www.pharmaerudition.org

ISSN: 2249-3875

International Journal of Pharmaceutical Erudition

Research for Present and Next Generation

NOV 2025

Vol: 15 Issue:03

(41--47)

ISSN 2249-3875

International Journal of Pharmaceutical Erudition

Research Paper

EVALUATION OF WOUND HEALING EFFICACY OF NEOMYCIN NANOSPONGES GEL IN WISTAR RATS

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Wound healing is a critical process that involves tissue repair, inflammation, and regeneration, which can be impacted by various factors including infections. The use of topical agents for enhancing wound healing has been explored extensively, with a focus on delivering drugs effectively. This study evaluates the wound healing efficacy of neomycin-loaded nanosponge gel in Wistar rats. Neomycin, an antibiotic, is commonly used in preventing infections, but its clinical applications are limited due to systemic toxicity when administered orally or intravenously. The incorporation of neomycin into a nanosponge system aims to improve its localized delivery, enhance its therapeutic effect, and reduce systemic side effects. Neomycin nanosponge gel was formulated and applied topically to full-thickness wounds in Wistar rats. A total of 24 Wistar rats were divided into four groups, including a control group, an inducer group, a standard treatment group (Soframycin), and a treatment group (Neomycin nanosponges gel). Wounds were created on the dorsal surface of the rats, and treatments were applied topically once daily for 21 days. Wound contraction and body weight changes were measured as key indicators of healing. The results demonstrated that the Neomycin nanosponges gel significantly improved wound closure, with a wound contraction of 90.76% by day 21, which was comparable to the Soframycin group's 96.99%. Body weight analysis showed minimal systemic effects, with slight reductions observed in the treatment groups. The study concluded that Neomycin nanosponges gel is a promising alternative for wound healing, showing efficacy similar to the standard treatment.

Keywords: Wound healing, Neomycin nanosponges, Soframycin, Wistar rats, Wound contraction.

INTRODUCTION

Wound healing is a complex physiological process through which the skin or other tissues repair after injury. The mechanism involves a cascade of cellular events, including inflammation, tissue proliferation, remodelling, and eventual restoration of tissue integrity and function **(Broughton *et al.,* 2006).** Effective wound management is crucial in preventing complications like infections, excessive scarring, and delayed healing. Various pharmacological and medicinal strategies have been developed to enhance wound healing, with topical treatments being particularly pivotal for effective management of both acute and chronic wounds **(Gupta *et al.,* 2020).**Traditional wound healing agents, such as antibiotics, have been widely used to mitigate infection and promote tissue repair **(Vikram *et al.,* 2017).** Among these, neomycin, a broad-spectrum antibiotic, is often included in topical formulations for its ability to prevent bacterial infections in the wound area **(Dhandapani *et al.,* 2012).** However, traditional neomycin formulations can suffer from limitations in bioavailability, skin penetration, and sustained release, which impedes their efficacy in chronic wounds **(Tiwari *et al.,* 2018).** Nanotechnology has emerged as a promising solution to overcome these drawbacks by enhancing the delivery and effectiveness of active agents. Nanosponges, which are cross linked polymeric nanoparticles with high drug-loading capacities, offer an innovative method for encapsulating therapeutics like antibiotics. They can improve drug stability, control release profiles, and increase permeability across the skin barrier **(Sharma *et al.,* 2014).** Recent studies have demonstrated that nanosponges, when used in wound-healing formulations, significantly improve healing rates by enhancing the delivery of active drugs like neomycin to the targeted site **(Patel *et al.,* 2020).**In the context of wound healing, neomycin-loaded nanosponges gel has shown great potential, with preliminary studies reporting accelerated wound healing due to the sustained release of the antibiotic and enhanced antibacterial activity **(Thakur *et al.,* 2019).** The inclusion of nanosponges in a gel formulation could provide a moist wound environment conducive to faster and more efficient healing while preventing infection.The Wistar rat model is commonly used in preclinical research to evaluate the effectiveness of wound-healing agents, owing to its well-characterized physiology and ease of use **(Singh *et al.,* 2019).** In this study, we aim to evaluate the wound-healing efficacy of neomycin nanosponges gel in Wistar rats, comparing its effects with a standard therapeutic agent, Soframycin, which is a commonly used antibiotic for wound care **(Das *et al.,* 2013).** Specifically, we seek to assess parameters such as wound contraction and body weight, with a view to investigating the potential of neomycin-loaded nanosponges as a promising topical treatment for improving wound healing.

MATERIAL AND METHOD

Animal required

The animals Wistar Rat (procured from in-house animal facility of PBRI) weighing 150-200gwere selected and appropriate sized propylene cages were used to keep these rats. At 22 ± 2 ◦C temperature with 12/12-h light and dark cycle the stay of rats was maintained. All the animalswere fed with commercially available rat normal pellet diet (NPD) purchased from Keval Sales Corporation, Vadodara and water ad libitum was provided up to the end of the study.

In-vivo wound healing activity

Total of 24 animals were selected and segregated in 4 groupscontaining six animals each. They were anaesthetized with slight vapour inhalation of anaesthetic ether in anaesthesia chamber. The animals' dorsal surfaces were shaved, and a wound with a diameter of roughly 1 cm was created by excising the entire skin thickness from the sterile dorsal marked area. Animals were housed in a separate cage according to the groups. The wound continued to be exposed for twenty one days, each rat's wounds were left open and the standard and test samples were applied topically once a day. The contraction of wound was expressed as percentage of the reduction in wound size(El-Banna *et al.,* 2022; Akanksha *et al.,* 2009; Wilhelm *et al.,* 2017). We calculated the percentage of wound contraction using the following formula.

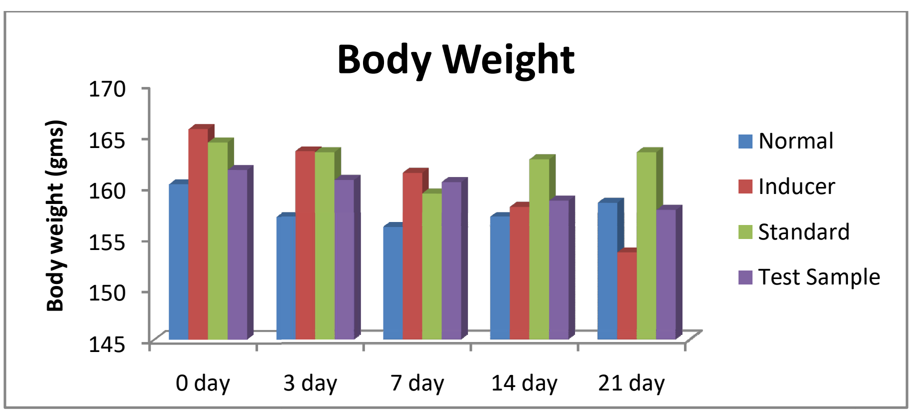
$$Percentage of wound contraction = \frac{Initial wound area - Specific day wound area}{Initial wound area} \times 100$$

Table 1: Design of experiment

S.No.	Groups	Number of animals	Dose
1	Control	6	Normal Control
2	Inducer	6	Wound treated with vehicle only
3	Standard	6	1% w/w Soframycin
4	Nanosponges gel	6	1%w/wgel of Neomycin Nanosponges

Table 2: Body Weight (gm)

S. No.	Group	Body Weight (cm)				
		0 day	3 day	7 day	14 day	21 day
I	Normal	160.2±6.082	157±6.082	156±4.725	157±7.010	158.4±6.082
II	Inducer	165.6±5.010	163.4±6.082	161.3±6.806	158±6.244	153.5±7.211
III	Standard	164.3±7.211	163.3±9.539	159.3±9.451	162.6±8.888	163.3±10.40
IV	Test Sample	161.6±10.40	160.6±10.21	160.4±16.50	158.6±12.05	157.7±8.717*



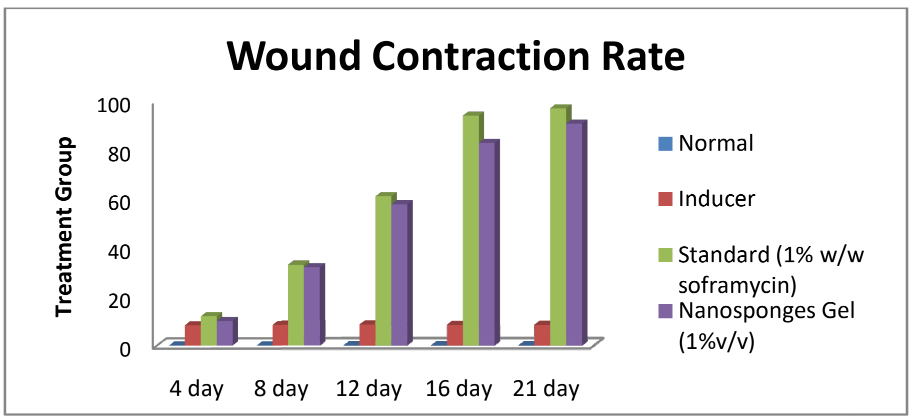
Graph 1: Body Weight Assessment

Wound contraction studies

Wound contraction is another parameter used to assess wound healing. Significant wound contraction was shown in table.

Table 3: Percentage wound closure in various treatment groups

Sr. No.	Formulation	Area of wound during different days of observation (%)				
		4 day	8 day	12 day	16 day	21day
1	Normal	0	0	0	0	0
2	Inducer	8.31±0.7123	8.45±0.8144	8.49±0.7824	8.39±0.8849	8.42±0.9810
3	Standard (1% w/w Soframycin)	11.99±0.7437	33.03±0.7279	60.99±0.6429	93.98±0.6431	96.99±0.2523
4	Nanosponges Gel (1% w/w Neomycin nanosponges)	10.05±0.7823	31.98±0.5239	57.76±0.5519	82.86±0.5532	90.76±0.5824



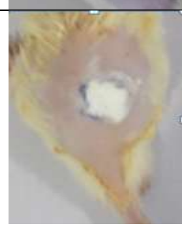
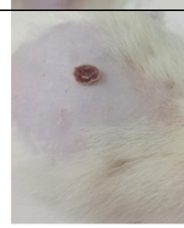
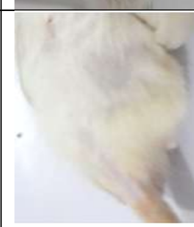
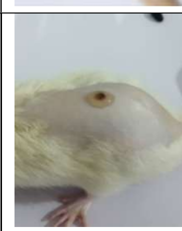
Graph 2: Evaluation of wound healing activity

DISCUSSION

Wounds are major case of physical disabilities. A wound which is disturbed state of tissue caused by physical, chemical, microbial (or) immunological insults (or) typically associated with loss function. According to the wound healing society wounds are physical injuries that results in an opening (or) break of the skin that cause disturbance in the normal skin anatomy and function(Gonzalez *et al.*, 2016; Kalalinia *et al.*, 2021). Wound healing is an interaction of complex cascade of cellular and bio chemical actions healing to the restoration of structura

Images of wound closure

Table 4: Images of wound closure in various treatment groups

Group	0 Day	3 Day	7 Day	14 Day	21 Day
Normal					
Inducer					
Standard (1% w/w soframycin cream)					
Nanosponges gel (1% w/w Neomycin nanosponges)					

and functional integrity with regain of strength of injured tissues. Involves continuous cell – cell interaction and cell matrix interactions that allow the process to proceed in different overlapping phases and process including inflammation, wound contraction, Re epithelialization tissue, re modelling, & formation of granulation tissue with angiogenesis(Schreml *et al.,* 2010).

The study assessed both body weight and wound contraction as key parameters in evaluating the effects of various treatments. The study analyzed body weight data over a 21-day period, revealing that the normal group maintained stable weight, while the inducer group experienced a gradual decrease in weight. The standard group, treated with a known therapeutic agent, showed fluctuations but no major reduction. The test sample group, treated with nanosponges gel, showed a slight weight loss, suggesting mild systemic effects of the treatment. Wound contraction analysis showed notable differences between the groups. The normal group showed no wound healing due to no induction, while the inducer group showed minimal wound contraction. The standard group, treated with 1% Soframycin, demonstrated faster wound closure, while the nanosponges gel group showed substantial wound healing, starting at 10.05% on day 4 and reaching 90.76% by day 21. This suggests that the nanosponges gel offers a promising wound-healing effect, though slightly less potent than the standard treatment. In summary, the wound contraction studies highlight the significant healing potential of the nanosponges gel, with results comparable to the standard treatment. These findings support the efficacy of nanosponges gel in enhancing wound healing. Images of wound closure would have documented the visual progress of healing across the treatment groups over the observation period.

CONCLUSION

The study demonstrated that Neomycin nanosponges gel possesses significant wound healing efficacy in Wistar rats, comparable to the established standard treatment, Soframycin cream. While the gel did not exhibit the same rapid healing rate as Soframycin, it showed a marked improvement in wound contraction over a 21-day period, with a closure of 90.76% by day 21. The minimal systemic effect on body weight suggests that the treatment is well-tolerated. These findings support the potential of Neomycin nanosponges gel as a promising alternative therapeutic agent for wound healing, highlighting its effectiveness and potential for further clinical development.

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