

Original Article

## From peel to heal: A polyherbal gel with antibacterial and wound healing benefits

Jorige Archana<sup>1</sup>, Taha Yasmeen<sup>1</sup>

<sup>1</sup>Department of Pharmacology, Raja Bahadur Venkata Rama Reddy Women's College of Pharmacy, Hyderabad, Telangana, India.

**\*Corresponding author:**

Dr. Jorige Archana,  
Professor and Head,  
Department of Pharmacology,  
Raja Bahadur Venkata Rama  
Reddy Women's College  
of Pharmacy, Hyderabad,  
Telangana, India.

archanacology@gmail.com

Received: 06 June 2024  
Accepted: 28 January 2025  
EPub Ahead of Print: 10 July 2025  
Published: 12 March 2026

DOI  
10.25259/IJPP\_297\_2024

Quick Response Code:



### ABSTRACT

**Objectives:** Wound healing and antimicrobial activity are closely linked, as infections can significantly impair healing by affecting granulation tissue development and tensile strength. Bacteria in wounds form bio films and secrete chemicals that disrupt the skin's defences. This persistent infection hampers the immune cells' ability to eliminate bacteria, stalling the skin and cell renewal processes. So aqueous peel extracts of *Musa paradisiaca*, *Carica papaya*, and *Phaseolus vulgaris* were studied for antibacterial activity against various bacterial strains. and their wound healing activity is evaluated in combination as a Polyherbal gel (PHG).

**Materials and Methods:** Aqueous extracts of peels of *Musa paradisiaca*, *Carica papaya*, and *Phaseolus vulgaris* were prepared by maceration and antibacterial activity was evaluated against pathogenic strains. A 5% polyherbal gel was prepared using peel extracts to evaluate dermal toxicity and wound healing potential in an incision wound model in rats.

**Results:** the antibacterial activity of *Phaseolus vulgaris* was highest against *Proteus mirabilis* (43.25±0.94 mm), followed by *Carica papaya* (42.95 ± 0.048 mm), and finally, *Musa paradisiaca* (41.41 ± 0.36 mm), which exhibited the highest antibacterial activity against *E. coli*. Rats treated with PHG had an earlier epithelialisation period (12.6 ± 0.614 days) than the control group. An increase in wound breaking strength of 23.37 ± 0.235 g and raised levels of hydroxyproline of 0.126 ± 0.00073 µg were observed in all PHG-treated rats. The PHG formulation developed from the combination of aqueous extracts of *Musa paradisiaca*, *Carica papaya*, and *Phaseolus vulgaris* showed wound recovery effects on various phases of healing cascades.

**Conclusion:** The antimicrobial properties of peel extracts may significantly contribute to improved collagen synthesis, increased wound breaking strength, and decreased microbial load, all of which enhance the wound healing process.

**Keywords:** Antibacterial, *Carica papaya*, Hydroxyproline, *Musa paradisiaca*, *Phaseolus vulgaris*, Polyherbal gel, Wound healing

### INTRODUCTION

Wound healing is a normal physiological reaction to tissue injury that involves a complex interaction of many cell types, cytokines, mediators and the vascular system. This process is separated into four phases: haemostasis, inflammation, proliferation and tissue remodelling. Each phase must occur in the proper order, at the right time, and at the right intensity for the best results.<sup>[1]</sup> During the pre- and post-harvesting procedures of fruits and vegetables, a substantial amount of peel waste is generated. Typically, this material ends up in landfills, causing environmental risks. Recent research has revealed that these peels contain a variety of bioactive chemicals, including steroids, glycosides,

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 License, which allows others to remix, transform, and build upon the work non-commercially, as long as the author is credited and the new creations are licensed under the identical terms.  
©2026 Published by Scientific Scholar on behalf of Indian Journal of Physiology and Pharmacology

phenols, flavonoids, triterpenoids, tannins, carotenoids, ellagitannins, Vitamin C, anthocyanins and essential oils. Efficient extraction of these chemicals can significantly increase the value of the peels. Fruit and vegetable peels can be used to reduce environmental impact and improve health by adding these health-promoting chemicals into enriched food items. Fruit and vegetable peels contain bioactive compounds that have been shown to have a variety of health benefits, including promoting wound healing, treating acne, combating diarrhoea and rotavirus, addressing degenerative muscular diseases and fighting bacterial and fungal infections. In addition, these control cancer, malaria, coughs, allergies, cardiovascular complications, diabetes, liver disease, dental plaque and inflammatory ailments such as rheumatism and menstrual pain. These chemicals also increase metabolism, lower blood pressure and promote skin health.<sup>[2,3]</sup> Medicinal plants speed up tissue repair, fight infection and encourage blood clotting to help wounds heal.<sup>[4]</sup>

There has been extensive research on the pulp of fruits such as bananas (*Musa paradisiaca*), papayas (*Carica papaya*) and French beans (*Phaseolus vulgaris*), but little attention has been given to the wound-healing properties of their peels. Furthermore, there have been no reports of polyherbal gel (PHG) formulations that integrate peels from fruits and vegetables. Therefore, this study aims to explore the antibacterial properties of these peels and their wound-healing activity in combination.

## MATERIALS AND METHODS

### Preparation of peel extracts

Peels from the related pods of *P. vulgaris* (*Fabaceae* family), *M. paradisiaca* (*Musaceae* family) and *C. papaya* (*Caricaceae* family) were gathered from the local market. The peels were carefully rinsed, dried and pulverised into a fine powder. Each peel powder was macerated with water for a duration of 3 days. Following maceration, muslin cloth was used to filter the mixture before it was put through a rotary evaporator to evaporate. At least, two iterations of this extraction process were conducted. The dry extracts that resulted were combined, weighed and kept at 4°C in sealed containers.<sup>[5,6]</sup> The per cent yield of all extracts was calculated using the following formula.

$$\text{Yield (\%)} = \left( \frac{\text{Dry weight of extract}}{\text{Dry weight of Plant material}} \right) \times 100$$

### Preliminary phytochemical analysis of peel extracts

#### Test for carbohydrates

To 2 mL of filtrate, two drops of alpha-naphthol and 1 mL of Conc. H<sub>2</sub>SO<sub>4</sub> were added (alongside of test tube). The presence or absence of a violet ring was observed.

#### Test for tannins

To 2 mL of filtrate, 5–10 drops of 10% lead acetate was added, presence or absence of yellow precipitate was observed.

#### Test for alkaloids

The filtrate was mixed with 2 mL of Dragendroff's reagent. The presence or absence of a reddish-brown precipitate was observed.

#### Test for reducing sugars

0.5 mL Benedict's reagent was added to 0.5 mL of filtrate and boiled for 2 min. The presence or absence of red colour precipitate was observed.

#### Test for glycosides

To 1 mL of extract, 1 mL of 0.1 M Sodium Hydroxide was added and diluted with distilled water. Presence or absence of yellow colour was observed.

#### Test for proteins

To 1 mL of filtrate, a few drops of sodium hydroxide (10%) two drops of copper sulphate (3%) and were added. The presence or absence of violet or red colour was observed.

#### Test for amino acids

To 2 mL of filtrate, few drops of ninhydrin were added. Presence or absence of purple colour was observed.

#### Test for flavonoids

To 2 mL of filtrate, a few drops of NaOH were added. A deep yellow colour converted to a colourless solution after the addition of dilute HCl was observed.

### Evaluation of antibacterial effect of peel extracts

Plant extracts' antibacterial capacity was evaluated on Mueller–Hinton agar plates with selected Gram-negative and Gram-positive bacteria.<sup>[7]</sup> All organisms obtained and well identified by the Department of Microbiology, Osmania University, Hyderabad. The bacterial strains were inoculated in nutritional broth and incubated at 37°C throughout the night to adjust the turbidity to 0.5 McFarland standards, giving a final inoculum of 1.5 × 10<sup>8</sup> Colony forming units (CFU)/mL. The plates were lawn-cultured using standardised microbial culture broth. Plant extracts with concentrations of 300 mg/mL and 0.5 mg/mL of Ofloxacin (used as a reference) were prepared using Dimethyl Sulfoxide. Six wells measuring 9 mm in diameter were drilled into the inoculation material of the agar plate using a sterile borer. Using a sterile

micropipette, 50 µL of the standard and tests were added into the wells. After that, the plates were placed at 37°C in a bio-oxygen demand incubator for 24 h. Each bacterial strain's zone of inhibition was evaluated following incubation.

### Preparation of PHG

In a beaker, the required amount of Carbopol 940 was dissolved in distilled water with continuous stirring. The Carbopol was allowed to swell overnight in the beaker. 0.2 mL of 0.5% methylparaben, 5 mL of distilled water and 0.1 mL of 0.2% propylparaben were mixed and heated in a water bath. Glycerine was added to this mixture when it had cooled, and then the necessary amount of each extract was added. After that, this blended material was well-mixed. Continuous stirring was used to integrate the final product into the premade Carbopol gel base to give a PHG. To get the mixture to the proper skin pH, NaOH was added dropwise. The desired gel consistency was obtained by adding a sufficient quantity of water. The composition of PHG is given in Table 1.

Ingredients	Quantity
Carbopol-934	0.2 g
<i>Musa paradisiaca</i>	1 g
<i>Carica papaya</i>	1 g
<i>Phaseolus vulgaris</i>	1 g
Glycerin	2 mL
NaOH (1%)	Q.s
Methyl paraben	0.2 mL
Propyl paraben	0.1 mL
Distilled water	Up to 20 g
PHG: Polyherbal gel	

### Evaluation of *in vivo* wound healing activity

#### Animals

Albino male Wistar rats of 180–200 g weight were employed in the study. The animals were maintained at the standard laboratory conditions with 12 h light and dark cycle. They were fed with standard pellets and water ad libitum. The study protocol was approved by Institutional animal ethics committee (IAEC) (RBVRR/1320/08/2023.), RBVRR Women's College of Pharmacy (RBVRRWCoP).

#### Acute dermal toxicity study

Acute dermal toxicity study was performed by a limit test at 2000 mg/kg dose. Six rats were divided into two groups comprising three animals each. 10% hair was depilated from dorsal area. Group I received topical application of gel base

**Table 2:** Experimental design.

Groups	Treatment
Group 1 (n=6)	Control (Gel base applied topically)
Group 2 (n=6)	Standard (5% w/w Povidone iodine ointment topically)
Group 3 (n=6)	PHG (5%) applied topically
PHG: Polyherbal gel, n: number of rats	

and regarded as control group. Group II received 5% PHG topically at a dose of 2000 mg/kg. All animals were kept under observation for 14 days for any signs of dermal toxicity.

#### Incision wound model

Eighteen rats were segregated into three groups each containing six animals and were allowed to treatment schedule, as shown in Table 2.

The animals were anaesthetised, and a 2 cm paravertebral incision was made through the full thickness of the shaved skin on both sides of the vertebral column using a sharp scalpel. After achieving complete haemostasis, the wounds were closed with interrupted sutures spaced a few cm apart. Following suturing, the wound was left undressed, and 200 mg of simple gel base, standard drug (Povidone Iodine) and PHG were applied to respective groups topically to the wound area starting from the 1<sup>st</sup> day and continuing for 9 days. On the 10<sup>th</sup> day, rats were anaesthetised and the sutures were removed to measure wound-breaking strength (WBS).<sup>[8]</sup>

WBS was measured on the 10<sup>th</sup> day of the first incision. The rats were anaesthetised. Both sides of the wound were grasped with forceps, ensuring that the edges were aligned and directly opposing each other. One side of the forceps was fixed and the other side was connected to a measuring cylinder made up of polypropylene, through a string run over to a pulley. By gradually increasing the water level, the wound edges can be separated from the fixed end. The weight of the water was recorded at the moment the wound began to open.<sup>[9]</sup> The WBS was calculated using the following formula:

$$\text{WBS} = \text{Breaking Strength (g)} / \text{Cross section area of skin (mm}^2\text{)}$$

The epithelisation period was evaluated by counting the number of days required for scaling off the dead tissue remnants from the wound surface, leaving a raw wound behind.<sup>[10]</sup>

The tissue collected from the wound was analysed for hydroxyproline content. The tissue was dried in a hot air oven at 60–70°C and subjected to hydrolysis in 6 N HCl at 130°C for 4 h in sealed tubes. 450 µL of chloramine-T was mixed with hydrolysate and the oxidation was allowed

to proceed for 25 min at room temperature. 0.5 mL of Ehrlich's aldehyde reagent was added to each sample, mixed gently and incubated the samples at 65°C for 20 min. The absorbance of each sample was read at 550 nm using a UV spectrophotometer.<sup>[11]</sup>

### Statistical analysis

Statistical analysis was conducted using GraphPad Prism 10. All values are expressed as Mean  $\pm$  Standard Error Mean (SEM). Data were analysed using a one-way analysis of variance, followed by the Tukey-Kramer Multiple Comparisons Test, with significance levels set at  $P < 0.1$ ,  $P < 0.01$ ,  $P < 0.001$  and  $P < 0.0001$ .

## RESULTS

### Percentage yield of peel extracts

The percentage yield of each peel extract was calculated. It was observed that *M. paradisiaca* and *C. papaya* showed nearby yields, whereas *P. vulgaris* showed a higher yield, as depicted in Table 3.

### Phytochemical analysis of peel extracts

The preliminary phytochemical screening of *M. paradisiaca*, *C. papaya* and *P. vulgaris* showed the presence of various phytochemicals, alkaloids, tannins, glycosides, amino acids, proteins and flavonoids [Table 4].

S. No.	Plant name	Yield (%)
1	<i>Phaseolus vulgaris</i>	15.44
2	<i>Musa paradisiaca</i>	10.2
3	<i>Carica papaya</i>	9.56

Phytochemicals	<i>Musa paradisiaca</i>	<i>Carica papaya</i>	<i>Phaseolus vulgaris</i>
Carbohydrates	+	+	+
Tannins	+	+	+
Alkaloids	+	+	+
Reducing sugars	--	--	+
Glycosides	+	+	+
Proteins	+	+	+
Amino acids	+	+	+
Flavonoids	+	+	+

Where (+): Present, (--) : Absent

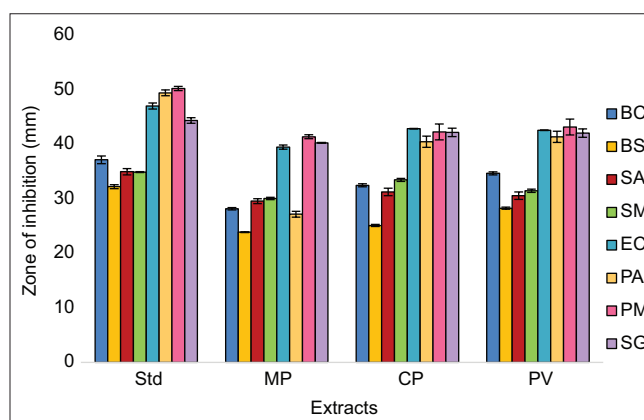
### Evaluation of *In vitro* antibacterial activity of peel extracts

The antibacterial activity of the various peel extracts exhibited different levels of zone of inhibition against the selected microorganism as shown in Figure 1, when tested by the agar well diffusion method. From the selected peel extracts, *P. vulgaris* showed excellent antibacterial activity when compared to others as it showed good zones of inhibition which is similar to the standard. *P. vulgaris* showed maximum antibacterial activity against *Proteus mirabilis* (43.25 $\pm$ 0.94 mm), whereas *C. papaya* showed maximum antibacterial activity against *Escherichia coli* (42.95  $\pm$  0.048 mm) and last *M. paradisiaca* showed maximum antibacterial activity against *Proteus mirabilis* (41.41  $\pm$  0.36 mm), as indicated in Figure 1.

### Evaluation of *in vivo* wound healing activity

#### PHG characterisation

The formulated PHG was evaluated for various characteristics which include its physical parameters through visual observation, the gel was dark brown in colour, homogenous texture with no grittiness, whereas pH, spreadability and extrudability of gel were also good, as shown in Table 5.



**Figure 1:** Comparison of antimicrobial efficacy of Standard (at 0.5mg/ml) with peels extracts (at 300mg/ml) against different Microorganisms. Std: Standard; MP: *Musa paradisiaca*; CP: *Carica papaya*; PV: *Phaseolus vulgaris*; BC: *Bacillus cereus*; BS: *Bacillus subtilis*; SA: *Staphylococcus aureus*; SM: *Streptococcus mutans*; EC: *E.coli*; PA: *Pseudomonas aeruginosa*; PM: *Proteus mirabilis*; SG: *Streptococcus gordonii*

Physical parameters	pH	Spreadability	Extrudability
Dark brown, homogenous, no grittiness	7.03	36.3	Good

PHG: Polyherbal gel

### Acute dermal toxicity

No signs of skin irritation, adverse reactions or behaviour were observed in PHG (5%) treated animals. The animals were found active with no mortality for the period of 14 days of observation. These served as the foundation for determining if the formulation was safe for dermatological use.

### Incision wound model

Control rats manifested WBS as  $11.47 \pm 0.359$  g on the 10<sup>th</sup> post-wound day. PHG-treated rats showed WBS as  $23.37 \pm 0.235$  g ( $P < 0.0001$ ), while standard-treated rats showed WBS as  $24.38 \pm 0.223$  g ( $P < 0.0001$ ). Wound-breaking strength for the test and standard group was found to be significantly more than the control group, as shown in Figure 2.

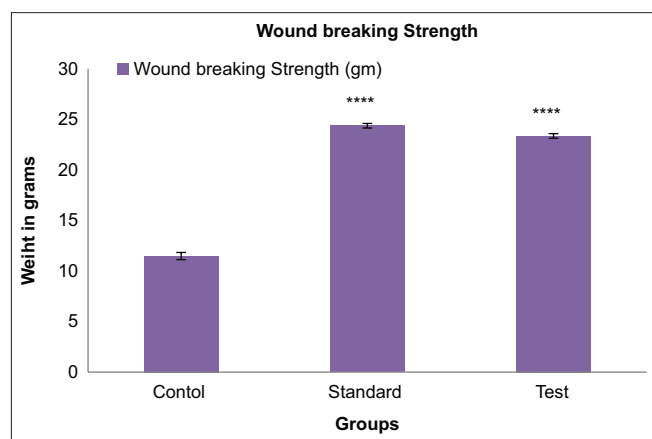
The mean epithelialisation period observed with control rats was  $22.5 \pm 0.619$  days, while the mean epithelialisation

period observed with PHG-treated rats and standard-treated rats was  $12.6 \pm 0.614$  days ( $P < 0.001$ ), and  $11.5 \pm 0.562$  days ( $P < 0.0001$ ), respectively. The epithelialisation period in the test and standard groups was significantly reduced compared to the control group, as depicted in Figure 3.

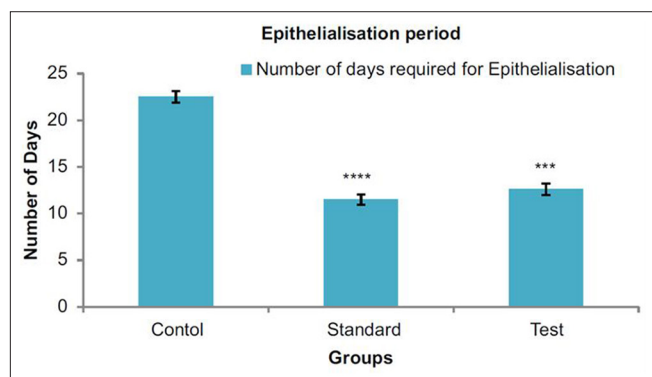
Control rats showed  $0.073 \pm 0.00057$   $\mu$ g of hydroxyproline, while PHG-treated rats showed  $0.126 \pm 0.00073$   $\mu$ g of hydroxyproline ( $P < 0.0001$ ), whereas standard treated rats showed  $0.131 \pm 0.00083$   $\mu$ g of hydroxyproline ( $P < 0.0001$ ). The test and standard groups demonstrated a significant rise in hydroxyproline levels when compared with the control group, as shown in Figure 4.

## DISCUSSION

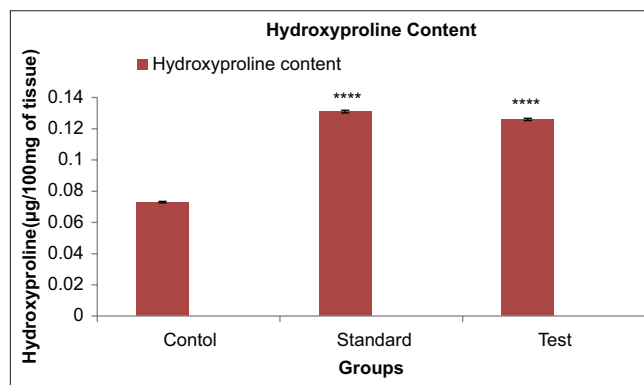
The literature has extensively demonstrated the ethnotherapeutic efficacy of *M. paradisiaca*, *C. papaya* and *P. vulgaris*, especially their ability to effectively combat *Pseudomonas aeruginosa*. This microbe is a major contributor to several skin infections, which can cause meningitis, cystic fibrosis, subcutaneous nodules, fluid-filled lesions, metastatic abscesses and musculoskeletal infections.<sup>[12]</sup> The pathophysiology of *Proteus mirabilis* in wound infections, as well as its antibiotic resistance, provide substantial challenges worldwide. Protein bioactive substances from *P. vulgaris* may be a promising choice for the treatment of Enterobacterales such as *Proteus mirabilis*.<sup>[13]</sup> The choice of polar solvents to extract biologically active components from the peels is largely responsible for the aqueous extracts' exceptional antibacterial properties against a variety of human infections.<sup>[14]</sup> Choosing to include these peels in a gel improves the formulation's all-around antibacterial effectiveness. *C. papaya's* main active ingredients are flavonoids and polyphenols, which have antibacterial and antioxidant qualities.<sup>[15]</sup> *P. vulgaris* is abundant in chemicals known as phytosterols and phytostanols which possess potent broad-spectrum antibacterial and antifungal efficacy.<sup>[16]</sup>



**Figure 2:** Effect of Poly Herbal Gel (Test) on Wound breaking Strength. All values are represented as mean  $\pm$  standard error mean (SEM), n = 6 animals in each group. \*\*\*\* $P < 0.0001$  compared to Normal control



**Figure 3:** Effect of Polyherbal Gel (Test) on Epithelialisation period. All values are represented as mean  $\pm$  standard error mean (SEM), n = 6 animals in each group. \*\*\*\* $P < 0.0001$  compared to Normal control.



**Figure 4:** Effect of Polyherbal gel (Test) on Hydroxyproline content. All values are represented as mean  $\pm$  standard error mean (SEM), n = 6 animals in each group, \*\*\*\* $P < 0.0001$  compared to Normal control.

PHG was found to have improved wound healing activity, with each peel extract having a unique pharmacological significance. *C. papaya* is widely recognised for its antioxidant, immunomodulatory, antibacterial and anti-inflammatory qualities. Papaya's core and secondary bioactive ingredients, including lipase, chymopapain, papain and carotenoids such as lycopene,  $\beta$ -cryptoxanthin and  $\beta$ -carotene, are responsible for its anti-inflammatory and antioxidant characteristics<sup>[17,18]</sup> that underlies wound healing mechanism. *M. paradisiaca* may contain bioactive substances including flavonoids and polyphenols with strong free radical scavenging action.<sup>[19]</sup> This could account for why extract from banana peels heals lesions on the skin. Many therapeutic actions, such as analgesic, anti-inflammatory, antioxidant, antibacterial and antitubercular properties, have been found for *P. vulgaris*. Important chemical components include proteins, carbohydrates, tannins, alkaloids, glycosides, amino acids (tyrosine, leucine, arginine and L-pipecolic acid), flavonoids, allantoin and inositol are probably responsible for these actions. Specifically, allantoin helps hydrate the skin, lessen itching, heal small wounds and enhance the general texture and look of the skin. Faster healing and a lower microbial burden are two benefits of these phytochemical components.<sup>[20,21]</sup>

Wounds treated with PHG show an improvement in WBS, which could be the result of increased collagen concentration and fibre stabilisation. The increased hydroxyproline content in tissues ensures the rise in total protein and collagen contents at the wound site by PHG.

Wounds and bacteria are associated because the former creates biofilms in the wound and releases compounds that interfere with the skin's defence mechanisms. The immune system is unable to eradicate the harmful bacteria causing this ongoing infection, which inhibits the growth of new skin cells. If this wait is prolonged, the wound won't heal. A serious infection may arise from increased bacterial load at the wound site, which could result in problems.<sup>[22]</sup> Antimicrobial activity is a bonus for wound healing because infections can significantly hinder the healing process by decreasing tensile strength and granulation tissue development. By eradicating harmful germs and encouraging efficient granulation tissue production and tensile strength, the PHG formulation's broad-spectrum antibacterial action probably aids in the accelerated healing process.

## CONCLUSION

*P. vulgaris*, *C. papaya* and *M. paradisiaca* peel extracts were evaluated for their antibacterial potential. The prepared PHG with these extracts showed good physical qualities and safety. *In vivo* wound healing studies with PHG showed significant improvements in wound healing that can be attributed to collagen production and lowering the microbial burden

by the PHG formulation which speeds up tissue repair and fortifies wounds, improving wound healing. Further, an investigation that dwells into mechanisms of wound healing by PHG may pave the way to the clinical applicability of this formulation

**Authors' contributions:** AJ: Manuscript design, review and revision of the final manuscript; TY: Literature review, data acquisition and statistical analysis.

**Ethical approval:** The study protocol was approved by Institutional Animal Ethics Committee with approval number (RBVRR/1320/08/2023.), RBVRRWCoP, dated 8th February 2023.

**Declaration of patient consent:** Patient consent was not required as there are no patients in this study.

**Financial support and sponsorship:** Nil.

**Conflicts of interest:** There are no conflicts of interest.

**Use of artificial intelligence (AI)-assisted technology for manuscript preparation:** The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

## REFERENCES

1. Singh S, Young A, McNaught CE. The physiology of wound healing. *Surgery (Oxford)* 2017;35:473-7.
2. Budiati T, Suryaningsih W, Bethiana TN. Antimicrobial of tropical fruit and vegetable waste extract for food-borne pathogenic bacteria. *Italian J Food Saf* 2022;11:10510.
3. Saleem M, Saeed MT. Potential application of waste fruit peels (orange, yellow lemon and banana) as wide range natural antimicrobial agent. *J King Saud Univ Sci* 2020;32:805-10.
4. Nagori BP, Solanki R. Role of medicinal plants in wound healing. *Res J Med Plant* 2011;5:392-405.
5. Chaughule RS, Barve RS. Role of herbal medicines in the treatment of infectious diseases. *Vegetos* 2024;37:41-51.
6. Wolcott RD, Cutting KF, Dowd SE, Percival SL. Types of wounds and infections. In: *Microbiology of wounds*. Boca Raton: CRC Press; 2010. p. 219-32.
7. Abirami S, Jabesta J, Renitta RE, Anand DA, Samrot AV. Antimicrobial activity of flower extracts against wound pathogens and fungi. *Curr Res Green Sustain Chem* 2021;4:100076.
8. Dev SK, Choudhury PK, Srivastava R, Sharma M. Antimicrobial, anti-inflammatory and wound healing activity of polyherbal formulation. *Biomed Pharmacother* 2019;111:555-67.
9. Dwivedi D, Dwivedi M, Malviya S, Singh V. Evaluation of wound healing, anti-microbial and antioxidant potential of *Pongamia pinnata* in wistar rats. *J Tradit Complement Med* 2017;7:79-85.
10. Pawar RS, Chaurasiya PK, Rajak H, Singour PK, Toppo FA, Jain A. Wound healing activity of *Sida cordifolia* Linn. in rats. *Indian J Pharmacol* 2013;45:474-8.
11. Reddy GK, Enwemeka CS. A simplified method for the analysis of hydroxyproline in biological tissues. *Clin Biochem* 1996;29:225-9.

12. OECD. Guidelines for testing of chemicals (Test No. 402), acute dermal toxicity. United States: OECD; 1987.
13. Ebrahim AE, Abd El-Aziz NK, Elariny EY, Shindia A, Osman A, Hozzein WN, *et al.* Antibacterial activity of bioactive compounds extracted from red kidney bean (*Phaseolus vulgaris* L.) seeds against multidrug-resistant Enterobacterales. *Front Microbiol* 2022;13:1035586.
14. Parasuraman S, Thing GS, Dhanaraj SA. Polyherbal formulation: Concept of ayurveda. *Pharmacogn Rev* 2014;8:73.
15. Martial-Didier AK, Hubert KK, Parfait KE, Kablan T. Phytochemical properties and proximate composition of papaya (*Carica papaya* L. var solo 8) peels. *Turk J Agric Food Sci Technol* 2017;5:676-80.
16. Obistioiu D, Cocan I, Tirziu E, Herman V, Negrea M, Cucerzan A, *et al.* Phytochemical profile and microbiological activity of some plants belonging to the Fabaceae family. *Antibiotics* 2021;10:662.
17. Jeon YA, Chung SW, Kim SC, Lee YJ. Comprehensive assessment of antioxidant and anti-inflammatory properties of papaya extracts. *Foods* 2022;11:3211.
18. Pavithra CS, Devi SS, Suneetha WJ, Kumari BA, Rani CV. Antioxidant activity of papaya peel and developed chapathis. *Int J Curr Microbiol Appl Sci* 2017;6:636-40.
19. Falowo TT, Ejidike IP, Lajide L, Clayton HS. Polyphenolic content of *Musa acuminata* and *Musa paradisiaca* bracts: Chemical composition, antioxidant and antimicrobial potentials. *Biomed Pharmacol J* 2021;14:1767-80.
20. Ombra MN, d'Acierno A, Nazzaro F, Riccardi R, Spigno P, Zaccardelli M, *et al.* Phenolic composition and antioxidant and antiproliferative activities of the extracts of twelve common bean (*Phaseolus vulgaris* L.) endemic ecotypes of Southern Italy before and after cooking. *Oxidat Med Cell Longev* 2016;2016:1398298.
21. Castillo F, González DR, Moore-Carrasco R. Effects of *Phaseolus vulgaris* extract on lipolytic activity and differentiation of 3T3-L1 preadipocytes into mature adipocytes: A strategy to prevent obesity. *J Nutr Metab* 2019;2019:5093654.
22. Edwards R, Harding KG. Bacteria and wound healing. *Curr Opin Infect Dis* 2004;17:91-6.

**How to cite this article:** Archana J, Yasmeen T. From peel to heal: A polyherbal gel with antibacterial and wound healing benefits. *Indian J Physiol Pharmacol.* 2026;70:71-7. doi: 10.25259/IJPP\_297\_2024