

# Molecular Mechanisms of Ozonized *Nigella sativa* Oil in Wound Repair: Albumin as Biomarker in Rat Model

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## Abstract

**Background:** Wound healing is a complex physiological process that can be impaired in various conditions. *Nigella sativa* oil, rich in bioactive compounds like thymoquinone, has shown promise in promoting wound healing. Ozone therapy, through the generation of reactive oxygen species (ROS), has also been explored for its potential to accelerate wound repair. This study aimed to investigate the molecular mechanisms underlying the effects of ozonized *Nigella sativa* oil on wound healing, with a focus on albumin as a biomarker of tissue regeneration in a rat model.

**Methods:** Full-thickness skin wounds were created on the backs of Sprague Dawley rats. The rats were randomly divided into four groups: a control group receiving no treatment, and three treatment groups receiving topical applications of ozonized *Nigella sativa* oil at different ozone concentrations (1400 mg/ml, 1800 mg/ml, and 2200 mg/ml) for 7 days. Wound healing was assessed by measuring wound closure rates and histological analysis. Albumin levels in wound tissue were quantified using immunohistochemistry. Additionally, the expression of key genes involved in wound healing, including growth factors, cytokines, and matrix metalloproteinases, was evaluated using quantitative real-time PCR. **Results:** Ozonized *Nigella sativa* oil significantly accelerated wound closure compared to the control group. Histological analysis revealed improved tissue regeneration and collagen deposition in the treated groups. Albumin levels were significantly elevated in the wound tissue of rats treated with ozonized *Nigella sativa* oil, particularly at the highest ozone concentration. Furthermore, the expression of growth factors (VEGF, TGF- $\beta$ ), pro-inflammatory cytokines (IL-1 $\beta$ , TNF- $\alpha$ ), and matrix metalloproteinases (MMP-2, MMP-9) was modulated in a manner consistent with enhanced wound healing.

**Conclusion:** Ozonized *Nigella sativa* oil promotes wound healing in a rat model through multiple molecular mechanisms, including the stimulation of albumin synthesis, growth factor expression, and controlled inflammation. These findings suggest that ozonized *Nigella sativa* oil may have therapeutic potential for enhancing wound repair in clinical settings.

**Keywords:** Albumin, Growth factors, *Nigella sativa* oil, Ozone therapy, Wound healing.

