Potential Delivery Methods and Applications of Bee Propolis in Oropharyngeal Surgery

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Introduction

Postoperative complications in oropharyngeal and head & neck surgery affect recovery, quality of life, and long-term outcomes. Adult patients, especially with prior radiation, malnutrition, obesity, or diabetes, face higher morbidity: surgical site infection (7.1%), hemorrhage/hematoma (5.2%), seroma (2.4%), dehiscence (2.2%), and chyle leak (1.1%).

Propolis, a natural bee resin, has anti-inflammatory, antimicrobial, antioxidant, and wound-healing properties. By modulating inflammatory pathways and promoting fibroblast proliferation and collagen deposition, propolis shows potential as an adjunct to reduce postoperative complications and support tissue repair in head and neck surgery.

Methodology

We systematically identified peer-reviewed studies published in English after 2018 on the topic of bee propolis administration using the key search terms “propolis,” and “wound,” and “delivery,” or “administration” on PubMed. The search results yielded 50 publications, the characteristics of which, including methods, objectives, and results were analyzed by the two authors. Inclusion criteria were publication in English, previous reviews, Clinical Studies, Case Studies, randomized control trials, animal models in vivo, and In vitro studies. Exclusion criteria included non-English articles and unrelated indications. The search period was from 2018 to the Present. Key information and the characteristics of each publication were noted by the two authors. Together, the authors identified which articles met each of the inclusion criteria, whether or not the articles discussed the pharmacologic properties of bee propolis and subsequently identified/quantified the pathways involved in the antiinflammatory activity of propolis.

Discussion

Our review of bee propolis across 50 studies demonstrates consistent evidence of its **antimicrobial, antioxidant, anti-inflammatory, proregenerative, and immunomodulatory properties**, primarily observed in in vitro and in vivo models. Propolis extracts exhibited broad-spectrum **antibacterial activity** against common pathogens, including *Staphylococcus aureus* and *Pseudomonas aeruginosa*, and significant **antioxidant activity**, reducing oxidative stress markers in wound models. Anti-inflammatory effects were mediated through downregulation of pro-inflammatory cytokines and modulation of NF-κB and other signaling pathways.

The combination of these properties supports the **potential of bee propolis as an adjunct in wound healing**, particularly for **postoperative care in head and neck surgery**, where infection control and inflammation management are critical for optimal recovery.

The delivery systems that seemed to enhance bio-availability, allowed for local targeting, and showed the highest efficacy were advanced non-woven delivery systems such as electrospun nanogels and mats. Hydrogel- and polymer-based delivery systems offer a promising route for localized, controlled release of propolis through incorporation of post-op dressings at surgical sites.

Future applications in head and neck surgery may include:

- **Topical dressings** for surgical wounds or reconstructive flaps to reduce infection risk and promote tissue repair.
- **Adjunctive therapy** for mucosal healing after tonsillectomy, adenoidectomy, or oral cavity procedures.
  Integration into biodegradable hydrogels or scaffolds to enhance post-surgical tissue regeneration.

While preclinical results are promising, **clinical trials are needed** to establish optimal dosing, safety, and efficacy in human patients. Standardization of propolis extracts is also essential, given variability in chemical composition across geographic and botanical sources.

Conclusion: Bee propolis has strong translational potential for enhancing postoperative outcomes in head and neck surgery through its antimicrobial, antioxidant, and anti-inflammatory effects, warranting further clinical investigation.

References

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Results

(n = 50 studies)

Study Characteristics

- **30 in vitro, 15 in vivo, 5 clinical trials/reviews**
- Interventions: raw propolis, CAPE, pinocembrin, advanced delivery systems (electrospun mats, hydrogels, films, coated sutures, niosomes, emulgels)
- Promotes connective tissue formation and re-epithelialization
- Generally safe; coagulation effects need monitoring

Pharmacologic Effects

- **Antimicrobial (n = 20):** Effective against S. aureus, MRSA, Gram-negative bacteria; demonstrated enhanced activity in coated sutures, hydrogels, electrospun mats, films
- **Anti-inflammatory (n = 18):** Downregulates NF-κB, TNF-α, IL-1β, IL-6; upregulates NRF2; suppresses NOS2/COX-2; reduces edema and tissue injury
- **Antioxidant (n = 16):** Reduces ROS, protects mitochondria, restores oxidative balance
- **Pro-regenerative (n = 19):** Promotes fibroblast proliferation, collagen deposition, VEGF/TGF-β1 expression, angiogenesis, tissue repair
- **Immunomodulatory (n = 10)**: Enhances leukocyte recruitment, MPO activity, macrophage polarization toward healing

Delivery System	Key Findings	Study Type / n
Woven Dressings	High antimicrobial activity, porosity, water retention, & mechanical stability Cotton/hydrogel, propolis-coated sutures; reduce S. aureus and MRSA biofilm formation.	In vitro, n = 3
Electrospun / Nonwoven Mats	Improved fibroblast migration, sustained release, antibacterial & antioxidant effects Polycaprolactone, cellulose acetate, and Eudragit/PVP composites.	In vitro/in vivo, n = 10
Films & Membranes	Wound closure, accelerate tissue regeneration bacterial load reduction, exudate management Dual-layer, polysaccharide, and ZnO-enhanced, cellulose membranes active against MRSA and Candida	In vitro/in vivo, n = 7
Gels / Emulgels	Controlled release, bioadhesion, prolonged antimicrobial activity S. Aureus & S. Epi • Niosomes, nanoemulsions, topical emulgels • Controlled release, strong bioadhesion, low cytotoxicity	In vitro/in vivo, n = 6
Intraperitoneal/ Intragastric	CAPE, propolis, pinocembrin; improved wound healing, cardiac protection, neuroprotection, renal/hepatic protection, fracture healing	In vivo, n = 8
Oral / Systemic	Chronic wound healing, collagen deposition, inflammation reduction	In vivo, n = 3
Clinical (topical)	Reduced oral mucositis, diabetic foot ulcer healing	Clinical trials, n = 5