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FORMULATION AND EVALUATION OF TERMINALIA ARJUNA BARK EXTRACT HERBAL EMULGEL FOR WOUND HEALING

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ABSTRACT

Wound healing is a complex biological process involving inflammation, proliferation, and tissue remodeling. Herbal-based topical formulations have gained considerable attention because of their therapeutic efficacy, reduced side effects, and improved patient compliance. Terminalia arjuna is a medicinal plant widely recognized for its antioxidant, anti-inflammatory, antimicrobial, and wound healing properties due to the presence of bioactive constituents such as tannins, flavonoids, triterpenoids, and glycosides. The present study aimed to formulate and evaluate a Terminalia arjuna extract-loaded emulgel for wound healing activity. The ethanolic bark extract of Terminalia arjuna was incorporated into an emulgel system prepared using suitable oils, emulsifying agents, gelling agents, and stabilizers. The formulated emulgel was evaluated for physicochemical characteristics including appearance, pH, viscosity, spreadability, drug content, stability, and in vitro release profile. Wound healing efficacy was assessed using suitable experimental models by monitoring parameters such as wound contraction, epithelialization period, and tissue regeneration. The formulated emulgel exhibited desirable physical characteristics, good stability, and controlled release behavior. The presence of phytoconstituents in Terminalia arjuna promoted collagen synthesis,

enhanced tissue repair, and accelerated wound contraction. The findings suggest that Terminalia arjuna emulgel has significant potential as an effective herbal topical formulation for enhancing wound healing and may serve as a promising alternative to conventional wound management therapies.

KEYWORDS: Terminalia arjuna, emulgel, wound healing, collagen synthesis, antimicrobial activity, epithelialization.

INTRODUCTION

Ayurveda is the oldest surviving complete medical system in the world. Derived from its ancient Sanskrit roots ayus' (life) and 'veda" (knowledge) and offering a rich, comprehensive outlook to a healthy life, its origins go back to nearly 5000 years. Terminalia arjuna is a large, evergreen tree, with a spreading crown and dropping branches. It has been grown in most parts of India and used in Ayurvedic formulations since ancient times. Besides its wide range of medicinal uses, T. arjuna is planted for shade and ornamental purposes. Terminalia's active constituents include tannins, cardenolide, triterpenoid saponins (arjunic acid, arjunolic acid, arjungenin, arjun glycosides), flavonoids (arjunone, arjunolone, luteolin).

Fig. no. 1: Terminalia arjuna.

Gallic acid, ellagic acid, oligomericproanthocyanidins (OPCs), phytosterols, calcium, magnesium, zinc, and copper. Improvement of cardiac muscle function and subsequent improvement in the pumping activity of the heart seems to be the primary benefit of Terminalia. It is thought that the saponin glycosides might be responsible for the inotropic effect of Terminalia, while the flavonoids and OPCs provide free radical antioxidant activity

and vascular strengthening.3 A dose-dependent decrease in heart rate and blood pressure was noted in dogs given Terminalia intravenously.4 Recently, two new cardenolide cardiac glycosides were isolated from the roots and seeds of Terminalia. Various parts of plant have been investigated for the presence of phytoconstituents and pharmacological activities. Many useful phytoconstituents have been isolated from T. arjuna. Triterpenoids are mainly responsible for cardiovascular properties. Tannins and flavonoids are responsible for its anticancer properties. The present review summarizes the ethnic use, pharmacological activities of the extracts and phytoconstituents of T. arjuna for last 90 years. To cure human diseases, medicinal plants have been a major source of therapeutic agents since ancient time."

4. Plant profile

4.1 Botanical Profile

Botanical Name: Terminalia arjuna (Roxb. Ex DC.) Wight & Arn.

Common Names: Arjun tree, White Murdah, Neer matti, Sadaru

Family: Combretaceae (Indian almond family)

Genus: Terminalia

Species: T. arjuna

4.2 Taxonomical Classification

Kingdom: Plantae (Plants)

Division: Magnoliophyta (Flowering plants)

Class: Magnoliopsida (Dicotyledons)

Order: Myrtales

Family: Combretaceae

Genus: Terminalia

Species: arjuna

5. Chemical constituents

The dry bark from the stem contains about 20 to 24% of tannin, whereas That of the bark obtained from the lower branches is up to 15 to 18%. The tannins present in arjuna Bark are of mixed type consisting of both hydrolysable and condensed tannins. The tannins are reported to be present are (+) catechol, (+) gallocatechol, epicatechol, epigallocatechol, and ellgic acid. The flavonoids such as arjunolone, arjunone, and baicalein have been reported from the stem hark. The triterpenoid compounds arjunetin, arjungenin, arjunoglucoside I and II, and terminoic acid have Also been reported from the bark. The root contains number of

triterpenoids such as arjunoside I and II. Terminic acid, oleanolic acid, arjunic acid, arjunolic acid, etc. The fruits also contain 7 to 20% of Tannins. A pentacyclic triterpene glycoside arjunoglucoside III has been reported from the fruits Along with hentriacontane, mynistyloleate and arachidic stearate.

6. Pharmacological Action

A number of previous studies reported a wide number of pharmacological activities of T. aquna can be used to treat diabetics, heart diseases as well as for the treatment of wound. It has antiviral. Antibacterial, anticancer and other potential anti-ailment properties.

1 Antimicrobial activity

Perumalsamy et al (1998) reported that the aqueous extracts of T. arjuna bark holds major antimicrobial Activity against Proteus vulgaris, Klebsiellaarrogenes, Escherichia coli and Pseudomonas aerogenes. The Presence of antibacterial activity in the bark of T. arjuna exhibiting selectively maximum activity against S. epidermidis (Singh et al, 2008). Antimicrobial activity of different solvent extracts from T. arjuna Reported previously are summarized.

2. Antifungal activity

The organic extracts of five Terminalia species (T. arjuna, T. chebula, T. Bellerica, T. catappa and T. alata) were tested with plant pathogenic fungi ie. A flavus, A. alternate, A. Niger, A. brassicicola, and H. tetramera. The leaves extracts of all five plants found to inhibit these plant Pathogens (Shinde et al., 2011). The bark extracts were more effective than fungicide (control) used in This antifungal test. Moderate antifungal activity against C. albicans, C krusei and C. parapsilosis was Exhibited by a mixture of arjunolic acid with minimum inhibitory concentration (MIC) values in the Range of 50-200 µg/ml (Puvanakrishnan et al., 2010).

7. MATERIAL AND METHODS

7.1 Plant Material

The bark of Terminalia arjuna was collected from a local herbal supplier/market and authenticated by a qualified botanist or pharmacognosist. The collected plant material was washed to remove impurities, shade-dried at room temperature, and powdered using a mechanical grinder. The powdered bark material was passed through a suitable sieve to obtain uniform particle size and stored in an airtight container until further use for extraction

and formulation studies.

7.2 Extraction Process of Terminalia arjuna Bark

Fresh bark of Terminalia arjuna was collected and washed to remove impurities. The bark was shade-dried for 7–10 days and then powdered using a grinder. The dried powder was passed through a sieve for uniform particle size.

7.3 Maceration

Approximately 100 g of powdered bark was extracted with ethanol (70–95%) using the maceration method or Soxhlet apparatus for 6–8 hours. The extract obtained was filtered.

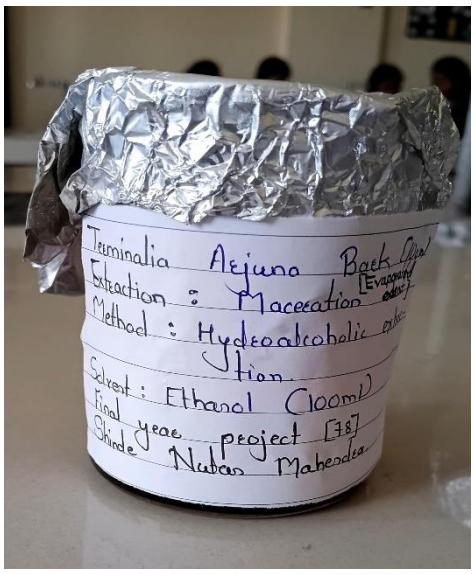

Fig. no. 2: Maceration.

using Whatman filter paper to remove insoluble particles. The filtrate was concentrated.

Fig. no. 3: Filteration.

using a rotary evaporator or by evaporation on a water bath at 40–50°C until a semisolid mass formed. The concentrated extract was dried and stored in an airtight container for further formulation of emulgel. Preliminary phytochemical screening of the ethanolic extract of Terminalia arjuna was performed to identify the presence of various phytoconstituents using standard procedures.

7.4 Phytochemical screening

A small quantity of Terminalia arjuna ethanolic extract was dissolved in a suitable solvent. Different qualitative tests were carried out according to standard methods for identification of phytoconstituents. Color changes or precipitate formation were observed and recorded Preliminary screening of secondary metabolites such as alkaloids, Flavonoids, saponins, phytosterols, lactones, terpenoids, and Glycosides was carried out according to the common phytochemical:

1) Test for Tannins (Ferric Chloride Test)

Add 2–3 drops of ferric chloride solution to the extract.

Blue-black or greenish-black coloration indicates tannins.

2) Test for Flavonoids (Alkaline Reagent Test)

Add a few drops of sodium hydroxide solution to the extract.

Formation of intense yellow color that becomes colorless after adding dilute acid indicates flavonoids.

3) Test for Saponins (Foam Test)

Shake the extract vigorously with distilled water.

Formation of stable foam indicates saponins.

4) Test for Alkaloids (Mayer's Test)

Take 2 mL of plant extract.

Add few drops of Mayer's reagent.

Formation of a cream or white precipitate indicates the presence of alkaloids.

5) Test for Terpenoids

Shake the extract vigorously with distilled water.

Formation of stable foam indicates saponins.

6) Test for Glycosides (Keller–Killiani Test)

Add glacial acetic acid and ferric chloride followed by concentrated sulfuric acid.

Brown ring formation indicates glycosides.

7.5 Ingredients Table

Sr.no	Excipients	Quantity for F1 batch	Quantity for F2 batch	Quantity for F3 batch
1.	Terminalia arjuna extract	2.7g	2.7g	2.7g
2.	Guar gum	1g	1.5g	2g
3.	Gum acacia	2g	2g	2g
4.	Coconut oil	5.3ml	5.3ml	5.3ml
5.	Glycerin	2.7ml	2.7ml	2.7ml
6.	Honey	2.7ml	2.7ml	2.7ml
7.	Rose water	q.s	q.s	q.s

7.6 Formulation of emulgel

1: Preparation of Gel Base

Take rose water (about 5–6 ml) in a beaker, Add glycerin (2.7 ml) and mix well. Slowly sprinkle guar gum (0.5–1 g) with continuous stirring, Allow it to hydrate for 15–20 minutes, Stir to obtain a smooth, lump-free gel base.

Step 2: Preparation of Oil Phase

Take coconut oil (5 ml) in a separate beaker. Heat gently using a water bath at 40–50°C.Do not overheat.

Step 3: Preparation of Aqueous Phase

Take another beaker and add Honey (2.7 ml), Remaining rose water, Add Terminalia arjuna extract (2.7 g), Stir until a uniform mixture is formed.

Step 4: Addition of Emulsifier

Add gum acacia (2 g) into the aqueous phase, Mix properly to form a smooth dispersion.

Step 5: Emulsion Formation

Slowly add the oil phase into aqueous phase with continuous stirring, Continue stirring until a stable oil-in-water (O/W) emulsion is formed.

Step 6: Formation of Emulgel

Add the prepared emulsion into guar gum gel base slowly, Mix gently and uniformly, Avoid incorporation of air bubbles.

8. Evaluation of emulgel

1. Colour and Odour

Physical parameters like colour and odour were examined by visual examination.

2. Consistency

Smooth and no greediness is observed.

3. PH

PH of prepared herbal ointment was measured by using digital PH meter. The solution of ointment. Was prepared by using 100ml of distilled water and set aside for 2hrs. PH was determined in Triplicate for the solution and average value was calculated.

Fig. no. 4: Digital pH meter.

4. Spreadability

One of the criteria for a emulgel is that it should possess good spreadability. Spreadability is a term expressed to denote the extent of area to which the formulation readily spreads on application To skin or affected part. The therapeutic efficacy of a formulation also depends on its spreading value. The time taken for the upper slide to travel the distance of 6.0 cm and separated away from the lower slide under the influence of the weight was Noted.8

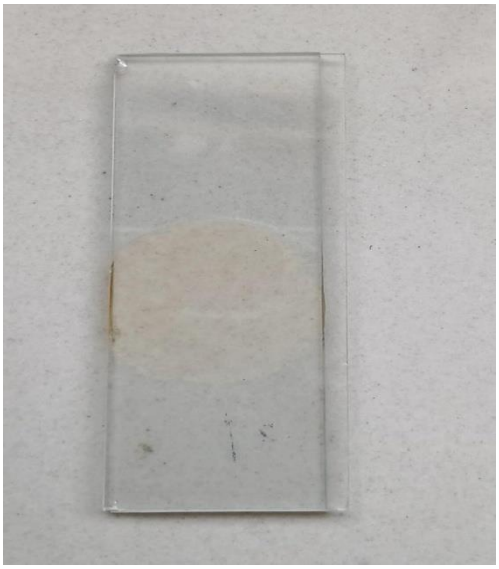

Fig. bo. 5: preadability.

The experiment was repeated by three times and the mean time was taken for calculation. Spreadability was calculated by using the following formula:

Formula:- m x I / t (spread ability)

Where,

S – Spreadability

m-Weight tied to the upper slide

l – Length of the glass

t – Time taken in seconds

5. Extrudability

The formulation was filled in collapsible tube container. The extrudability was determined in terms of Weight of ointment required to extrude 0.5cm of ribbon of ointment in 10 seconds.

6. Solubility

Soluble in boiling water, miscible with alcohol, ether, chloroform.

7. Washability

Formulation was applied on the skin and then ease extend of washing with wate.

8. Stability study

Stability study was performed as per ICH guideline.13 The purpose of stability testing is to provide Evidence on how the quality of a drug substance or drug product varies with time under the influence of A Variety of environmental factors such as temperature, humidity and

light. Therefore, stability studies Provide data to justify the storage condition and shelf-life of the drug product. For drug substance, such Studies establish the retest date in addition to the storage condition of raw material. Stability studies Were performed for selected formulation with 25 ± 2° C and 60 ± 5% RH and 40 ± 2° C and 75 ± 5% RH Conditions for 6 months. The samples were analyzed at 0, 3 and 6 months interval for colour, Physical Appearance and pH.

9. Rheological study

The viscosity of the formulated batches was determined using a cone and Plate viscometer with Spindle 7 (viscometer Brookfield RVDV‑I Prime). The assembly was connected to a thermostatically controlled circulating Water bath maintained at 25°C. The formulation was added to a beaker Covered with thermostatic jacket. Spindle was allowed to move freely Into the emulgel and the reading was noted.

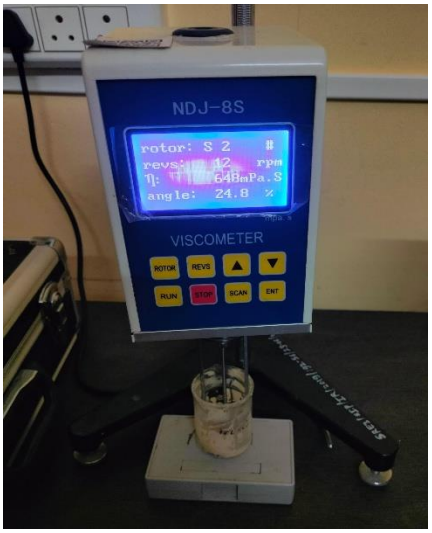

Fig. no-6: Digital pH meter.

9. RESULT

9.1 Phytochemical Screening

Sr No.	Phytochemical test	Test perfoemed	Result	Inference
1.	Tannins	Ferric chloride	Black colour present	Tannins present
2.	Flavonoids	Shinoda test	Res colour present	Flavonoids present
3.	Test for alkoloids	Mayers test	Orange precipitate present	Alkoloids present
4.	Test for Terpenoids	Salkowski test	Reddish Brown interface	
5.	Glycosides	Killer killani test	Brown ring	Cardiac glycosides present
6.	Saponins test	Foam test	Stable foam formation	Indicates saponins

9.2 Evaluation parameters

Test	Result
Colour and odour	Pleasant characteristic odour with uniform brownish color
Consistency	Smooth homogeneous
pH	6.5-7.0(skin compatible)
Spreadability	Good
Extrudability	Easily extrudible
Solubility	Soluble in ethanol
Washability	Easily washable
Stability	Stable with no phase separation
Viscosity	Appropriate viscosity for topical application

The Terminalia arjuna herbal emulgel was successfully prepared and evaluated for various physicochemical parameters. The formulation exhibited a smooth, homogeneous appearance with no visible signs of phase separation, grittiness, or lump formation. The color of the formulation was brownish with a characteristic herbal odor.

The pH of the prepared emulgel was found to be within the acceptable skin pH range, indicating compatibility for topical application. Viscosity measurements demonstrated suitable consistency and good rheological behavior for application on the skin. Spreadability studies indicated that the formulation could be easily spread over the skin surface with minimal effort.

10. CONCLUSION

The developed emulgel formulation of bark extract from Terminalia arjuna demonstrated suitable physicochemical properties and showed potential as an effective herbal topical drug delivery system for wound healing applications. The formulation exhibited acceptable appearance, homogeneity, pH, spreadability, viscosity, and stability characteristics, indicating good patient applicability and formulation consistency. The incorporation of natural excipients improved the formulation profile and supported better drug release and skin retention properties. Based on the evaluation results, the prepared herbal emulgel may serve as a promising alternative to conventional topical formulations because of its ease of application and potential therapeutic benefits. Further in vivo studies and clinical investigations are required to confirm its safety, efficacy, and long-term wound-healing performance.

11. REFERENCES

1. Mores, Kathleen, Understanding and overcoming the challenges of effective case management for patiems with chronic wounds. The Case Manager, 2005; 16(2): 62-3.67.
2. Mustoe, Thomas. Understanding chronic wounds: A unifying hypothesis on their pathogenesis and implications for therapy. The American Journal of Surgery, 2004; 187(5): $65.
3. Williams NS, Christopher JKB, O'Connell PR. Baily and love's Short Practice of surgery, chapter 57 venous disorders 25th ed. UK. Hodder Arnold part of Hachette, 2008; 901.
4. SRB's Manual of Surgery, Siren Bhat M 4th edition Jaypee Brothers Medical Publishers, 249.
5. Shatri A. Sushruta Samhita with Ayurved Tarva Sandipika Commentary, Sutrasthana. Varanasi: Chowkhambha Sanskrit Sansthan, 2009, 98 Su Su 23/7.Formulation by TLC method. International Journal of Pharmaceutical Science, Review & Research, 2010; 2(1): 25-8.
6. Shastri A. Sushruta Samhita with Ayurved Tarva Sandipika Commentary, Sutrasthana. Varanasi: Chowichambha Sanskrit Sansthan, 2009; 95. Su 22/7.
7. https://en.wikipedia.org/wiki/Terminalia_arjunal/media/File:Terminalia arjuna-1.jpg Accessed on 30.05.2016.
8. Shastri A. Sushruta Samhita with AyurvedTarvaSandipika Commentary, Sutrasthana Varanasi: Chowkhambha Sanskrit Sansthan, 2009; 8 Sasu: 1/55.
9. Srivastava P. Durgaprasad S. Burn wound healing property of Cocosnucifera: An appraisal. Indian J Pharmacol, 2008; 40(4): 144-6.
10. Aneja K.R., Sharma C., and Joshi R., Antimicrobial activity of Terminalia arjuna Wight & Am. An ethnomedicinal plant against pathogens causing car infection. Braz J. Otorhinolaryngol, 2012; 78(1): 68-74.
11. Anjaneyulu C., Shyamkumar B, and Giri C.C., Somatic embryogenesis from callus cultures of Terminalia chebularetz: An important medicinal tree, Trees, 2004; 18: 547-552. http://dx.doi.org/10.1007/s00468- 004-0344-9
12. Bachaya H.A., Iqbal Z., Khan M.N., Jabbar A., Gilani A.H., and Din L.U. In vitro and in vivo Anthelmintic activity of Terminalia arjuna bark, Int. J. Agric. Biol., 2009; 11(3): 273-278.
13. Bauer R.W., Kirby M.D.K., Sherris J.C. and Turck M., Antibiotic susceptibility testing by Standard single dise diffusion method, Ame. J. Clinic, Pathol., 1966; 45: 493-96.

14. Chittora M., Suthar R.K., and Purohit S.D., Root colonization and improved growth Performance of micro propagated Terminalia bellerica Rosh, plantlets inoculated with Piriformosporaindica During ex vitro acclimatization, acta Horticult, 2010; 865: 193-198.
15. Lal UR. Department of Natural Products, National Institute of Pharmaceutical Education and Research (NIPER), Sector 67, S A S Nagar 160062, Punjab, India. Sci Pharm., 2009; 77: 605-16.
16. Ayurvedic Pharmacopoeia of India. Part-2 Appendices, vol-2, 1st ed. New Delhi: Govt. of India, Ministry of Health of Family Welfare, 2008; 165-7.
17. Quality Standards of Indian Medicinal Plants. Indian Council of Medicinal Research, New Delhi, 2005; 2: 198.
18. Kapoor LD. Handbook of ayurvedic medicinal plants, Boca Raton, FL: CRC Press, 1990; 319-320.
19. Bone K. Clinical applications of ayurvedic and Chinese herbs, Warwick, Queens land, Australia. Phyte therapy Press, 1996; 131-133.
20. Dwivedi S. Terminalia arjuna Wight & Am. -A useful drug for cardiovascular disorders. J Ethno pharm., 2007; 114: 114-29.
21. The Ayurvedic Pharmacopoeia of India. Part-1, vol. II, ist ed. New Delhi, Government of India, Ministry of Health & Family Welfare, Dept. of Indian Systems of Medicines & Homeopathy, 1999; 17-18.
22. Wallis TE. Textbook of pharmacognosy. V ed. CBS Publishers and distributors, 2005.
23. Ghosh P, Pradhan RC, Mishra S, Patel AS, Kar A. Physicochemical and nutritional Characterization of jamun (Syzygiumcuminii). Current Research in Nutrition and Food Science Journal, 2017; 5: 25-35.
24. Shrikant Baslingappa S, Nayan Singh JT, Meghatai MP, Parag MH. Jamun Syzygiumcumini (L.)): a review of its food and medicinal uses. Food Nutrition Sciences, 2012; 3: 1100-1117.
25. Raza A, Butt MS, Suleria HAR. Jamun (Syzygiumcuminii) seed and fruit extract Attenuate hyperglycaemia in diabetic rats. Asian Pacific journal of tropical biomedicine, 2017; 7: 750- 754.
26. Sharma SB, Nasir A, Prabhu KM, Murthy PS. Antihyperglycemic effect of the fruit- pulp of Eugenia jambolana in experimental diabetes mellitus. Journal of Ethnopharmacology, 2006; 104: 367-373.
27. Getia GC. A review on the role of jamun, syzygiumcuminiskeels in the treatment of Diabetes. Int J Complement Alternate Med., 2018; 11: 91-95.

28. Chikezie PC, Ojiako OA, Nwufo KC. Overview of anti-diabetic medicinal plants: The Nigerian research experience. J Diabetes Metab, 2015; 6: 546. 15.Anjali V, Sindhu G, Girish C. A review on pharmacology and phytochemistry of Syzygiumcumini. Ndian Journal of Pharmaceutical Biological Research, 2017; 5: 24-28.
29. Shahnawaz M, Sheikh SA, Nizamani S. Determination of nutritive values of Jamun fruit(Eugenia jambolana) products. Pakistan Journal of Nutrition, 2009; 8: 12751280.
30. Shani J, Goldschmied A, Ahronson Z, Sulman FG. Hypoglycaemic effect of Trigonellafoenumgraecum and Lupinustermis (leguminosae) seeds and their major alkaloids In alloxan diabetic and normal rats. Arch Int Pharmacodyn Ther., 1974; 210(1): 27–36.
31. Ghosal S, Srivastava RS, Chatter DC, Dutta SK. Extractives of Trigonella – Fenu-greekine, a new steroidal sapogenins -peptide ester of Trigonellafoenumgraecum. Phytochem, 19741; 3: 2247–51.23. Handa SS, Khanuja SPS, Longo G, Rakesh DD. Extraction technologies.