

Gum Arabic-Based Bioactive Coatings Enriched with Natural Additives: A Biostimulation and Biocontrol Strategy for Postharvest Fruit Preservation

Ilham ZERBET^{1*}; Loubna BENIDIRE²; Brahim ALAYOUA¹; Chaima BOUKHAROUAA¹; Mustapha FAGHIRE¹; Issam SADKI¹¹Laboratory of Plant Biotechnology, Department of Biology, Faculty of Sciences, Ibn Zohr University, Agadir 80000, Morocco²Department of Biology, Faculty of Sciences Ben M'Sik, Hassan II University of Casablanca, Casablanca 20000, Morocco

INTRODUCTION & AIM



Postharvest fruit losses reach **30–50%** worldwide and are mainly due to dehydration, microbial decay, and biochemical degradation. Synthetic plastic packaging provides short-term protection but raises environmental and health concerns.

Gum Arabic (GA)—a natural exudate from *Acacia tree*—is an edible, biodegradable, film-forming polymer with strong emulsifying and stabilizing properties.



Aim

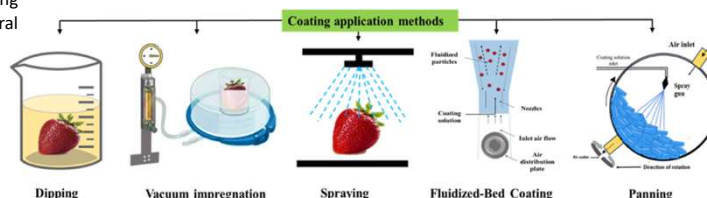
- Evaluate the performance of **GA-based edible coatings** for fruit preservation,
- Assess the enhancement achieved by **natural additives** (essential oils, polyphenols, waxes),
- Highlight their roles as **biostimulator** (ripening delay) and **biocontrol** (antimicrobial/antioxidant) strategies.

METHOD

A structured review of experimental studies evaluating gum Arabic coatings alone or enriched with natural additives.

Categories of Additives

- Essential oils (EOs)** → antimicrobial activity
- Polyphenols** → antioxidant properties
- Waxes** → hydrophobic barrier
- Other biopolymers** (starches, cellulose derivatives)



Evaluation Criteria

- Physicochemical: **weight loss, firmness, color, °Brix**
- Biochemical: **antioxidant activity, phenolics**
- Microbial: **yeast/mold load, decay incidence**
- Sensory attributes

RESULTS & DISCUSSION

1. GA alone

Applying gum Arabic creates a semi-permeable film that slows fruit respiration. This natural barrier significantly reduces moisture loss, helping maintain firmness during storage. GA also delays color degradation and preserves ascorbic acid, contributing to better physicochemical stability over time.

Tableau 1: Effects of gum Arabic coatings on the post-harvest preservation of various fruits: reduction in weight loss, texture maintenance, delayed ripening, and preservation of sensory and nutritional qualities.

Study Details	Effects on Conservation			Influence on Sensory Quality			References
	Reduction in weight loss	Maintaining texture	Delayed maturation	Effects on color	Impact on taste	Nutrient Preservation	
Effects of gum Arabic coating on the preservation of strawberries	Weight loss reduced by 10–15%	Texture maintained for up to 10 days	Delayed maturation of 3–5 days	More vivid and stable color	Slightly improved sweet taste	Preservation of vitamins C and A	Fadavi et al., 2005
Preserving apples with gum Arabic coating	Weight loss reduced by 8–12%	Firm texture maintained for up to 14 days	Delayed maturation of 5–7 days	Color maintained longer	Fresh and crunchy taste	Preservation of polyphenol content	Demirci et al., 2007
Use of gum Arabic for the preservation of bananas	Weight loss reduced by 5–10%	Texture maintained for up to 7 days	Delayed maturation of 2–4 days	More stable yellowish color	Improved taste with less bitter notes	Preservation of vitamins B and C	Reineccius et al., 1991
Effect of gum Arabic on the preservation of peaches	Weight loss reduced by 12–18%	Firm texture maintained for up to 10 days	Delayed maturation of 4–6 days	Bright and attractive color	Sweeter and less acidic taste	Preservation of antioxidants	Nussinovitch et al., 1997

2. GA + Essential Oils

Combining GA with essential oils provides strong antifungal and antibacterial properties. This formulation effectively reduces decay incidence and limits mold development. Moreover, it enhances sensory acceptability by improving appearance and reducing visible defects.

3. GA + Polyphenols

The incorporation of polyphenols increases the antioxidant capacity of the GA coating. This synergy slows enzymatic browning, particularly in sensitive fruits such as berries, apples, and bananas. GA-polyphenol coatings extend shelf life while maintaining key quality attributes.

4. GA + Waxes

When GA is combined with natural waxes, the water vapor barrier becomes more efficient. This reduces weight loss, especially in high-respiration fruits like peppers and cucumbers. The hydrophobic nature of waxes enhances postharvest stability and limits shriveling.

Tableau 2: Effects of gum Arabic coatings enriched with natural additives according to fruit type

Natural additives used	Observed effects	References
Essential oils (lemongrass, oregano), wax	↓ Breathability, ↑ firmness, ↓ mildew, color retention	Tiamiyu et al., 2023; Maqbool et al., 2011
Polyphenols (pomegranate), chitosan, EO	↓ Browning, ↓ water loss, texture, and aroma maintenance	Maqbool et al., 2011
Essential oils (cinnamon, clove), pectin	↓ Microbial activity, ↓ weight loss, preservation of color and firmness	El-Anany et al., 2009; Khaliq et al., 2016
Green tea extract, carnauba wax	↑ dehydration resistance, ↓ microbial deterioration, gloss retention	Naqash et al., 2022
Polyphenols, beeswax	↓ oxidation, ↑ shelf life, ↓ internal juice loss	Moradinezhad et al., 2018

Discussion

Gum Arabic functions as a biostimulant, slowing ripening processes and helping preserve overall fruit quality. When enriched with natural additives—essential oils, polyphenols, or waxes—it also acts as a biocontrol agent, inhibiting microbial growth and reducing oxidative reactions. These formulations offer a sustainable, biodegradable solution aligned with the Sustainable Development Goals (SDGs), making them a promising alternative to conventional postharvest treatments.

CONCLUSION

- Gum Arabic is a promising **eco-friendly coating matrix** for fruit preservation.
- Natural additives significantly enhance **biocontrol** (antimicrobial) and **biostimulation** (ripening delay).
- GA-based coatings reduce postharvest losses and support **sustainable food systems**.
- Valorization of Moroccan *Vachellia raddiana* gum supports regional bioeconomy.

FUTURE PERSPECTIVES

- Nanoencapsulation of essential oils for improved stability.
- Combination with other biopolymers (chitosan, alginate).
- Smart coatings with freshness indicators.
- Industrial-scale application.

References

- Zerbet, I., & Benidire, L. (2025). Gum Arabic: A Sustainable Biotechnological Solution... IGI Global. <https://doi.org/10.4018/979-8-3693-9826-5.ch014>
- Key studies (1991–2023) on edible coatings, essential oils, polyphenols, and waxes supporting postharvest quality preservation and shelf-life extension.