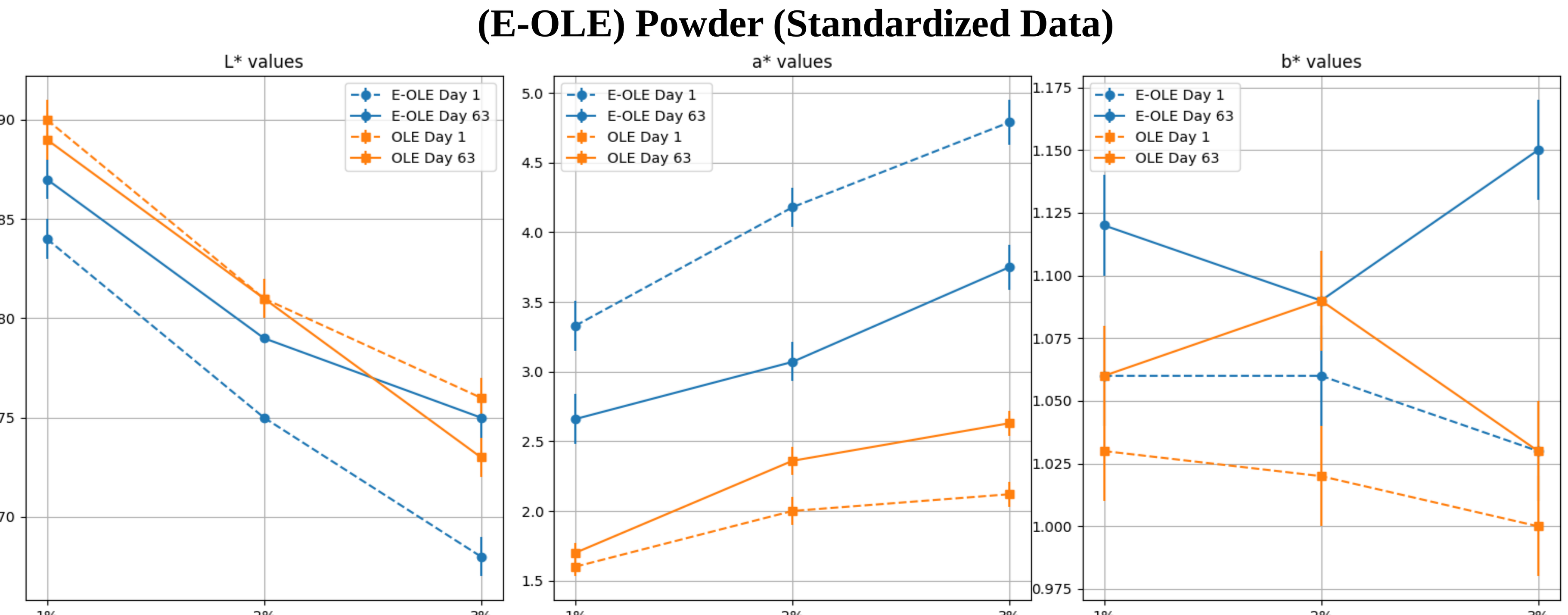
**Table 1: Physicochemical Properties of Cheese Enriched with OLE and E-OLE Powder: Effect on pH, Fat, Protein, Dry Matter, and Chloride (Standardized Data)**

| | Storage period (days) | Standardized data | | | | | |
|---|---|---|---|---|---|---|---|
| | | **E-OLE** | | | **OLE** | | |
| | | E-OLE 1% | E-OLE 2% | E-OLE 3% | OLE 1% | OLE 2% | OLE 3% |
| pH | 1 | $1.01^{Ac} \pm 0$ | $1.02^{Ab} \pm 0$ | $1.04^{Aa} \pm 0$ | $1.00^{Ad} \pm 0$ | $1.00^{Ad} \pm 0$ | $1.00^{Ad} \pm 0$ |
| | 63 | $0.95^{Bb} \pm 0$ | $0.95^{Bb} \pm 0$ | $0.96^{Bb} \pm 0.01$ | $0.98^{Ba} \pm 0.01$ | $0.98^{Ba} \pm 0.01$ | $0.98^{Ba} \pm 0$ |
| Fat | 1 | $0.93^{Ac} \pm 0.01$ | $0.87^{Bd} \pm 0.01$ | $0.84^{Ae} \pm 0$ | $0.98^{Aa} \pm 0.01$ | $0.96^{Ab} \pm 0.01$ | $0.96^{Ab} \pm 0$ |
| | 63 | $0.96^{Aa} \pm 0.02$ | $0.91^{Ab} \pm 0.01$ | $0.84^{Ac} \pm 0.01$ | $0.97^{Aa} \pm 0.03$ | $0.97^{Aa} \pm 0.01$ | $0.95^{Aa} \pm 0$ |
| Chloride | 1 | $0.94^{Ab} \pm 0$ | $0.90^{Ac} \pm 0$ | $0.82^{Bd} \pm 0$ | $0.97^{Aa} \pm 0.02$ | $0.96^{Aa} \pm 0.01$ | $0.96^{Aab} \pm 0.01$ |
| | 63 | $0.95^{Aab} \pm 0.02$ | $0.91^{Ab} \pm 0.02$ | $0.84^{Ac} \pm 0$ | $1.00^{Aa} \pm 0.02$ | $0.98^{Aa} \pm 0.04$ | $0.97^{Aa} \pm 0.04$ |
| Dry matter | 1 | $1.03^{Ac} \pm 0$ | $1.05^{Ab} \pm 0$ | $1.08^{Ba} \pm 0$ | $0.99^{Ad} \pm 0$ | $0.99^{Bd} \pm 0$ | $0.99^{Bd} \pm 0$ |
| | 63 | $1.02^{Bc} \pm 0.05$ | $1.05^{Bb} \pm 0$ | $1.08^{Aa} \pm 0$ | $1.00^{Be} \pm 0.01$ | $1.00^{Ade} \pm 0$ | $1.01^{Ad} \pm 0$ |
| Protein | 1 | $0.99^{Ac} \pm 0.01$ | $1.08^{Ab} \pm 0$ | $1.09^{Aa} \pm 0.01$ | $1.00^{Ad} \pm 0.01$ | $0.99^{Ad} \pm 0$ | $0.99^{Ad} \pm 0$ |
| | 63 | $1.05^{Ab} \pm 0.01$ | $1.07^{Ba} \pm 0$ | $1.08^{Aa} \pm 0.01$ | $0.99^{Acd} \pm 0.01$ | $1.00^{Ac} \pm 0.01$ | $0.98^{Ad} \pm 0.01$ |

- pH: ↓ in all samples after 63 days.
- Fat: ↓ with E-OLE and OLE; stronger effect at higher E-OLE levels .
- Chloride: ↓ with E-OLE (dose-dependent).
- Dry matter & protein: ↑ in E-OLE samples.

➔ **Encapsulation improves functional and nutritional properties of Cantal-type cheese.**

**Figure 1: Color Variation (L, a, b*) in Cheese Enriched with OLE and Encapsulated OLE (E-OLE) Powder (Standardized Data)**

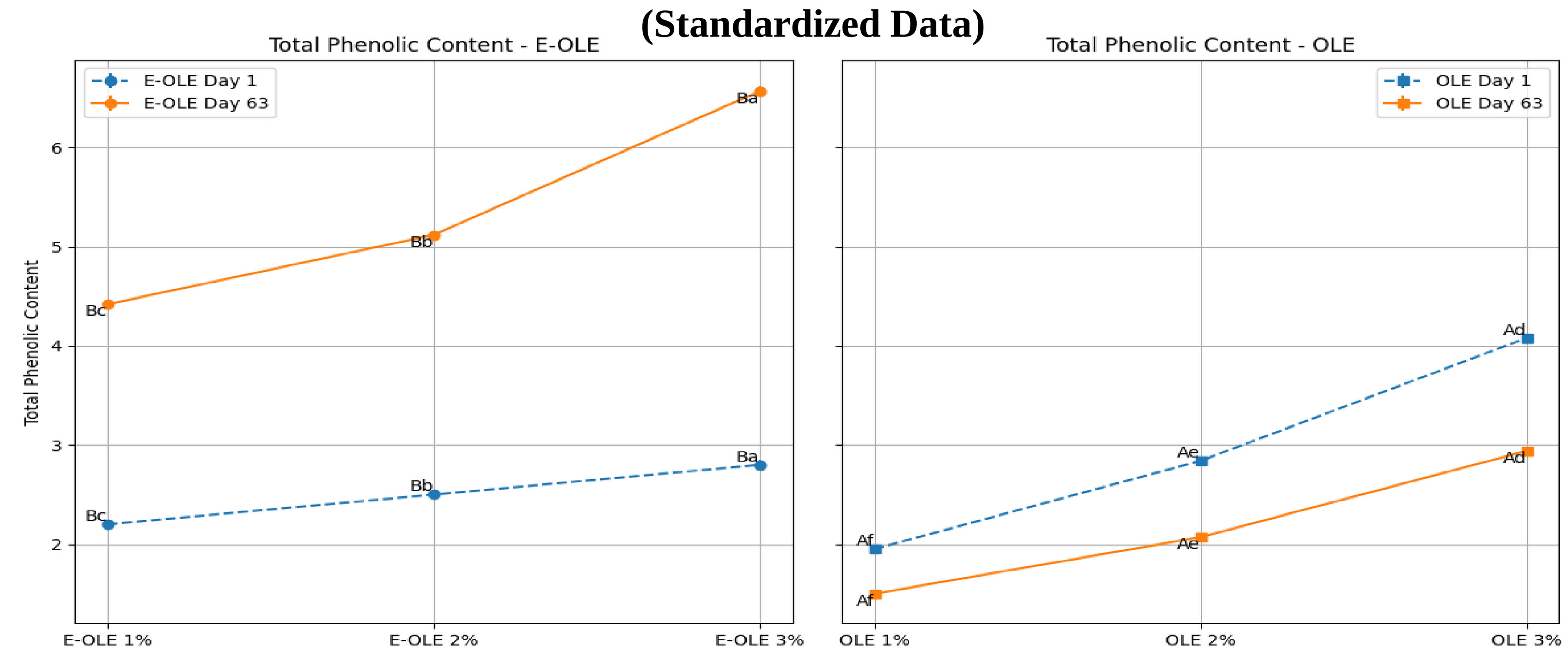



- **Lightness (L*):** ↓ with E-OLE/OLE; encapsulation maintains brightness.
- **Redness (a*):** ↑ with concentration; E-OLE ↓ over time, OLE ↑.
- **Yellowness (b*):** Slight ↑ with E-OLE/OLE and storage.

➔ **Mechanism:** Encapsulation stabilizes pigments and appearance.

## RESULTS & DISCUSSION

**Figure 2: Total Phenolic Content (TPC) of Cheese Enriched with OLE and E-OLE Powder (Standardized Data)**




- TPC: ↑ with E-OLE and OLE; E-OLE maintains TPC better during storage.
- Antioxidant activity (ABTS): ↑ with both extracts; slight decrease by day 63.

➔ **Encapsulation effect: Protects polyphenols, enhances stability and bioavailability.**

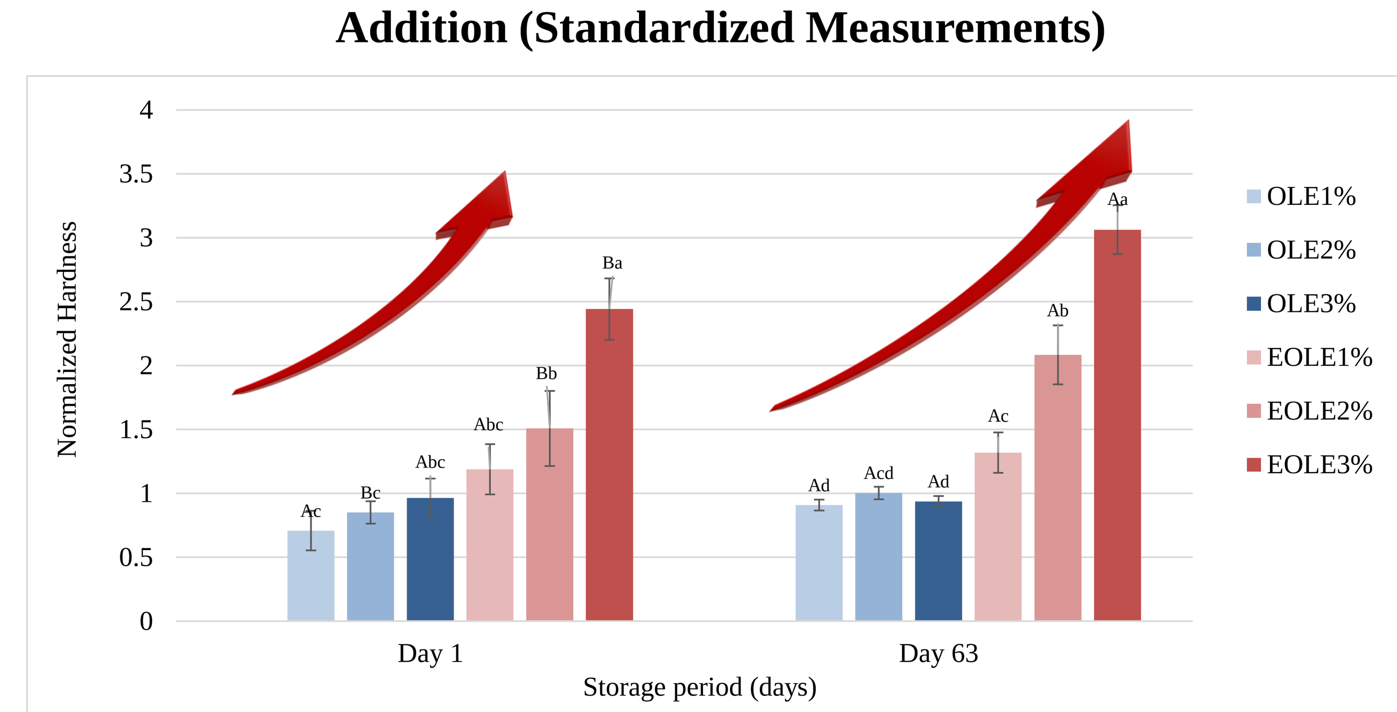
**Table 2: Microbial Stability of Cheese Enriched with OLE and E-OLE Powder (Standardized Data)**

| Microorganism | Storage period (days) | Standardized data | | | | | |
|---|---|---|---|---|---|---|---|
| | | **E-OLE** | | | **OLE** | | |
| | | E-OLE 1% | E-OLE 2% | E-OLE 3% | OLE 1% | OLE 2% | OLE 3% |
| Total aerobic mesophilic flora | 1 | 0.94 | 0.92 | 0.77 | 0.74 | 0.33 | 0.09 |
| | 63 | 1.03 | 1.05 | 0.92 | 0.84 | 0.34 | 0.26 |
| Yeasts and molds | 1 | 1.43 | 1.79 | 3.57 | 0.59 | 0.70 | 0.52 |
| | 63 | 1.42 | 0.81 | 1.08 | 0.63 | 0.89 | 0.33 |
| Lactococcus | 1 | 0.92 | 0.83 | 0.73 | 0.91 | 90.91 | 277.27 |
| | 63 | 0.22 | 0.12 | 0.01 | 0.57 | 0.21 | 0.15 |
| Lactobacillus | 1 | 0.95 | 0.79 | 0.67 | 0.84 | 1.20 | 0.02 |
| | 63 | 0.79 | 0.58 | 0.67 | 6.58 | 5.17 | 4.50 |
| Enterococcus | 1 | 0.08 | 0.36 | 0.14 | 0.55 | 0.45 | 0.40 |
| | 63 | 0.55 | 0.27 | 0.27 | 0.78 | 0.38 | 0.17 |
| Staphylococcus spp | 1 | 0.79 | 0.48 | 0.53 | 0.67 | 0.15 | 0.03 |
| | 63 | <100 | <100 | <100 | <100 | <100 | <100 |

- AMF: ↓ with E-OLE/OLE; max inhibition 91% (3%).
- Yeasts & Molds: High E-OLE/OLE ↓ growth by day 63.
- Lactic Acid Bacteria: E-OLE ↓ dose-dependently; OLE less sustained.
- Pathogens: Strong inhibition; Staphylococci nearly absent.

➔ **Take-home: 2–3% E-OLE/OLE improves microbial stability; encapsulation prolongs effect.**

**Figure 3: Evaluation of Cheese Hardness with OLE and E-OLE Powder Addition (Standardized Measurements)**




✓Hardness: ↑ with E-OLE (dose-dependent); OLE no effect.
✓Storage effect: Hardness ↑ over 63 days.
➔ **Mechanism: E-OLE improves protein cross-linking and network stability; OLE polyphenols interact directly with caseins.**

## CONCLUSION

The addition of E-OLE enhanced the quality of Cantal-type cheese during storage.
Higher concentrations improved antioxidant activity and microbial stability while positively affecting composition and texture—raising protein, dry matter, hardness, and cohesiveness, and reducing fat, chloride, total aerobic mesophilic counts, and elasticity—without compromising overall cheese quality.