Research Article

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EXPLORING THE WOUND HEALING POTENTIAL OF PRAPAUNDARIKADYA TAILA AND ITS NOVEL FORMULATIONS: AN EXPERIMENTAL STUDY

Vismitha KR [1]* and Surekha S. Medikeri [2]

[1] PG Scholar, Department of PG and PhD Studies in Rasashastra and Bhaishajya Kalpana, Govt. Ayurvedic Medical College, Bengaluru, Karnataka, India

[2] Principal and HOD, Department of PG and PhD Studies in Rasashastra and Bhaishajya Kalpana, Govt. Ayurvedic Medical College, Bengaluru, Karnataka, India

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***Corresponding author**
E-mail: vismithakr37@gmail.com

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ABSTRACT

Aims: This study aimed to evaluate the wound healing efficacy of Prapaundarikadya taila in its traditional oil form and its modified formulations ointment and emulgel to enhance usability, shelf life, and patient compliance. Methods: Acute dermal toxicity studies were conducted per OECD guidelines. Wound healing activity was assessed using excision wound models in Wistar albino rats, supported by biochemical and antioxidant parameter analyses. Results: Acute dermal toxicity studies demonstrated no adverse effects, indicating safety for topical application. In wound healing assessments, the Prapaundarikadya taila and emulgel formulations showed significant efficacy ($p<0.05$), with accelerated wound closure and improved biochemical markers. The ointment demonstrated moderate efficacy in comparison. Discussion: The emulgel formulation exhibited superior therapeutic potential, likely due to enhanced skin contact time and patient compliance, while retaining the efficacy of the traditional oil. The study highlights the potential of Prapaundarikadya Taila in modernized forms to improve wound care outcomes. Conclusion: The findings suggest that the Emulgel and Prapaundarikadya Taila may offer enhanced therapeutic benefits in wound care, warranting further investigation into their clinical applications.

Keywords: Prapaundarikadya taila; Prapaundarikadya taila ointment, Prapaundarikadya taila Emulgel, Wound healing, Vrana ropana.

INTRODUCTION

Wound healing is a complex biological process involving tissue repair and regeneration. [1] It is a vital function of the body that ensures the restoration of damaged or injured tissues. However, various factors, including infections, poor circulation, and underlying diseases, can hinder this process, leading to delayed healing or even non-healing wounds.

Acharya Sushruta, in the Sushruta Samhita, Sutrastana[2], and Chikitsasthana, provided a detailed description of Vrana (wound) and outlined 60 treatment methods known as Shashti Upakrama[3]. Among these, the application of Taila is an ancient and effective method.

Taila Kalpana[4] is a versatile medicinal preparation that falls under the category of Sneha Kalpana. It is effectively used for various diseases, both internally and externally. Ayurveda, a traditional Indian system of medicine, offers a plethora of herbal formulations for wound healing. One such formulation is Prapaundarikadya Taila. Prapaundarikadya taila[5] mentioned in Charaka Samhita, Dwivruneeya chikitsa and Chakradatta explained it in Vranashothaadikhara[6] for the management of vrana. Ointment and emulgel are the new topical dosage in modern science which play a very important role in external route of drug administration. They are easy to apply and store.

Ointments are semisolid formulations that typically exhibit viscoelastic properties when subjected to shear stress. They usually contain active medicinal ingredients and are designed for external use on the skin or mucous membranes. Ointments enhance the full absorption of active components, offering a safe, stable, and easy-to-apply option that extends the contact time between the medication and the affected skin. Emulgel is an innovative drug delivery system that combines the properties of both gels and emulsions, making it particularly effective for the delivery of hydrophobic drugs. By gelling an emulsion with the addition of gelling agents, emulgel provides a solution for incorporating hydrophobic drugs into a hydrophilic gel matrix. This system offers several advantages, such as improved bio adhesion, viscosity, and long-term stability, enhancing patient compliance. One of the key benefits of emulgel is its suitability for dermal application, allowing the treatment to be localized at the site of application, unlike systemic administration methods like ingestion or injection[7].

The ingredients of Prapaundarikadya taila[5] like Prapaundarika (*Nelumbo nucifera* Gartn), Madhuka (*Glycyrrhiza glabra* Linn.), Kakoli (*Lilium polyphyllum* D. Don.), Ksheerakakoli (*Fritillaria roylei* Hook.), Chandana (*Santalum album* Linn.), Raktachandana (*Pterocarpus santalinus* Linn.) possess kashaya, tiktha and madhura rasa and sheetha veerya which helps in wound healing. However, traditional oil-based forms can be challenging to handle, prompting the development of modern alternatives like ointments and emulgels, which offer improved patient compliance. This study evaluates the wound healing potential of Prapaundarikadya Taila in its original form compared to its modified formulations as ointment and emulgel.

MATERIALS AND METHODS

Drugs Tila taila was collected from local oil mill, Mandya. ingredients for Tila taila murchana was collected from Amrith Kesari Depot, Mamulpet, Bangalore, Karnataka, India. All

Materials required for the preparation of Prapaundarikadya Taila were collected from S P Kajarekar Pharmacy Belagavi, Karnataka, India. Excipients used in this study were used from PES College of Pharmacy, electronic city, Bangalore, Karnataka, India. Both murchitha Tila taila and Prapaundarikadya taila were prepared as per classical reference. Murchitha Tila taila was prepared using raw Tila taila, water and kalka. Prapaundarikadya taila was prepared by using 1 part of murchitha Tila taila ,1/4th part of kalka, 4 parts of water. Prapaundarikadya taila ointment was prepared by using bees wax and emulsifying wax. Emulgel was prepared by using carbopol and triethanolamine in gel phase, methylparaben as preservative, tween 80, span 80, Prapaundarikadya taila and water. Silver nitrate was used as reference standard drug. Samples of Prapaundarikadya taila and its modified form of ointment and emulgel were prepared and coded as PT (Prapaundarikadya taila), PTO (Prapaundarikadya taila ointment), and PTE (Prapaundarikadya taila emulgel). The experimental study was conducted in Department of Pharmacology, Faculty of Pharmaceutical Science, PES University Electronic City Bengaluru, Karnataka, India.

Experimental Animals

A total of 30 adult and healthy Wistar strain albino rats (8-10 weeks of age) of either sex (150-200 g) was procured from Biogen Laboratory Animal Facility, CPCSEA registered animal supplier (CPCSEA Registration number 971/PO/RcBiBt/ S2006/CPCSEA), and were maintained under controlled conditions of temperature (23±03 ^{0}C), humidity (50±5%), and 12-hour light and dark cycles. The animals were randomized into five groups of six animals each and housed in large, spacious sanitized polypropylene cage containing sterile paddy husk as bedding during the experimental period and were maintained on a standard diet and water ad libitum. Ethical clearance was obtained from the Department of Pharmacology, PES College of Pharmacy, Bengaluru, Karnataka, India, as per the protocol outlined in the publication of the Committee for the Purpose of Control and Supervision of Experiments on Animal standard guidelines. (CPCSEA) and approval was obtained from the Institutional Animal ethics committee (IAEC) with reference no: FPS/IAEC/171/2024. After presenting in IAEC meeting held on 22/08/2024.

Acute Dermal Toxicity Study

An acute dermal toxicity study was performed for Prapaundarikadya taila as per OECD 402 guidelines. Six healthy female rats were used in the study. The dose was calculated according to their body weight. 250 mg/kg b.w, 500 mg/kg b.w, and 1000 mg/kg b.w, test substances were applied uniformly over an area that is approximately 10% of the total body surface area. Test substance was held in contact with the skin with a porous gauze dressing and non-irritating tape throughout a 24-hours exposure period. The test site was further covered in a suitable manner to retain the gauze dressing and test substance, ensuring that the animals could not ingest the test substance. According to the OECD guidelines for dermal toxicity studies, there was typically a washout period of 48 hours. This means that after the exposure period, the test substance was removed from the skin using water or an appropriate solvent, and observations continued for 48 hours to monitor any delayed reactions or toxicity. Parameters like changes in Skin and fur, eyes, mucous membrane, salivation, lethargy, sleep, diarrhea, coma, tremors were considered[8].

Excision Wound Model

In the excision wound model, five groups of animals, each including six rats, were used. The animal's dorsal fur was trimmed with an electric clipper, and the anticipated wound area was created. It was then anesthetized with ketamine hydrochloride (50 mg/kg, i.p., body weight) as stated above. On the shaved dorsal region, an impression was created, and the area of the wound to be created was identified. Using toothed forceps, a surgical blade, and sharp scissors, a full thickness excision wound with a circular area of 314 mm^2 was produced along the marking. Rats were exposed to the open environment while still undressed. From the day of the procedure of creating the wound until the complete healing, the vehicle, standard ointment, Prapaundarikadya taila, Prapaundarikadya taila emulgel, and Prapaundarikadya taila ointment were used once daily. The wound contraction and epithelialization period was assessed in this model. Every 4th day after wound creation, wound contraction was measured as a percentage contraction on the 4th, 8th, 12th, and 16th day after wound formation. All of the rats were anesthetized at the end of the study, and tissue samples were taken from the healed wounds, leaving a 5mm margin of normal skin around the edges of the healed wounds. Biochemical analyses were conducted on specimen tissues preserved in a 10% formalin solution[8].

Study design

Thirty wounded rats were divided into five groups, each consisting of 6 animals, and administered the following treatment for 16 days. Group I animals Sham control received the vehicle for 16 days. Group II animals were the standard group treated with silver nitrate ointment (0.2% W/w). Group III, IV, and V animals treated with Prapaundarikadya taila, Prapaundarikadya emulgel, and Prapaundarikadya ointment applied topically for 16 days.

Evaluation of the Wound Healing Parameters

1. Measurement of wound contraction and epithelization period[10] (Excision model).
2. Biochemical parameters
   a. Total Protein[11]
   b. Hydroxyproline estimation[12]
   c. Hexosamine estimation[13]
3. Tissue antioxidant parameters
   a. Superoxide dismutase (SOD)[14]
   b. Lipid peroxidation (LPO) [15]
   c. Glutathione (GSH)[16]

Statistical analysis

The data were expressed as mean + SEM (standard error of the mean). The statistical analysis was performed by one-way analysis of variance (ANOVA) followed by Dunnett's test for multiple comparisons using the GraphPad Prism 9 statistical program. The level of significancewas determined in comparison with the control group. The results were considered statistically significant if the p-value was <0.5 or less.

RESULTS

The acute dermal toxicity study of Prapaundarikadya Taila (PT) and its formulations (ointment and emulgel) at doses of 250 mg, 500 mg, and 1000 mg in rats showed no observable changes across all parameters, including skin and fur condition, eyes, mucous membrane, behavior, salivation, lethargy, sleep, diarrhea, coma, and tremors. These results indicate that all tested doses of

PT and its formulations are non-toxic under the conditions of this study.

The results of wound contraction indicate that all treatments showed progressive wound contraction over 16 days. By day 16, trial 1 (PT), trial 2 (PTE) and, trial 3 (PTO) treated groups showed a significant increase in % change on day 16 with (96.29, 95.48, 89.36) which is more healing compared to the silver nitrate ($p < 0.05$ and $p < 0.01$, respectively), when compared to the disease control (Sham control) group. The reference standard silver nitrate shows a significant increase in % change on day 16 with 75.91 when compared to sham control. The trial groups show better results compared to other groups. The Sham Control group exhibited a contraction of 62.61% on Day 16, which reflects a significant improvement ($p < 0.001$) but is notably lower than that of the treatment groups.

The data indicates that the epithelization period was significantly reduced in the STD group (18.83 days) compared to the sham control, suggesting that silver nitrate effectively promotes wound healing. While the PT (24.17 days) and PTE (22.33 days) treatments showed some improvement over the sham control, they were not as effective as silver nitrate. The PTO group (20 days) demonstrated a moderate reduction in epithelization time, but it was not statistically significant. Overall, the results suggest that silver nitrate is a promising intervention for accelerating wound healing.

Elevated total protein levels in wound tissue indicate enhanced synthesis of proteins required for cell repair and regeneration during healing. The total protein levels were significantly elevated in all treatment groups compared to the Sham Control group, which had a mean of 3.039 ± 0.154 ($p < 0.001$). Specifically, Trial 1 (PT) exhibited the highest protein concentration at 6.132 ± 0.048, followed closely by Trial 2 (PTE) at 5.920 ± 0.096 and Trial 3 (PTO) at 4.421 ± 0.209, indicating enhanced tissue repair and regeneration capabilities. The reference standard, Silver Nitrate, also demonstrated a significant increase **(**5.665 ± 0.114**),** supporting the overall trend that the treatments effectively promote protein synthesis essential for wound healing.

Hydroxyproline is a major component of collagen. Its measurement reflects collagen deposition, crucial for tissue strength and repair. All treatment groups (PT, PTE, and PTO) increased hydroxyproline levels compared to the sham control group, indicating enhanced collagen synthesis and wound healing potential. Among the treatments, emulgel (78.55 ± 0.096) showed the closest results to the standard silver nitrate (82.73 ± 0.114), followed by ointment (73.37 ± 0.209) and P T (66.86 ± 0.048). ANOVA and Tukey's post hoc test confirm significant differences between groups ($P < 0.0001$), with the standard treatment outperforming all others, while Emulgel exhibited superior efficacy over oil and ointment.

Hexosamine is involved in the synthesis of glycosaminoglycans, essential for extracellular matrix formation, which supports wound repair. The hexosamine results showed that the standard (silver nitrate), Prapaundarikadya taila, emulgel, and ointment treatments all increased hexosamine levels compared to the sham control, indicating improved glycosaminoglycan synthesis, which plays a key role in wound healing. The PTO group (0.862 ± 0.209) had the highest hexosamine levels, followed closely by PTE (0.842 ± 0.096) and the standard (0.842 ± 0.114), with minimal variation between these groups. Statistical analysis (ANOVA) revealed significant differences between groups ($P = 0.0023$), and Tukey's test confirmed that all treatments significantly improved hexosamine content compared to the sham control, further suggesting enhanced tissue repair.

SOD is an enzyme that neutralizes superoxide radicals, protecting cells from oxidative damage and promoting the wound healing process. The Superoxide Dismutase (SOD) results indicate a significant variation in oxidative stress across the treatment groups. The sham control group showed the highest SOD levels (1609.45 ± 12.03), indicating a healthy oxidative balance. Silver nitrate (1035.47 ± 50.29, $P < 0.01$) and Prapaundarikadya taila treatment (877.03 ± 33.88, $P < 0.01$) significantly reduced SOD levels compared to the sham control, suggesting higher oxidative stress. PTE (1374.75 ± 24.87) and PTO (1563.55 ± 12.69) showed a decrease in SOD levels, but this reduction was not statistically significant compared to the sham control. The ANOVA results ($P = 0.0076$) confirm that the groups differ significantly. Dunnett's post hoc test highlights that Prapaundarikadya taila and silver nitrate treatments caused significant reductions in SOD, while emulgel and ointment did not show substantial changes. Thus, the PT treatment aligns more closely with the standard silver nitrate in reducing oxidative stress, while emulgel and ointment maintain SOD levels closer to the sham control, indicating moderate antioxidant effects.

LPO measures oxidative degradation of lipids, and lower levels indicate reduced oxidative stress, beneficial for the wound healing environment. The results of the LPO (Lipid Peroxidation) analysis suggest a significant decrease in LPO levels in the treated groups compared to the Sham control group. The Sham control group exhibited the highest LPO levels (6.772 ± 0.021), indicating increased oxidative stress, which is detrimental to the wound healing process. All treated groups—Trial 1 (PT), Trial 2 (Emulgel), and Trial 3 (Ointment)—demonstrated significantly reduced LPO levels (3.230 ± 0.087, 3.004 ± 0.199, and 3.043 ± 0.127, respectively). This reduction is a positive indication of diminished oxidative stress and enhanced healing potential. The Silver Nitrate standard group also showed decreased LPO levels (6.585 ± 0.016), but the difference compared to the Sham control was not statistically significant. The treated groups (Trials 1, 2, and 3) showed more substantial reductions in LPO levels compared to the Silver Nitrate group, demonstrating the superior antioxidant activity and potential wound-healing efficacy of the treatments under study. Thus, the treatments effectively reduced oxidative damage, aiding in the wound healing process.

GSH is a vital antioxidant that helps neutralize free radicals and supports cellular defense mechanisms, enhancing tissue repair in wounds. The tissue glutathione (GSH) levels varied significantly among the different treatment groups. The Sham Control group exhibited the highest GSH levels (111.44 ± 1.091), indicating higher oxidative stress. The Standard (Silver Nitrate) group had the lowest GSH levels (21.004 ± 1.281), suggesting reduced oxidative stress due to the treatment. Among the trial groups, the oil-treated group showed relatively high GSH levels (99.63 ± 0.966), while the PTE (84.166 ± 0.361) and PTO (92.034 ± 0.536) groups exhibited moderate GSH levels.

Table 1: Composition of Trial 1 (Prapaundarikadya Taila)

Ingredients	Parts used	Quantity
Prapaundarika	Stem	1/4th part
Yashtimadhu	Root	1/4th part
Kakoli	Root	1/4th part
Ksheera kakoli	Root	1/4th part
Shweta Chandana	Heart wood	1/4th part
Rakta Chandana	Heart wood	1/4th part
Seasame oil	Seeds	1 part
Water	4 parts	

Table 2: Composition of Trial 2 (Prapaundarikadya Taila Emulgel)

Ingredients	Quantity (in grams)
Carbopol	2
Tween 80	2.16
Span 80	0.84
Methyl paraben	0.3
Triethanolamine	q.s
Water	q.s
Prapaundarikadya taila	15

Table 3: Quantity of Ingredients for Ointment Base

Ingredients	Quantity (in grams)
Bees wax	20
Emulsifying wax	2.5

Table 4: Composition of Trial 3 (Prapaundarikadya Taila Ointment)

Ingredients	Quantity
Ointment base	22.5g
Prapaundarikadya taila	77.5ml

Table 5: Details of Experimental Animals

Species	Wistar Albino Rats
Age/weight/gender	8–10-week-old /150-200 gm wt./either sex (6 female rats for dermal toxicity study)
No. of rats used	30
IAEC approval No.	FPS/IAEC/171/2024
No of days each animal housed	40 days
Animals procured from	Biogen Laboratory Animal Facility Survey No.162, 1st cross, TVS road, near Anekal- TVS road cross attibele, Bengaluru, Karnataka, India
CPCSEA Reg. No	971/PO/RcBiBt/S2006/CPCSEA

Table 6: Treatment Schedule for Wound Healing Activity

Group	Animal number	Group	Treatment	Dose & Route	Duration of treatment
I	6	Sham control	Excision wound Vehicle (tila taila)	3.33 %w/v (Topical)[9]	1st to 16th day
II	6	Standard	Excision wound Silver Nitrate ointment	0.2%w/w (Topical)	1st to 16th day
III	6	Trial - 1	Excision wound Prapaundarikadya taila	1000mg/kg (Topical)	1st to 16th day
IV	6	Trial - 2	E Excision wound P Prapaundarikadya taila emulgel	250 mg /kg (Topical)	1st to 16th day
V	6	Trial - 3	Excision wound Prapaundarikadya taila ointment	500 mg /kg (Topical)	1st to 16th day

Table 7: Percentage of Wound Area Contraction Occurring with treatment of Prapaundarikadya Taila, Emulgel and Ointment

Group	Group name	Percentage of change in wound area contraction		
		Day 0	Day 8	Day 16
I	Sham control	100	43.01	62.61
II	STD (Silver nitrate)	100	47.86	75.91
III	PT (Trial 1)	100	65.20	96.29***
IV	PTE (Trial 2)	100	67.47***	95.48***
V	PTO (Trial 3)	100	55.70	89.36

Values in parentheses represents %percentage wound contraction); ***P<0.0001 compared to Day 0

Table 8: Mean of change in Epithelization Period occurring with treatment of Prapaundarikadya Taila, Emulgel and Ointment

Group	Group name	Epithelialization period in days
I	Sham Control	23.67±2.805
II	STD (Silver Nitrate)	18.83±2.317**
III	Prapaundarikadya taila (oil) (Trial 1)	24.17±2.318
IV	Prapaundarikadya emulgel (Trial 2)	22.33±2.160
V	Prapaundarikadya ointment (Trial 3)	20.00±2.366*

Effect of Prapaundarikadya trials treated groups on Epithelialization period. Values are expressed in Mean±S.D. for six animals. *P ≤0.01; **P≤0.001; *** P≤0.0001 as compared using Dunnett's Multiple Comparison Test.

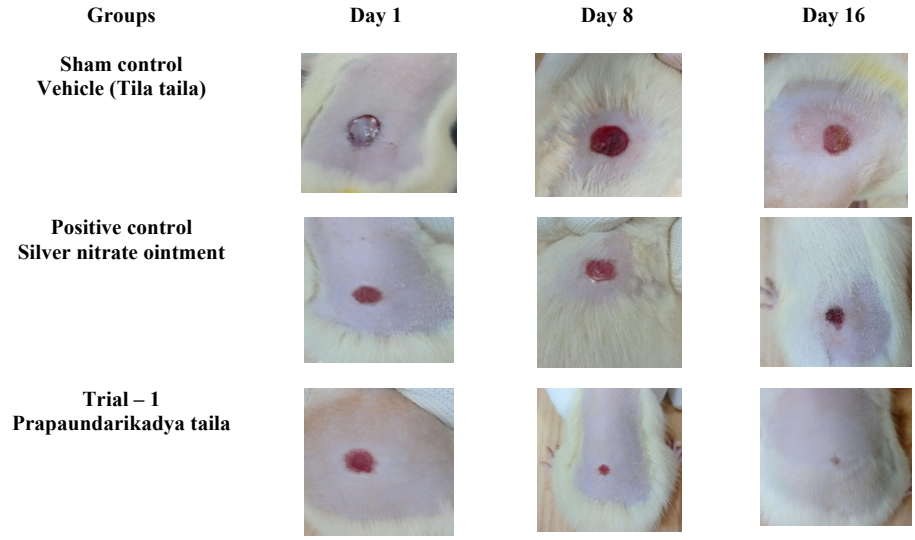
Table 9: Mean and Standard Error Values of Biochemical Parameters

Group	Total protein	Hydroxyproline	Hexosamine
Sham Control	3.039 ± 0.154	44.65 ± 0.1548	0.610 ± 0.1548
STD (Silver Nitrate)	5.665 ± 0.114***	82.73 ± 0.1144	0.842 ± 0.1144
Trial 1 (PT)	6.132 ± 0.048***	66.86 ± 0.0488	0.822 ± 0.0488
Trial 2 (PTE)	5.920 ± 0.096***	78.55 ± 0.0964	0.842 ± 0.0964
Trial 3 (PTO)	4.421 ± 0.209***	73.37 ± 0.2099	0.862 ± 0.2099

Table 10: Mean and Standard Error Values of Tissue Antioxidant Parameters

Group	SOD	LPO	GSH
Sham Control	1609.45 ± 12.03	6.772 ± 0.021	21.004 ± 1.281
Standard (Silver nitrate)	1035.47 ± 50.29**	6.585 ±0.016ns	111.44 ±1.091***
Trial 1 (PT)	877.03 ± 33.88**	3.230 ±0.087***	99.63 ± 0.966***
Trial 2 (PTE)	1374.75 ± 24.87ns	3.004 ±0.199***	84.166 ± 0.361***
Trial 3 (PTO)	1563.55 ± 12.69 ns	3.043 ±0.127***	92.034 ± 0.536***

Figure 1: Trial drugs



Trial – 2 Prapaundarikadya taila emulgel

Trial – 3 Prapaundarikadya taila ointment

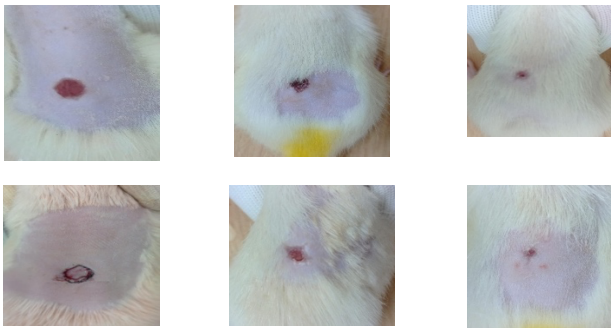
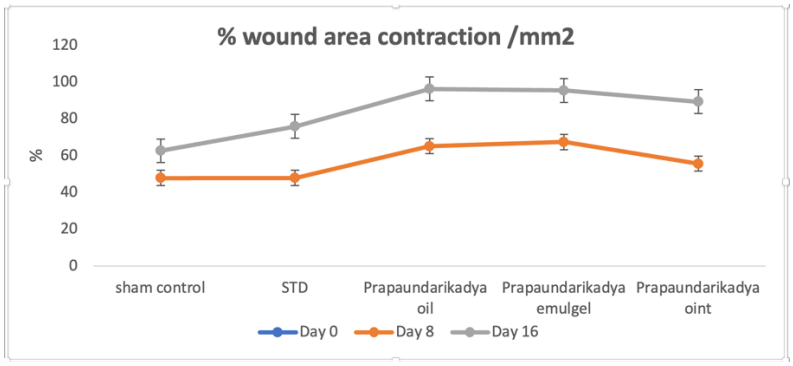
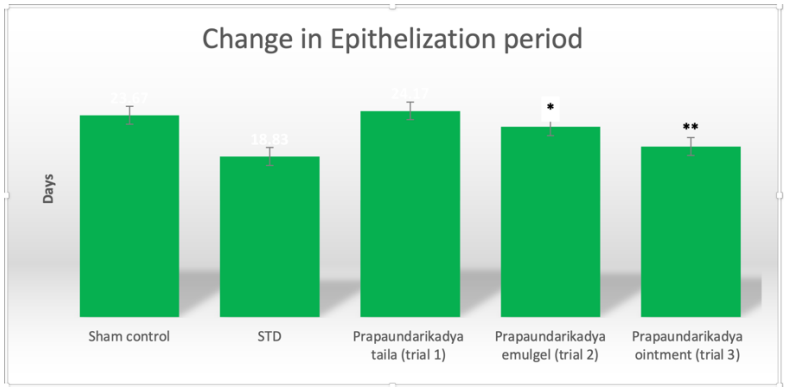


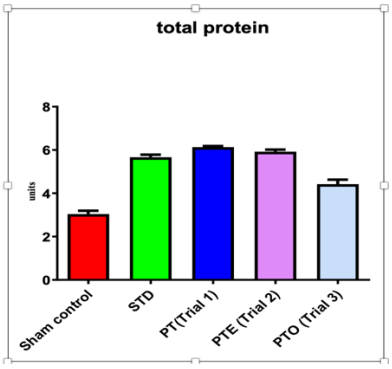
Figure 2: Wound healing images of different trial on day 1st , 8th and 16th day



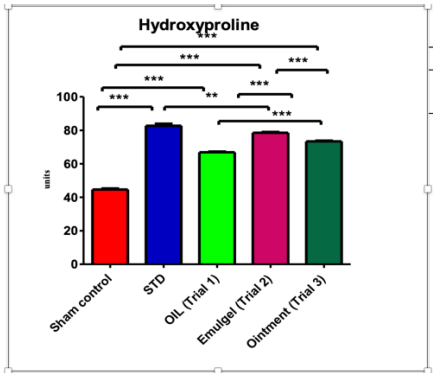
Graph 1: Effect of trials on wound contractions



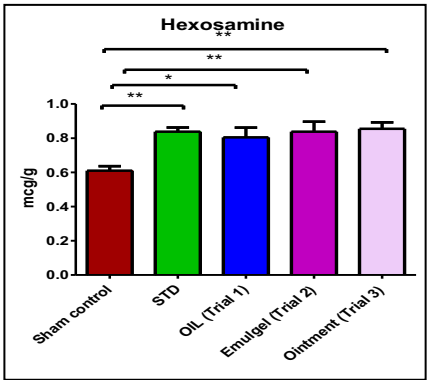
Graph 2: Effect of trials on epithelialization



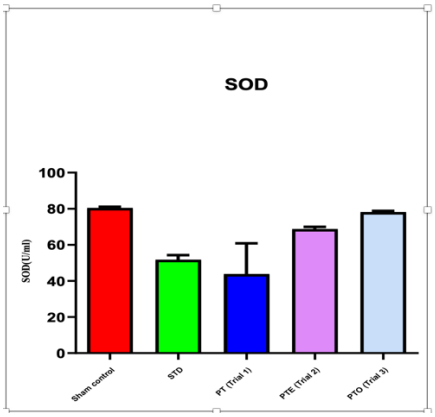
Graph 3: Effect of trials on total protein



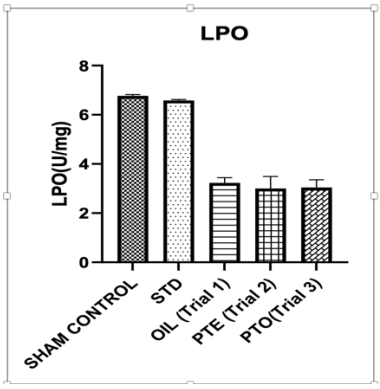
Graph 4: Effect of trials on hydroxyproline



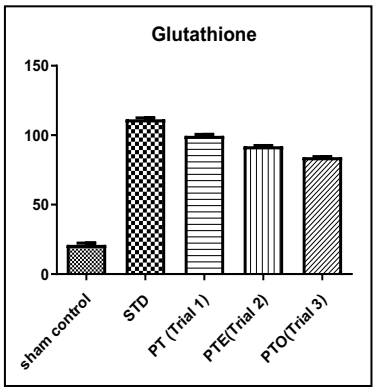
Graph 5: Effect of trials on hexosamine



Graph 6: Effect of trials on SOD



Graph 7: Effect of trials on LPO



Graph 9: Effect of trials on glutathione

DISCUSSION

All treatments promoted progressive wound contraction over 16 days, with significant improvement compared to the Sham Control. By day 16, the Prapaundarikadya taila, Emulgel, and Ointment treatments showed higher percentages of wound contraction (96.29%, 95.48%, and 89.37%, respectively), compared to the Silver Nitrate group (75.91%). These results suggest that the trial treatments enhanced the wound healing process more effectively than the standard treatment. The Silver Nitrate treatment significantly reduced the epithelization period (18.83 days) compared to the Sham Control, indicating its efficacy in promoting rapid wound closure. While the Prapaundarikadya taila (24.17 days) and Emulgel (22.33 days) showed improvement, they were not as effective as Silver Nitrate. The Ointment treatment (20 days) demonstrated moderate efficacy but did not achieve statistical significance. All treatments increased protein levels, indicating enhanced tissue repair. The Prapaundarikadya taila treated group had the highest protein concentration, followed by Emulgel and Ointment, with Silver Nitrate showing comparable effects. Collagen synthesis was promoted by all treatments, with Emulgel showing results closest to the Silver Nitrate standard, reflecting strong potential for tissue strength and repair. Hexosamine levels were elevated in all treated groups, with Ointment showing the highest increase, indicating enhanced extracellular matrix formation essential for wound healing. Silver Nitrate and Prapaundarikadya taila treatments significantly reduced SOD levels, indicating higher oxidative stress, while Emulgel and Ointment maintained SOD levels closer to the Sham Control, indicating moderate antioxidant effects. All trial treatments significantly reduced LPO levels compared to the Sham Control, suggesting better oxidative stress management and enhanced healing potential. Silver Nitrate treatment reduced GSH levels, indicating reduced oxidative stress, while the Prapaundarikadya taila treated group had the highest GSH levels, followed by Emulgel and Ointment.

Emulgels offer a unique drug delivery system by combining the properties of emulsions and gels. They enhance drug delivery to the skin through improved bio adhesion and controlled release, ensuring localized treatment. Additionally, emulgels provide better stability and patient compliance compared to traditional formulations. Ointments work primarily by forming an occlusive layer on the skin, which enhances hydration and promotes prolonged contact time of active ingredients. This facilitates deeper penetration of the active components into the skin layers, aiding in sustained therapeutic action.

The formulation Prapaundarikadya taila chosen for the study is indicated in vrana ropana (wound healing), containing ingredients, Tila taila, Prapaundarika, Yashtimadhu, kakoli, Ksheerakakoli, Chandana, and Raktachandana. Most of all the drugs possess madhura rasa, which is balakrita and sandhanakara, which is useful for wound healing. Prapaundarika, Chandana, and Raktachandana possess tikta and kashaya rasa. Tikta rasa is very helpful in performing shodhana of Kapha, it will scrape out the kledata and puya srava in vrana sthana. It has the special property of twak mamsasthirikarana, which helps to provide wound healing strength to local tissue. Kashaya rasa acts as a styptic and contributes to arrest bleeding because of its stambana guna. Sandhana guna of kashaya rasa helps in fastening the process of wound contraction and ropana karma helps in the formation of healthy granulation tissue, which is very necessary for the wound healing process. The properties of drugs like sandhana, ropana, and varnya, will contribute to the elimination of localized doshas in the site of vrana and help in wound healing. Chandana and Prapaundarika has laghu guna all other drugs have guru and snigdha guna. Guru and snigdha guna promote vrana ropana

whereas Kaphaghna and srotoshodhana property of laghu guna help in clearing the srotas and aid in the proliferation of surrounding connective tissue elements and capillaries that migrate into the site to be repaired. Chandana, Raktachandana and Tila taila have katu vipaka and all the other ingredients have madhura vipaka. Madhura vipaka helps to reduce the vitiated Vata dosha and katu viapaka helps to reduce Kapha dosha and helps to reduce pain and enhance healing. Except for Tila taila all ingredients have sheeta veerya. Sheeta veerya helps to pacify Pitta dosha. It also enhances Sandhana Karma and thus fastens the wound healing. Whereas ushna veerya of tila taila helps in Vrana shodhna. When a combination of these drugs is applied externally this helps in vrana ropana more than vrana shodhana. The lipophilic nature of the oil allows for efficient transport to target cells and subsequent delivery into the cell, facilitated by the lipid composition of the cell membrane. The phytoconstituents of the herbal drugs possess anti-inflammatory, antibacterial, and wound healing properties. Thus, the whole formulation of Prapaundarikadya taila and modified form of emulgel may be useful in wound healing, as the treated rats have shown better results when compared to the ointment treated group and sham control group.

CONCLUSION

The results demonstrate that all treatment groups, particularly the Prapaundarikadya taila and Prapaundarikadya taila Emulgel, effectively enhanced wound healing, as evidenced by faster wound contraction, increased collagen and protein synthesis, and improved antioxidant defense. Silver Nitrate remains a strong reference standard for wound healing, particularly in reducing the epithelization period. With the factual evidence obtained by experimental data, it has been concluded that both Prapaundarikadya taila and modified Emulgel, showed promising results in both biochemical and antioxidant parameters, suggesting potential as effective alternatives for wound care. The Prapaundarikadya taila Ointment treatment demonstrated moderate efficacy in wound healing but was less effective than the Prapaundarikadya taila or Emulgel formulations. The Prapaundarikadya taila can be considered as best for wound healing by observing the whole study. Both the Emulgel and ointment formulations of Prapaundarikadya Taila demonstrated efficacy, with the Emulgel providing a novel and effective approach for wound healing due to its stability, ease of application, and wound healing property.

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