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Clinical wound healing activity of *Terminalia arjuna* bark extract gel in goats

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Abstract
The experiment was conducted to evaluate the efficacy of a gel prepared from ethanolic bark extract of *Terminalia arjuna* on clinical cases of goats having wound presented to Veterinary clinical complex of College of Veterinary and Animal Sciences, MAFSU, Parbhani. 5% ethanolic bark extracted gel of *Terminalia arjuna* was formulated and was topically applied for assessing acute dermal toxicity on Wistar rats. Results revealed that 2000 mg/kg body weight is a safe dose as there were no any altered behavioral change and clinical reaction observed. Also on histopathological examination didn't show any toxicity related histoarchitectural changes in any of the organ of Wistar rats. After assessing the acute dermal toxicity of *Terminalia arjuna* gel formulation, its wound healing efficiency is tested on goats. 12 cases of goats with wound were selected and divided into 2 groups as group A and group B, treated topically with Povidone iodine solution and gel prepared from ethanolic bark extract of *Terminalia arjuna* respectively. The evaluation of gel for wound healing was done with monitoring the visual parameters (swelling, colour, pain, irritation, exudation and percent wound contraction) at day 0, day 7, day 14, day 21 and day 28 after/ till healing and hemato-biochemical parameters on day 0 and day 14 after treatment from both the groups were estimated. The result found that gel prepared from *Terminalia arjuna* has rapid rate of wound healing by reducing swelling, pain, irritation and exudation fastly, and the speed of wound contraction in group treated with *Terminalia arjuna* gel slightly faster than group treated with povidone iodine. The hemato-biochemical analysis revealed all observations were found in normal physiological range in both the groups. The *T. arjuna* gel was found safe for topical application and also promotes the rate of wound healing.

Keywords: *Terminalia arjuna* gel formulation, acute dermal toxicity, wound healing, goats

Introduction
Goat has been known as "poor man's cow." Goats can survive any weather well and effectively turn inferior grazing material that is undesirable for other livestock into high-quality, lean meat. However, they are frequently susceptible to get affected with wound due to poor management. It is known that goats could get affected with a variety of wounds as a result of their natural fighting behavior and grazing on thorny shrubs. The wounds on Goat could result in significant financial losses, thus it is crucial to handle them well. Wound healing is a multifaceted physiological process that involves a multitude of cells and events. It is a continually evolving process that involves role of blood cells, extracellular matrix, and parenchymal cells. It is dependent on various interrelated factors. Wound healing is one of the complex mechanisms; which begins at the molecular level and ends with visible scar formations. Several theories about wound healing have been proposed which include molecular and cellular mechanisms, activation of growth factors, angiogenesis, granulation tissues, and healing under scab **(**Enoch and Leaper, 2008) [10].
Several procedures are involved in wound care and management, such as dressing the wound, administering painkillers, applying anti-inflammatory agents, topical systemic antibacterial agents, and using medications that promote healing. (Thakur *et al.*, 2011) [23] But, research also suggests that a large number of these treatments are harmful to lymphocytes, fibroblasts, and other cells required for wound healing due to their own limitation However, no single substance has been presented as the preferred means for accelerating wound healing. To overcome these situation medicinal plants were utilized as ointments and medicines, and now the main ingredients of most drugs are obtained from

plants (Davoodi *et al.*, 2022) [4].
Alternative sources of medicines like herbal plant based medicines may soon become key components to deal with the limitation caused due to this modern medicine (Marume *et al.*, 2017) [14]. Plants have the immense potential for the management and treatment of wounds. These phytomedicine are not only cheap and affordable but are also safe. (Thakur *et al.*, 2011) [23]. Around 32 herbs 11 shrubs and 12 are known to have good and effective wound healing potential. Plant resources are used to produce over 70% of the medicinal drugs used to treat wounds, which include turmeric, neem, aloe vera, tulsietc (Patel, 2014) [16].
One such traditional medicinal herb is *Terminalia arjuna* (TA), *Terminalia arjuna* Roxb. (Family-Combretaceae) which is commonly known as Arjun tree and valued for its medicinal uses. *Terminalia arjuna* has many therapeutic benefits. It possesses anti-inflammatory, antioxidant, anti-ischemic, anti-atherosclerotic, antibacterial, anti-cancer, anti-fertility, and anti-mutagenic capabilities. The plant's primary bioactive components are glycosides (cardiac glucoside), flavonoids (arjunone and arjunolone), and triterpenoids (arjunolic acid). These compounds give anti-tumour, anti-inflammatory, anti-diabetic, wound-healing, antioxidant and broad-spectrum antimicrobial (against many gram negative bacteria) properties. (Jaiswal *et al.*, 2021, Ramesh and Palaniappan, 2023) [13, 19]. Due to its versatile composition of *Terminalia arjuna* is used to cure variety of disease (Dudhamal, 2016) [8]. Bark was discovered to be an essential part of the plant and to have a variety of biological functions. The bark of *Terminalia arjuna* contains 23% calcium salts and 16% tannins in aqueous extract. Alcoholic extract contains colouring matters and tannin. Also chemical analysis confirmed the presence of sugar, tannins (12%), colouring matter, glucoside, and carbonates of calcium, sodium, and traces of chloride of alkali metals (Ghosh, 1926; Gaikwad and Jadhav, 2018) [12, 11]. Keeping its wound healing activity in mind following objectives are decided to carry out research and set a bench mark on wound healing activities of *Terminalia arjuna* in goats.

Materials and Methods

Collection and authentication of plant material

Bark of *Terminalia arjuna* were collected from the Vasantrao Naik Marathwada Krishi Vidyapith (VNMKV), Parbhani and gets authenticated with the help of botanist from VNMKV, Parbhani.The bark of *Terminalia arjuna* was collected and processed for extraction. The dried bark was powdered using electrical grinder and 5% extract of the bark powder was prepared by mixing 5 gm of *Terminalia arjuna* bark powder in 100 ml of absolute ethanol. The mixture was kept in refrigerator with intermittent shaking for 48 hrs. The mixtures firstly filtered by using muslin cloth and then by using filter paper. The solvent from the filtrate obtained were evaporated and extract was used for the study.

Preparation of *Terminalia arjuna* gel formulation

18 gm of carbopol-940 was mixed in 900 ml of distilled water and kept the solution for 8-10 rs for proper dissociation of carbopol-940 in the distilled water. After 10 hrs, 5 ml of 98% tri-ethanol amine was poured drop by drop in the prepared mixture with continuously stirring and by adding 5% concentration of *Terminalia arjuna* bark extract in the prepared mixture and the volume of formulation was adjusted to 1000 ml by adding required distilled water.

Acute dermal toxicity of *Terminalia arjuna* gel in Wistar rats:

8-10 weeks old female Wistar rats with body weight ranging from 200-300 gm were used in the experiment. Study was started after necessary Institutional Animal Ethical Committee (IAEC) approval was accorded as per the resolution number IAEC/126/23 dated on 15/12/23. All the rats were maintained as per the standard laboratory conditions by implementing the CCSEA guidelines. The rats were housed in polycarbonate cages with corncob as bedding material. Water and pelleted feed were provided ad libitum for the duration of experiment. Optimum Temperature (22±3 °C), relative humidity (55±10%) and lighting (12 hrs light and 12 hrs dark) were maintained in the laboratory animal house, College of Veterinary and Animal Sciences, Parbhani.

Application of *Terminalia arjuna* gel formulation

Range finding study

The two female Wistar rats were used to begin the range finding study of the *Terminalia arjuna* gel formulation. The dose of 2000 mg/kg body weight was selected and patch of *Terminalia arjuna* gel formulation was applied on the prepared site on skin. The patch was taken off after a exposure period and skin lesion (erythema/edema) were recorded for 24, 48 and 72 hrs after removal of gel. In addition, behavioural patterns and abnormal clinical signs were examined throughout the experimental period. Reconfirmation of the range finding study was conducted on two more Wistar rats with same dose at 2000 mg/kg body weight.

Main study

The mainstudy was carried out by applying *Terminalia arjuna* gel formulation @ 2000 mg/kg body weight on another 2 Wistar rats, based on the data from the range finding study. During experimental period, parameters such as behavioural patterns, any adverse clinical signs, mortality (if any), grading of skin reaction, weekly body weight and feed intake, were observed. At day 14, all of the rats in the main study were humanely slaughtered and tissue samples of their heart, kidney, liver, lung, skin and spleen were taken in order to begin histopathological analysis. The tissues were collected and preserved in a 10% formalin solution. Following that, the tissue was paraffin embedded and processed according to standard operating procedure. For microscopic examination, the section were cut at 3 to 5 mm thickness and stained with Mayershematoxylene and eosin.

Clinical wound healing evaluation of *Terminalia arjuna* gel formulation in goats

Wound cases were selected irrespective of type, age, sex, strains, or body weight of dogs. Clinical wound cases reported to the Veterinary Clinical Complex (VCC), COVAS, Parbhani selected and grouped into A and B as mentioned in (Table 1). Visual parameters (wound swelling, wound colour, exudation from wound, pain sensation and wound irritation), percent wound contraction were observed and scored on day 0, day 7 and day 14 days or till complete healing. In addition, hematological analysis (Hb, PCV, TEC, TLC and DLC) and biochemical analysis (AST, ALT, BUN and Serum creatinineTP) were examined on day 0 and day 14.

Table 1: Number of cases and grouping of clinical wound cases of goats

Sr. No.	Group	Dose
1	Group A (n = 6)	The wounds were cleaned with normal saline and a thin film of topical povidone iodine (7.5% w/v) was applied twice daily till complete recovery
2	Group B (n = 6)	The wounds were cleaned with normal saline and a thin film of topical *Terminalia arjuna* gel formulation (5% w/v) was applied twice daily till complete recovery

Result and Discussion

The present experiment was conducted to assess acute dermal toxicity study of the Terminalia arjuna gel on a Wistar rats and evaluation of the wound healing capacity of the gel in clinical cases a goat having wound.

Application of *Terminalia arjuna* gel formulation

Behavioural parameters

The *Terminalia arjuna* gel formulation was removed after 24 hours and behavioural signs such as changes in skin and fur, eyes and mucous membranes were found normal. Moreover, the central and autonomic nervous system, respiratory and circulatory system were all found to be normal. There were no tremors, convulsions, salivation, diarrhoea, lethargy, sleep and coma was observed.

Mortality (if any)

No mortality was observed in both the main study and range finding study, in the rats exposed to the gel topically.

Skin reaction

After the *Terminalia arjuna* gel formulation was removed, observations showed that there were no adverse skin reactions (erythema and edema) during 24, 48 or 72 hours and scored as zero according to Draize [6] criteria of skin scoring. Based on observations, it was found that*Terminalia arjuna* gel formulation did not show any sign of dermal lesion on exposed skin area of rats and found safe for topical applications @ 2000 mg/kg body weight.

Weekly feed consumption

Feed was supplied ad-libitumly to experimental rats and their feed intake was calculated on weekly basis and was recorded in (Table 2).

Table 2: Weekly feed intake of each rat at different intervals in group I and group II

Group	Feed intake-Days interval		F cal	CoV
	7th	14th		
Control group	92.00±2.00	96.50±0.5	5.879	1.778
Main study group	90.00±1.00	94.50±0.5		
Values found to be non-significant				

Table 2 shown that, the feed consumption on day 7th in control group animals was observed to be 92.00±2.00 g as against 90.00±1.00 g in main study group animals. No statistically significant difference was observed in mean feed consumption on day 7th. However the feed consumption in both the group animals on day 14th was also observed to be statistically non-significant. (96.50±0.50 g in control group as against 94.50±0.50 g in main study group animals). From these observations it is reveals that topical application of *T. Arjuna* gel had not any significant effect on feed consumption.

Results and Discussion

Histopathological examination

Rats were sacrificed at the end after day 14 for necropsy and tissue samples of heart, kidney, liver, lung, skin and spleen were taken for histopathological analysis. There were no histo-architectural alterations observed in collected organ/ tissue as shown in (Image no. 1-6). It indicated there was no toxicity observed after topical application of gel formulation in acute dermal toxicity study in Wistar rats.

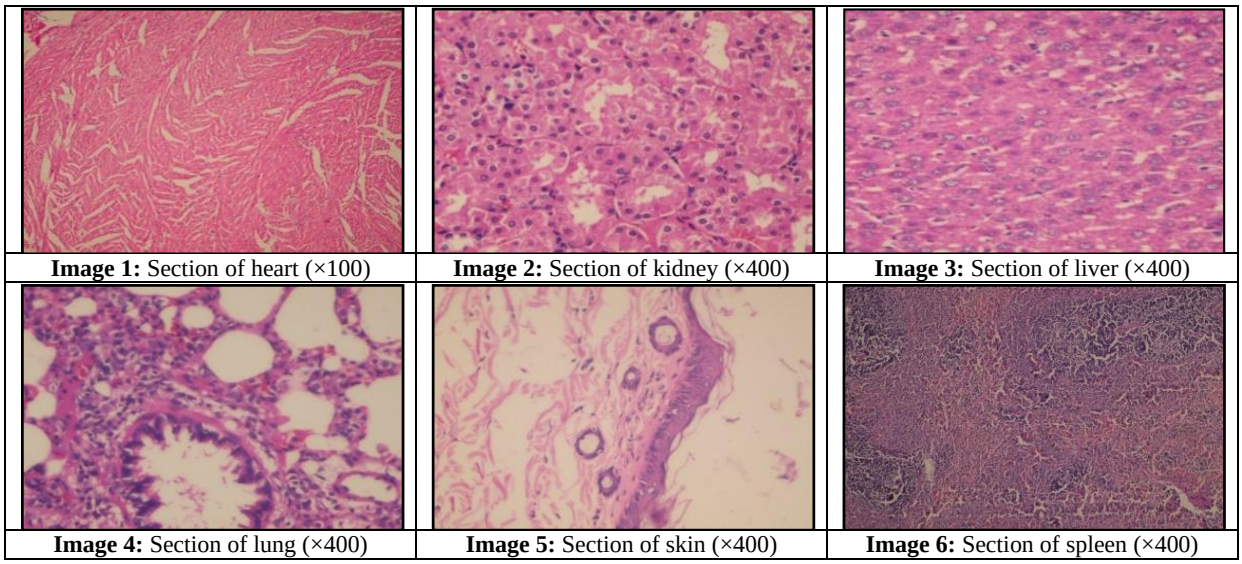

Image 1: Section of heart (×100) | **Image 2:** Section of kidney (×400) | **Image 3:** Section of liver (×400)

Image 4: Section of lung (×400) | **Image 5:** Section of skin (×400) | **Image 6:** Section of spleen (×400)

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

Acute dermal toxicity study of *Terminalia arjuna* 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 *Terminalia arjuna* gel in dogs Visual observations of wounds

Clinical wound healing efficacy of *Terminalia arjuna* gel in goats were evaluated by visual observations of wound swelling, pain, irritation, exudation, change in wound colour on weekly basis till complete wound healing in both group A and group B.

Swelling: Gel prepared in the present experiment using the bark of *T. arjuna* succeeded in reducing swelling more rapidly than iodine. There is gradual decrease in the peripheral swelling of the wound due to anti-inflammatory property of *Terminalia arjuna*. Similar studies has been demonstrated by Rajaram *et al.*, (2024) [18] and they have demonstrated that extract from the bark of *T. arjuna* can inhibit the production of nitric oxide (NO), lipopolysaccharide (LPS) stimulated macrophages, effectively reduced inflammatory responses. Also the gradual decrease in swelling was also observed by Tripathi *et al.*, (2004) [24], Rane and Mengi, (2003) [20] and Dudhamal, (2016) [8] after oral and topical application of bark extract in their experimental models.

Colour: Change in colour of the wound treated with *Terminalia arjuna* gel formulation at different intervals might be due to stages of wound healing, i.e., the formation of granulation tissue and epithelization at the wound site. of *T. arjuna* gel is might be due to consisted of phytochemical especially tannins, tannins acts as fast anti-inflammatory and wound healing activity by reduction in size of wound and enhancing the collagen tissue. Similar finding were reported by Rajaram *et al.*, (2024) [18]. Formation of granulation tissue and epithelization at the wound site.

Exudation: The wound treated with *Terminalia arjuna* gel showed decrease in exudates from severe exudation to no exudates from day o to day 28. This change may be due to anti-inflammatory property of *Terminalia arjuna*. *T. arjuna* has proven anti-inflammatory activity by reducing production of free radicals, once free radical production stop, on the other hand that leads to vasoconstriction and ultimate exudate production reduced. The observation related to exudate formation in the present study were similar to observation of Dudhamal, (2016) [8], Rajaram *et al.*, (2024) [18] and Dube *et al.*, (2017) [7].

Pain: The wound treated with *Terminalia arjuna* gel showed decrease in pain from moderate pain to no pain. This gradual decrease in pain might be due to analgesic, anti-inflammatory and antioxidant property of *T. arjuna*. Pain reduction effect of *T. arjuna* was proven in various laboratory animal models, however the finding in respect to pain were similar to the Morshed *et al.*, (2011) [15].

Irritation: In present study *Terminalia arjuna* gel treated wound showed early relief from irritation as compared to iodine. The gradual decrease in irritation is might be due to analgesic and anti-oxidative or scavenging property of *T. arjuna*. Morshed *et al.*, (2011) [15].The quality of wound healing was measured as percent wound area contraction. Wounds in group B, showed non significantly faster wound contraction compared to wounds in group A. The presence of phytochemical such as tannins, astringent, collagen stimulating factor in *T. arjuna* might be cause contraction in wound.. Rane and Mengi, (2003) [20] showed significant result in wound contraction, the supported by topical treatment including tannins in 50% ethanolic bark extract was found to be more effective for healing of wound. This significancy might be due to used oral and topical application in the form of hydrogel.. Patel *et al.*, (2011) [17] and Devi *et al.*, (2012) [5] also showed similar result. Complete wound healing of all cases was almost achieved up to day 28 in both *Terminalia arjuna* gel formulation and povidone iodine-treatment group (Table 4). The results of visual wound parameters and percent wound contraction suggested that *Terminalia arjuna* gel formulation has somewhat better wound healing activity than povidone iodine in goats.

Table 4: Mean values of wound contraction (%) in group A and group B

Groups	Days interval					F cal	CoV
	0th	7th	14th	21st	28th		
Group A	0	42.53^{c}±4.09	74.92$^{b±}$3.66	91.37$^{a±}$2.92	99.14 ^{a}±0.86	181.22	11.334
Group B	0	44.00^{c}±4.81	78.05b±4.42	97.79$^{a±}$1.41	99.57 ^{a}±0.43		
Treatments found to be Significantly different at 1% and 5% level CD (0.01) = 11.09 & CD (0.05) = 8.04							

Visual scoring pattern and percentage wound contraction in both A and B groups were shown non-significant differences, the wound was get healed on day 28 in both the groups.

Haematological analysis

Mean haematological parameters such as haemoglobin, packed cell volume, red blood cells, white blood cells, total leukocyte count and differential leucocyte count in group A and B were analysed on day 0 and 14 and mentioned in (Table 5). In group A, haemoglobin (Hb g/dl) values on 0 day was 9.71±0.30 which was non-significant increased to 10.24±0.14 on 14 day. In group B, haemoglobin values were 10.03±0.25 and 10.13±0.08 on 0 and 14 day of experiment respectively.

In group A, packed cell volume (PCV%) on day 0 was 29.10±0.13 and 14 day it was 29.71±0.16 on day 0 and 14 respectively. Similarly, in group B, it was 30.27±0.59 and 29.78±0.36. In group A, total erythrocyte count (TEC mil/mm^3) on day 0 and day 14 were 10.03±0.27 and10.16±0.22 respectively. In group B, the values were9.9±0.26 and 10.298±0.25 on day o and 14 respectively. In group A**,** total leukocyte count (TLC 10000 cu/mm) on 0 day was and on 14 day it was 10.12±0.10 and 9.83±0.69 and, in group B it was 10.10±0.16 and 9.90±0.14 respectively.

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

Group	Days interval		F cal	CoV
	Day 0	Day 14		
Haemoglobin (g/dl)				
Group A	9.71±0.30	10.03±0.25	1.148	5.218
Group B	10.24±0.14	10.13±0.08		
Packed cell volume (%)				
Group A	29.10±0.13	29.71±0.16	1.773	3.987
Group B	30.27±0.59	29.78±0.36		
Total Erythrocyte Count (mill/mm3)				
Group A	10.03±0.27	10.16±0.22	1.090	5.743
Group B	9.9±0.26	10.298±0.25		
Total leukocyte count (thousand/cumm)				
Group A	10.12±0.10	9.83±0.69	1.202	2.939
Group B	10.10±0.16	9.90±0.14		
Neutrophil (%)				
Group A	43.67±0.33	43.00±0.52	2.734	2.639
Group B	42.67±0.49	41.83±0.48		
Lymphocyte (%)				
Group A	51.33±0.33	52.66±0.33	2.090	2.345
Group B	52.50±0.67	53.00±0.58		
Monocyte (%)				
Group A	2.33±0.33	1.83±0.30	0.645	2.45
Group B	2.17±0.30	2.33±0.21		
Eosinophil (%)				
Group A	2.50±0.43	2.33±0.33	0.348	34.26
Group B	2.50±0.34	2.83±0.30		

In group A, Neutrophil% on day 0 was 43.67±0.33 and 14 day it was 43.00±0.52 respectively. Similarly, in group B, it was 42.67±0.49 and 41.83±0.48 at day 0 and day 14 respectively. In group A, lymphocyte% on day 0 was 51.33±0.33 and 14 day it was 52.66±0.33 respectively. Similarly, in group B, it was 52.50±0.67 and 53.00±0.58 at day 0 and day 14 respectively. In group A, Monocyte% on day 0 was 2.33±0.33 and 14 day it was 1.83±0.30 respectively. Similarly, in group B, it was 2.17±0.30 and 2.33±0.21 at day 0 and day 14 respectively.
In group A, Eosinophil% on day 0 was 2.50±0.43 and 14 day it was 2.33±0.33 respectively. Similarly, in group B, it was 2.50±0.34 and 2.83±0.30 at day 0 and day 14 respectively.

Haemoglobin: The mean haemoglobin value (g/dl) was observed to be non-significantly higher in group B than group A after 14 days of treatment However, all the values of haemoglobin recorded during the study were observed within the normal physiological range. Similar findings were also noticed by Acharya *et al.*, (2017) [1], Bhat, (2012) [3] and Singh, (2016) [22] during their study on wound healing in caprine. The increase in haemoglobin after day 14 in group might be due to difference in oxygen demand at wound site in different groups of above studies.

Packed cell volume: The value of PCV in group B was observed to have non-significantly decreased on the 14th day. However, all the values of PCV recorded during the study were observed within the normal physiological range. Similar finding were observed by Acharya *et al.*, (2017) [1].
Total erythrocyte count: In both group A and group B this non significant increase in erythrocytes were observed. However, all the values of erythrocyte recorded during the study were observed within the normal physiological range. Acharya *et al.*, (2017) [1].

Total leucocyte count: In both groups on day 0 of treatment elevated leucocyte count might be due to inflammation at wound sight and their mark reduction at day 14 might be due to decrease in inflammation and exudation. However, all the values of total leucocyte count recorded during the study were observed within the normal physiological range.
The present study produced similar results to Acharya *et al.*, (2017) [1], Waghmare, (2021) [25], Bhat, (2012) [3] and Anoop, (2015) [2] while studying the wound healing process in goats.

Neutrophill: In group A and group B there were non significantly decrease in neutrophil count on day 14. However, all the neutrophil values recorded during the study were observed within the normal physiological range. The present study observed similar results with a study conducted by Acharya *et al.*, (2017) [1] Waghmare, (2021) [25], Bhat, (2012) [3] and Anoop, (2015) [2] while studying the wound healing process in goats.

Lymphocyte: The value of lymphocytes was observed non-significantly increased on the day 14 in group B. This non significant increase might be due to anti-inflammatory and antioxidant property of *T. arjuna*..Similar result were noticed by Acharya *et al.* (2017) [1] to evaluate Waghmare, (2021) [25], Bhat, (2012) [3] and Anoop, (2015) [2] while studying the wound healing process in goats.

Monocyte: The value of lymphocytes was observed non-significantly increased on day 14 in group B. This increase in monocyte count might be due to tissue debris and stressful condition. However all the values of monocytes recorded during the study were observed within the normal physiological range. The present study observed similar results to a study conducted by Acharya *et al.*, (2017) [1] Waghmare, (2021) [25], Bhat, (2012) [3] and Anoop, (2015) [2] while studying the wound healing process in goats.

Eosinophill: The mean eosinophil count was observed to be non-significantly higher in group B than group A after 14 days of treatment. However, all the values of eosinophil count recorded during the study were observed within the normal physiological range. The present study observed similar results to a study conducted by Acharya *et al.*, (2017) [1].

Biochemical analysis
Biochemical parameters as aspartate aminotransferase, alanine transaminase, total protein, blood urea nitrogen and serum creatinine in group A and B were observed on day 0 and day 14 and mentioned in (Table 6). In group A, aspartate aminotransferase (AST) on day 0 was 47.21±1.09 while on day 14 was 45.54±0.82. In group B, aspartate aminotransferase on day 0 was 46.60±0.59 while on day 14 was 44.23±0.43. In group A, alanine transaminase (ALT) on day 0 was 22.03±1.50 while on day 14 was 21.800±1.19. In group B, alanine transaminase on day 0 was 23.15±0.72.while on day 14 was 21.01±0.86. In group A, Blood Urea Nitrogen (BUN) on day 0 and day 14 was observed 19.58±0.57 and on day 0 and 14 respectively. In

group B, total protein on day 0 was 20.01±0.29 while on day 14 was 19.77±0.45.In group A, serum creatinine on day 0 and day 14 was 1.005±0.67 and 0.95±0.05 respectively. In group B, blood urea nitrogen on day 0 was 0.928±0.02 while on day 14 was 0.847±0.03. In group A, total protein (TP) on day 0 and day 14 was 6.97±0.70 and 6.82±0.06 respectively. In group B, serum creatinine on day 0 was 7.03±0.15 while on day 14 was 6.75±0.21.

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

Group	Days interval		F cal	CoV
	Day 0	Day 14		
Aspartate transaminase (IU/L)				
Group A	47.21±1.09	45.54±0.82	2.825	2.825
Group B	46.60±0.59	44.23±0.43		
Alanine aminotransferase (IU/L)				
Group A	22.03±1.50	21.800±1.19	3.61	7.63
Group B	23.15±0.72	21.01±0.86		
Blood Urea Nitrogen (mg/dl)				
Group A	19.58±0.57	18.86±0.47	1.782	5.65
Group B	20.01±0.29	19.77±0.45		
Serum Creatinine (mg/dl)				
Group A	1.005±0.67	0.95±0.05	1.969	12.276
Group B	0.928±0.02	0.847±0.03		
Total Protein (g/dl)				
Group A	6.97±0.70	6.82±0.06	0.888	4.844
Group B	7.03±0.15	6.75±0.21		

Aspartate aminotransferase: In both the group A and B there was non significant decrease in aspartate transaminase value were observed. It might be due to haepato protective activity of *Terminalia arjuna.* Similarly Sangmithira *et al.*, (2016) [21] showed hepatoprotective activity in the in the ethanolic bark extract of *Terminalia arjuna.* It reduces the AST value significantly.

Alanine aminotransferase: In both the group A and B there was non significant decrease in ALT count were observed after 14 days of treatment. This slight non significant decrease might be due to hepatoprotective activity. Sangmithira *et al.*, (2016) [21] noticed the similar result but reduction in the ALT value significantly. This significancy might be due to oral route of administration.

Blood Urea Nitrogen: Blood urea nitrogen count was observed non significant reduction in group B than group A. Eggadi *et al.*, (2014) [9] noticed significant reduction in BUN value in the nephroprotective effect of an ethanolic extract of *Terminalia arjuna* bark (EETAB) at doses (200 and 400 mg/kg, body weight) against Cisplatin (7.5 mg/kg, ip)-induced nephrotoxicity in rats.

Serum creatinin: In both the group A and B there was non significant decrease in Serum creatinine count were observed after 14 days of treatment. The study conducted by Eggadi *et al.*, (2014) [9] to evaluate the nephroprotective effect of an ethanolic extract of *Terminalia arjuna* bark. The result found that there was a significant reduction in serum creatinine in rats treated with EETAB2 (400 mg/kg). this is might be due to orally administration of *Terminalia arjuna.*

Total Serum protein: In both the group A and B there was non significant decrease in Total protein count were observed after 14 days of treatment. A study conducted by Acharya *et al.*, (2017) [1] to evaluate the effect of application of Povidone iodine and *T. arjuna* on total serum protein in wound-affected goats shows a contrary result, which showed a significant decrease in total protein. This change might be due to a change in the normal metabolism of proteins in the body.

Statistical analysis

Statistical analysis was carried out by using Web Agri Stat Package version 2.0 (WASP 2). All the parameters were analyzed by using completely randomized design (CRD) statistical method (Anonyms, 2018 WASP version 2.0 http://www.ccari.res.in/wasp2.0/index.php).

Conclusion

The gel prepared from ethanolic bark extract of *Terminalia arjuna* showed no acute dermal toxicity in Wistar rat and could be easily applied topically. The wound healing capacity of *Terminalia arjuna* gel was indicated that it could be used safer and possibly alternative for treatment of wound.

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