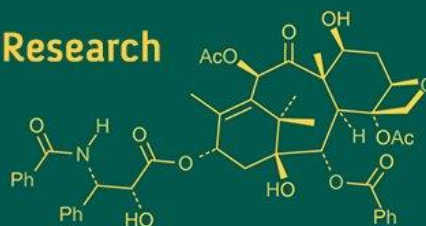
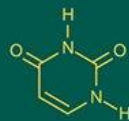
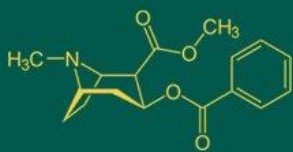


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Evaluation of wound healing activity of herbal gel formulation of *Tridax procumbens* and *Aloe vera* in goats

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Abstract

The present investigation was undertaken to determine the safety and wound healing potential of a herbal gel prepared from *Tridax procumbens* and *Aloe vera*. Dermal safety of the formulation was evaluated in female Wistar rats using the acute dermal toxicity protocol described under Organisation for Economic Co-operation and Development Guideline 402. The wound healing efficacy of the gel was assessed in thirty clinical wound cases in goats, which were randomly assigned to three treatment groups consisting of povidone iodine, 10% herbal gel, and 5% herbal gel.

No mortality, abnormal clinical signs, skin irritation, or treatment-related pathological changes were observed in rats following topical application of the herbal formulation. Histopathological examination of major organs and skin revealed normal tissue architecture, confirming the safety of the preparation. In goats, gradual improvement in wound condition was observed in all treatment groups; however, animals treated with the herbal gels showed marked reduction in swelling, exudation, pain, and local irritation during the healing process. The 10% formulation produced greater wound contraction and faster healing than the 5% formulation and showed results comparable to the standard treatment. Haematological and biochemical parameters remained within normal physiological limits throughout the study period.

The findings of the study indicate that the herbal gel containing *Tridax procumbens* and *Aloe vera* is safe for topical use and effectively promotes wound healing in goats. Among the tested formulations, the 10% gel exhibited superior therapeutic performance and may be considered a promising herbal alternative for wound management in veterinary practice.

Keywords: *Tridax procumbens*, *Aloe vera*, wound healing, goats, herbal gel, dermal toxicity, wound contraction

Introduction

A wound is defined as the disruption of the normal structure and continuity of the skin due to physical, chemical, or biological injury. The skin acts as a protective barrier, and any damage initiates a complex healing process involving haemostasis, inflammation, proliferation, and remodelling. Proper progression of these phases is essential for effective wound repair (Shivhare *et al.*, 2019; Guo and DiPietro, 2010). Goats play an important role in rural economy, and wounds are common due to their active nature and exposure to environmental hazards. Such injuries can lead to infection, delayed healing, and economic losses, highlighting the need for effective wound management strategies (Department of Animal Husbandry and Dairying, 2019; Farghali *et al.*, 2020). Herbal medicines have gained attention as alternative therapeutic agents due to their antimicrobial, anti-inflammatory, and tissue-regenerating properties. Among them, *Tridax procumbens* and *Aloe vera* are widely recognized for their wound healing potential and are commonly used in traditional medicine (Ghosh *et al.*, 2019; Manvitha and Bidya, 2014). Therefore, the present study was undertaken to evaluate the wound healing efficacy and safety of a herbal gel formulation containing *Tridax procumbens* and *Aloe vera* in goats [20, 12, 8, 10, 11, 18].

Materials and methods

Collection and authentication of plant material

Fresh leaves of *Tridax procumbens* were collected from the Parbhani region and authenticated by a botanist at VNMKV, Parbhani. The leaves were washed thoroughly, shade-dried at room

temperature (25-30 °C) for 7-10 days, and ground into fine powder after achieving constant weight. Fresh *Aloe vera* leaves were collected on the day of formulation and authenticated similarly. The leaves were washed, outer rind removed, and inner mucilaginous pulp was separated. The pulp was homogenized, filtered to remove fibrous material, and used in fresh form for preparation of herbal gel formulations.

Preparation of Herbal Formulation

The gel base was prepared by dispersing Carbopol-940 (2% w/v) in distilled water with continuous stirring and allowing it to hydrate for 8-10 hours. Triethanolamine (0.5% v/v) was then added gradually to obtain a uniform gel base. For preparation of the herbal gel, powdered *Tridax procumbens* leaves and fresh *Aloe vera* pulp were incorporated into the gel base at concentrations of 10% and 5%. The mixture was stirred continuously to achieve uniform consistency, and the final volume was adjusted with distilled water.

Acute Dermal Toxicity Study of herbal formulation

Acute dermal toxicity of the herbal gel formulation was evaluated in accordance with Organisation for Economic Co-operation and Development guideline 402. The experiment was conducted after obtaining approval from the Institutional Animal Ethics Committee (IAEC/142/25 dated 04/02/2025) and in compliance with Committee for Control and Supervision of Experiments on Animals (CCSEA).

Clinical wound healing evaluation of herbal formulation in goats

Total thirty clinical cases of wounds presented to Veterinary Clinical Complex, College of Veterinary and Animal Sciences, Parbhani, irrespective of age, sex, breed and type of wounds were included in the study. These clinical cases were further divided into three equal groups (n=10) as below mentioned in table no.1. The necessary permission was obtained from the Institutional Ethics Committee (IEC); its reference number is IEC-VCR (2)/09/2025.

Statistical analysis

Statistical analysis of various parameters was performed using Completely Randomized Design (CRD) with the help of the OPSTAT web-based statistical package developed by CCS Haryana Agricultural University, Hisar, for computation of ANOVA and related statistical tests.

Result and discussion

Dermal reaction of herbal formulation

The dermal toxicity was conducted in female Wistar rats to assess dermal tolerability of the herbal gel formulation. Healthy animals with intact skin were selected, and the dorsal area was shaved approximately 24 hours prior to application. The formulation was applied topically at a limit dose of 2000 mg per kilogram body weight over approximately 10% of the body surface area, and the site was covered with gauze and secured with a non-irritant dressing for 24 hours and animals were observed at 24, 48, and 72 hours for dermal reactions as per OECD guideline 402. No dermal irritation, clinical abnormalities, or systemic toxicity was observed in any group throughout the observation period, indicating that both formulations were safe for topical application.

Weekly feed consumption: Weekly feed intake of rats in both groups showed a gradual increase over the study period

(table 2). In group B, mean feed intake increased from 91.36 ± 0.38 g in the first week to 93.50 ± 0.47 g in the second week. Similarly, in group C, feed intake increased from 91.14 ± 0.32 g to 92.71 ± 0.47 g. Statistical analysis indicated that the differences between the groups were non-significant.

Weekly body weight of rats in group B and C

Body weight of rats in both groups increased progressively over the study period (table 3). In group B, mean body weight increased from 216.8 ± 1.82 g on day 0 to 231.8 ± 1.15 g on day 7 and 246.2 ± 0.58 g on day 14. Similarly, in group C, body weight increased from 217.0 ± 1.78 g to 231.0 ± 1.44 g and 246.0 ± 0.54 g on days 0, 7, and 14, respectively. The increase in body weight over time was significant within groups, while differences between the two groups were non-significant.

Histopathological Observations: Gross examination of major organs including heart, liver, spleen, lungs, kidneys, and treated skin revealed normal morphology. Histopathological evaluation showed largely normal tissue architecture in all organs (fig 1). Cardiac tissue exhibited well-organized muscle fibers with no evidence of necrosis or inflammation. Renal sections showed intact glomeruli and normal tubular structure. Liver sections maintained normal hepatocellular architecture, although mild degenerative changes were observed in some animals treated with the 10% formulation. Lung tissue displayed normal alveolar and bronchial structures with minimal localized alterations. Splenic tissue showed normal distribution of red and white pulp. Skin at the site of application exhibited intact epidermal and dermal layers with mild inflammatory changes in a few sections. Overall, no significant histopathological alterations were observed in either treatment group, indicating dermal safety of the herbal gel formulation.

Image no. 1-6: Histopathological analysis of heart, kidney, liver, lung, skin and spleen

Acute dermal toxicity study of herbal gel formulation revealed that the gel was safe to use topically with no unwanted effect or abnormalities in exposed rats was observed in terms of histopathology.

Evaluation of clinical wound healing efficacy of herbal formulation in goats

Wound contraction (%) in group A group B and group C

Statistical analysis indicated that treatment significantly influenced wound contraction. The wound healing effect of *Tridax procumbens* may be attributed to its phytoconstituents such as flavonoids, tannins, alkaloids, and saponins, which enhance collagen synthesis, angiogenesis, and epithelialization, thereby promoting tissue repair. Similar findings have been reported by Talekar *et al.* (2012), Shrivastav *et al.* (2020), and Ambulkar *et al.* (2020), who observed improved wound contraction, enhanced granulation tissue formation, and faster healing with *Tridax procumbens* formulations. *Aloe vera* also contains biologically active compounds such as polysaccharides, anthraquinones, and antioxidant vitamins that contribute to its anti-inflammatory and wound-healing properties. These constituents help reduce inflammation and accelerate tissue regeneration. Earlier studies by Surjushe *et al.* (2008), and Haritha *et al.* (2012) have demonstrated improved wound contraction and tissue repair with *Aloe vera* gel. In addition, Atiba *et al.*

(2011), Roy *et al.* (2022), and Brahma *et al.* (2020) reported enhanced wound healing and reduced healing time in animals treated with *Aloe vera*-based formulations [23, 21, 22, 13, 4, 19, 5].

The progressive increase in wound contraction indicated effective tissue repair and healing. The improved response in herbal gel-treated groups may be attributed to the phytoconstituents of *Tridax procumbens* and *Aloe vera*, which are known to enhance collagen synthesis, fibroblast proliferation, angiogenesis, and epithelialization. Their anti-inflammatory and antioxidant properties further support faster wound closure. Overall, the findings confirm a time-dependent increase in wound contraction, with better efficacy observed in the higher concentration herbal gel, indicating its potential as an effective topical wound healing agent.

Haematological and Biochemical analysis

Mean haematological parameters including haemoglobin, packed cell volume, red blood cell count, and total leukocyte count were evaluated in groups A, B and C on day 0 and day 14 of the study (table 5) and Biochemical parameters, including aspartate aminotransferase, alanine transaminase, total protein, blood urea nitrogen, and serum creatinine, were evaluated in groups A and B on day 0 and day 14, and the results are presented in table 6.

Haematological findings over 14 days showed only slight changes in haemoglobin, packed cell volume, erythrocyte and leukocyte counts, and differential counts among the groups. All values remained within normal physiological limits, and the differences were not statistically significant. Biochemical parameters including AST, ALT, total protein, albumin, blood urea nitrogen, and serum creatinine also displayed only

minor changes, all values remained within normal physiological limits, and the differences were not statistically significant. This indicates that the treatments did not harm liver or kidney functions.

Aloe vera has been reported to support haemoglobin recovery and improve red cell parameters in experimental models, indicating its haematinic potential (Akhter *et al.*, 2023; Archibong *et al.*, 2018). In addition to their effects on erythropoiesis, both plants exhibit immunomodulatory properties. *Tridax procumbens* has been shown to increase total leukocyte count and enhance both humoral and cell-mediated immunity (Tiwari *et al.*, 2004), while *Aloe vera* has demonstrated anti-inflammatory activity and regulation of leukocyte responses (Ahmad *et al.*, 2020; Kayode, 2017). Overall, these findings suggest that the maintenance of normal haematological parameters observed in the present study may be attributed to the protective, restorative, and immunomodulatory effects of the herbal formulation.

In addition to liver protection, both plants exhibit protein-preserving and tissue-repair properties. Extracts of *Tridax procumbens* have been reported to enhance collagen formation and improve biochemical parameters without adverse effects on protein status, while *Aloe vera* has shown protective effects against nephrotoxicity and restoration of total protein levels (Chatterjee *et al.*, 2012).

Furthermore, nephroprotective effects of both plants are supported by stabilization or reduction in serum urea and blood urea nitrogen levels. *Aloe vera* gel, particularly in diclofenac-induced toxicity models, has demonstrated notable renal protective potential, highlighting its therapeutic value (Iftikhar *et al.*, 2015) [2, 3, 24, 1, 17, 7, 14].

Table 1: Grouping and treatments of clinically wounded goats

Sr. No.	Group	Dose
1	Group A (n=10)	The wounds were cleaned with normal saline and a thin film of topical povidone iodine was applied twice daily till complete recovery
2	Group B (n=10)	The wounds were cleaned with normal saline and a thin film of topical herbal gel formulation (10% w/v) was applied twice daily till complete recovery
3	Group C (n=10)	The wounds were cleaned with normal saline and a thin film of topical herbal gel formulation (5% w/v) was applied twice daily till complete recovery

Table 2: Weekly feed intake of each rat at different intervals in group B and group C

Group	Feed intake-Days interval		Fcal
	1 st week	2 st week	
Group B	91.3 ± 0.38	93.5 ± 0.47	7.138
Group C	91.14 ±0.32	92.71 ± 0.47	
COV= 1.204			
CD=1.232			

Table 3: Weekly body weight at different interval of each rat in group B and group C

Group	Body weight-Days interval			F cal
	0 th	7 th	14 th	
Group B	216.8 ^c ± 1.82	231.8 ^b ± 1.15	246.2 ^a ± 0.58	96.386
Group C	217 ^c ± 1.78	231 ^b ± 1.44	246 ^a ±0.54	
Coefficient of Variation = 1.285				
Treatments found Significant C.D = 3.906				

Table 4: Wound contraction (%) in group A group B and group C

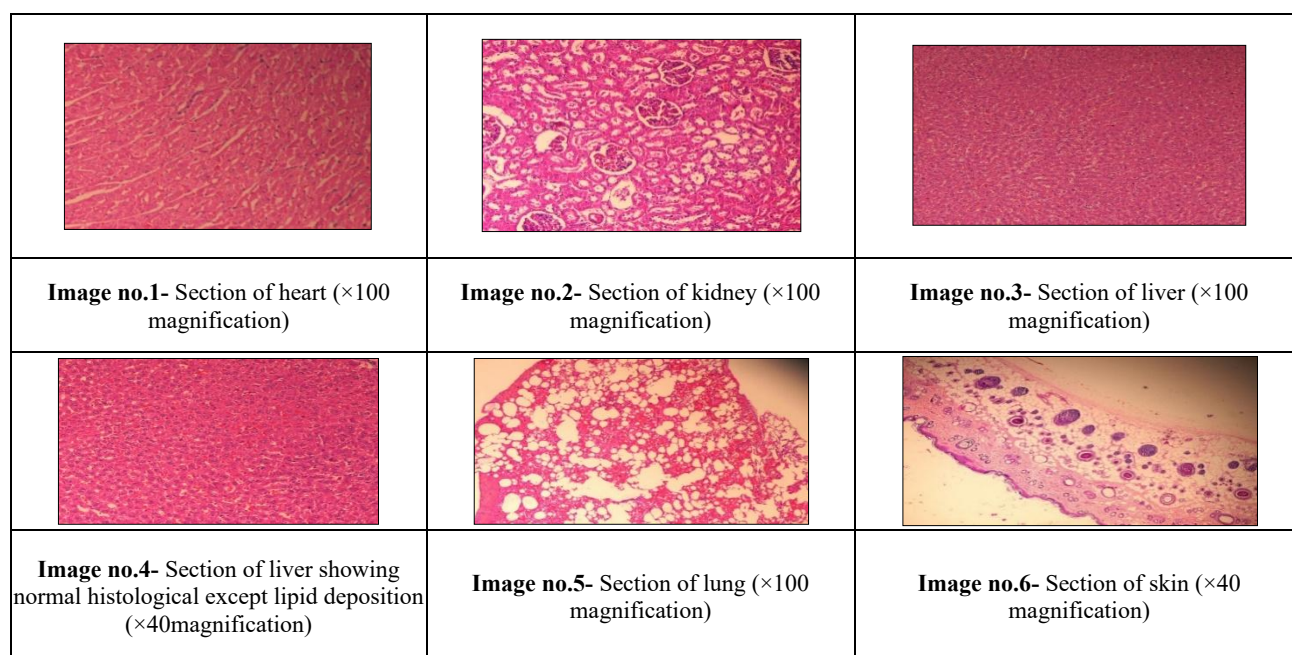
Group	Day Interval				F cal
	0 th	7 th	14 th	21 th	
A	0 ^d	42.42 ^c ±4.47	71.13 ^b ±5.71	86.87 ^a ± 4.9	17.323
B	0 ^d	31.74 ^c ±6.40	66.32 ^b ±4.51	80.00 ^a ±4.18	
C	0 ^d	29.60 ^c ±5.39	51.86 ^b ±5.38	76.19 ^a ±4.68	
COV=27.220					
Treatment found to be significantly different CD=14.456					

Table 5: Haematological analysis at different intervals in the group A and group B and group C

Group	Days interval		F cal	CoV
	Day 0	Day 14		
Haemoglobin (gm/dl)				
Group A	9.29 ± 0.23	9.61 ± 0.27	0.647	7.79
Group B	9.47 ± 0.20	9.8 ± 0.14		
Group C	9.48 ± 0.24	9.74 ± 0.27		
Packed cell volume				
Group A	29.09 ± 0.069	29.26 ± 0.064	0.077	7.06
Group B	29.11 ± 0.048	29.29 ± 0.071		
Group C	29.08 ± 0.046	29.17 ± 0.043		
Total Erythrocyte Count				
Group A	10.5 ± 0.26	10.77 ± 0.29	0.537	10.117
Group B	10.02 ± 0.35	10.36 ± 0.40		
Group C	9.99 ± 0.321	10.2 ± 0.33		
Total Leukocyte count				
Group A	9.43±0.16	9.67±0.15	2.039	4.082
Group B	9.60±0.14	9.79±0.14		
Group C	9.71±0.03	9.96±0.02		

Table 6: Biochemical analysis at different intervals in the group A group B and group C

Group	Days interval		F cal	CoV
	Day 0	Day 14		
Aspartate aminotransferase				
Group A	46.29 ± 0.23	45.91 ± 0.31	1.903	1.751
Group B	45.80 ± 0.26	45.29 ± 0.18		
Group C	45.78 ± 0.26	45.47 ± 0.25		
Alanine transaminase				
Group A	22.48 ± 0.15	21.91 ± 0.24	2.326	3.554
Group B	22.18 ± 0.31	21 ± 0.20		
Group C	22.06 ± 0.25	21.65 ± 0.27		
Total Protein				
Group A	6.83 ± 0.09	6.75 ± 0.09	2.44	2.632
Group B	7.0 ± 0.01	6.94 ± 0.21		
Group C	6.9 ± 0.021	6.9 ± 0.01		
Blood Urea Nitrogen				
Group A	19.16 ± 0.17	18.87 ± 0.19	0.689	2.999
Group B	19.25 ± 0.19	18.99 ± 0.16		
Group C	19.12 ± 0.16	18.91 ± 0.17		
Serum Creatinine				
Group A	1.0 ± 0.07	0.95 ± 0.07	8.316	2.26
Group B	1.001 ± 0.04	0.97 ± 0.06		
Group C	0.99 ± 0.08	0.97 ± 0.08		

**Fig 1-6:** Histopathological analysis of heart, kidney, liver, lung, skin and spleen

Conclusion: The present study demonstrated that the herbal gel formulation containing *Tridax procumbens* and *Aloe vera* was dermally safe and effective for wound management in goats. Acute dermal toxicity evaluation confirmed the absence of irritation, toxicity, or mortality in experimental animals, indicating its safety for topical application. Clinical evaluation revealed progressive wound healing in all groups, with reduction in swelling, exudation, pain, irritation, and improvement in wound colour over time. A significant increase in wound contraction was observed throughout the study period. The 10% herbal gel formulation showed better therapeutic response compared to the 5% formulation and exhibited healing effects comparable to the standard treatment. Haematological and biochemical parameters remained within normal physiological limits, indicating no systemic toxicity. Overall, the herbal gel formulation can be considered a safe, effective, and economical alternative for wound management in goats.

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