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HERBAL BASED BANDAGES: WOUND HEALING POTENTIAL

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ABSTRACT

Acute wounds can cause chronic forms of microbial growth because they take longer to heal the tissues. Adhesive herbal bandages are used to protect and promote quick wound healing process. Medicinal plants and their phyto-constituents have been utilised to cure the wound in the Ayurveda therapy. Herbal based bandage can have a big impact on wound healing process. In addition to their demonstrated superior wound-healing qualities, these herbal forms may also exhibit pharmacological effects, including antibacterial, antipyretic, antifungal, antiseptic, anti-inflammatory, and anti-oxidative properties, for further therapeutic efficacy. This review article mainly discuss the development of herbal based bandages and their potential wound healing process.

KEYWORDS: Herbal, Bandages, Wound, Healing

One of the biggest global challenges is wound care. Acute and chronic wounds, diabetes, trauma, burns, minor cuts, bruises, rashes, etc., can all be considered. Using the proper dressing materials to cover the wound and accelerate the healing process is one of the main therapeutic choices for these disorders (Kumar *et al.*, 2007). Archaeological ideas indicate that medicinal herbs and their phyto-constituents have been used to cure wounds from prehistoric times. Now, research focused on the development of innovative dressing materials that can offer the best wound care, facilitate nutrition exchange, and absorb wound exudate (Sen *et al.*, 2002; Pawar and Toppo, 2012).

Herbal preparations contain a wide range of phyto-constituents with pharmacological properties, and thought to be generally safe, even when used for long periods of time. Herbal based bandages offer the perfect environment for the healing process since they include a variety of bioactive substances that can influence the different stages of the wound healing process (James *et al.*, 2008; Vinchhi *et al.*, 2024). This review provides an insight into the preparation of herbal based bandages and its wound healing process.

Cinnamon Based Bandage

Cinnamon-containing polycaprolactone bandages were prepared by pressurised gyration method. Anti-fungal activity of prepared bandages was studied against *Candida albicans*. It was observed cinnamon-containing polycaprolactone bandages fibres could able to inhibit the fungal growth in the disk diffusion tests using Sabouraud Dextrose Agar plate. Interestingly, cinnamon-loaded fibres showed considerable anti-fungal activity against *Candida albicans*, when compared with raw cinnamon powder (Ahmed *et al.*, 2019).

Herbal Extract Based Bandage

Without the need for external dressing materials, a medical bandage with environmentally friendly herb extract *(Coriandrum sativum)* was developed for antibacterial and wound-healing activity. It was made by combining one cotton bandage with ten layers of extracted solution using the pad-dry-cure method. A second sample was made in a single layer using the same procedure, but with a coriander extraction solution that was ten times more concentrated. The treated materials underwent antimicrobial testing, SEM analysis, ATR analysis, and K/S value measurement. The samples' capacity to heal was demonstrated by applying them to a rabbit's wound site. Interestingly, the K/S value of the second sample was strikingly close to the 0.89 value of the eleventh layer of the first sample. The SEM image of the second sample revealed that a sizable layer of coriander extract had been applied to the fibre surface. ATR analysis verified that the treated sample contained the phytochemicals found in coriander extract. Zones of inhibition (ZOI) against Gram-positive and Gram-negative bacteria were 14 mm and 12 mm, respectively, in samples that had been padded with coriander extract. When the bandages were taken off after seven days, the wound had healed well (Ghosh *et al.*, 2023).

Bamboo Fibre Based Bandage

Bamboo fibre is a naturally occurring antibacterial, biodegradable, and environmentally friendly

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regenerated cellulosic fibre derived from bamboo plants. A study has been conducted to assess the anti-bacterial and anti-fungal properties of bandage fabrics made out of bamboo fibers and compared with those made from cotton and rayon. Consequently, bamboo was shown to have strong antimicrobial qualities, followed by cotton and rayon. The results of the following tests, such as growth rate, demonstrate that bamboo fabric has a far stronger antimicrobial effect than rayon and cotton. Compared to cotton, bamboo fabric has natural antimicrobial properties that make it better suited for medical gauze bandages (Basu and Balasubramaniyan, 2008).

Ti plant based bandage

The age-old technique of creating traditional bandages using fibre from Ti plant leaves has its roots in sustainable craftsmanship and cultural legacy. The painstaking process involves harvesting leaves from the hardy Ti plant, which is renowned for its robust and flexible fibres. This environmentally friendly approach guarantees a low environmental impact, which is consistent with sustainability ideals. The careful selection of ripe Ti plant leaves, which are then conveniently chopped and prepared for filament extraction, is the most crucial step in this astounding piece of work. The care with which these fibres were removed demonstrates the skill and patience that have been handed down through the centuries. The artisans show off their ability to turn raw materials into a product that is both functional and aesthetically pleasing by meticulously removing the fibres and then starting the complex weaving process. Weaving is a delicate hand-to-hand dance that creates the Bandage's strong yet flexible framework. To ensure the final product's solidity and longevity, this cycle necessitates precision as well as an understanding of the characteristics of Ti plant strands. The rich cultural tapestry of the village is shown by the weaving's motifs and patterns, many of which have symbolic importance. Every Bandage tells a unique tale, illustrating the traditions, beliefs, and background of the experts and their networks. In summary, the production of bandages using fibre from Ti plant leaves is a skilful fusion of culture, nature, and expertise (Keertan *et al.*, 2024).

Clove Bud Oil Based Bandage

Anatomical disturbance of the skin is a characteristic of wounds; this exposes the body to opportunistic microorganisms that lead to infections. Present-day bandages for wound healing offer little defence against this, and when they do, they frequently contain dangerous additives. In the past, plant-based components have been widely employed to treat wounds and have shown promise in these settings. In this study, 44.4% (v/v) of the fibres containing oil were created by pressurised gyration after the essential oil of clove buds (*Syzygium aromaticum*) was added to a polycaprolactone (PCL) solution. In vitro disc diffusion was used to examine the antibacterial activity of these bandage-like fibres, and the physical characteristics of the fibres were evaluated as well. The study demonstrated that fibre shapes with diameters of 10.90 ± 4.99 µm were beneficial. The oil fibres from clove buds showed strong antibacterial properties. Their relative inhibitory zone sizes against microbiological colonies of *Candida albicans*, *Escherichia coli*, *Staphylococcus aureus*, and *Staphylococcus pyogenes* were 30, 18, 11, and 20 mm. These microorganisms frequently cause issues in settings where the skin barrier is weak. Thus, the study's results are quite encouraging and point to clove bud oil as a highly viable natural substitute for contemporary treatment (Von Thadden *et al.*, 2022).

Pepper Horn Extracts Cotton Fabric

The application of pepper horn extracts in their nanoemulsion form as an antibacterial finishing agent for textile fabrics is not well documented. In order to compare the antibacterial qualities of pepper horn extract in two distinct forms—micro- and nanoemulsion—the current study was conducted. Absolute ethyl alcohol was used to extract the powder, and a rotary evaporator was used to create an oily, reddish-colored extract. 9,12-octadecadienal (29.99%), linalyl acetate (18.38%), Z, Z-10,12-hexadecadien-1-ol acetate (14.65%), and 2-methyl-1,5-hexadiene-3-ol (3.75%) have been identified as the main components of the capsicum extract. To assess the extract's antibacterial activity, various concentrations were directly loaded onto cotton fabric discs; it was discovered that the activity rose as the concentration decreased. Better antibacterial activity against G+ ve bacteria and yeast was demonstrated by the extract, whereas reduced activity against G-ve bacteria was observed. Using tween 80 and tetraethyl orthosilicste as precursors, various quantities of nanoemulsion for this extract were prepared, and their antibacterial properties were directly evaluated using the cup plate method. The biological activity of the ethanolic extract of capsicum and its nanoemulsion was assessed using the cytotoxicity assay. The resulting data demonstrates that, even after ten washing cycles, cotton fabric treated with a modest concentration of a capsicum-based nanoemulsion (2.5%) possesses exceptional antibacterial characteristics without affecting human cell lines. It is anticipated that the use of pepper horn extract-based nanoemulsion for effective antimicrobial cotton textiles will significantly lower the need for costly hazardous chemicals (El-Naggar *et al.*, 2020).

Nano-bandages with Plant Mediated Nanoparticles

Antibacterial nano-bandages were prepared utilising zinc oxide nanoparticles made the green way (with extracts from walnut leaves) and quince seed mucilage (a novel biopolymer)/chitosan/PEO. The optimal fibres were produced with the right sizes, shapes, and loadings of ZnO nanoparticles in a 20:80 quince seed mucilage to chitosan/PEO ratio. The best electro-spinning parameters were voltage = 18 kV, feed rate of polymer solution = 1 ml/h, and needle-to-collector distance = 12 cm. FT-IR spectroscopy, X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), and tensile testing were used to characterise the generated nanofibers. According to the results of an animal experiment, grade 2 burn wounds responded significantly to nano-bandages containing ZnO nanoparticles; the burns healed faster and no infections were found. After 21 days, their bodies showed no signs of burns, and their skin had fully recovered. The findings demonstrated that the created nano-bandage had a significantly larger impact on wound healing than the control and nano-bandage without nanoparticles (Darvishi *et al.*, 2021).

Herbal-Coated Bio-Bandage

The most common biomaterial applied to wounds to prevent infections and heal them is a bandage. Sticking plaster, another name for the adhesive bandage, shields the wound from dirt, bacteria, friction, and harm. The plant (*Chromolaena odorata*) leaf extracts applied to textiles are being investigated in this study as a possible medication to aid in wound healing. The ethanolic plant leaf extracts' antibacterial properties and phytochemical screening were investigated. Using the pad-dry curing process, the leaf extracts were applied to non-woven viscose rayon fabric. To ascertain the wound-healing process, the coated fabric's biological and physical characteristics were examined. Using conventional procedures derived from medical textiles, the pH and absorbency properties were assessed. Studies were conducted on the cytotoxicity (MTT assay), antibacterial effectiveness (standard protocol AATCC 100), and in vitro scratch wound assay employing cell lines. The outcomes demonstrated that the created herbal-coated bio-bandage has every quality needed for the perfect dressing. As a result, it can be advertised as a cutting-edge bio-bandage for wound healing (Sukirtha *et al.*, 2022).

Plant Based Bandage

A bandage is a common biomaterial that is applied to wounds to both treat them and prevent infections. An adhesive bandage, sometimes referred to as a sticking plaster (and also marketed under generic trademarks such as Band-aid or Elastoplasts), is a tiny dressing that is applied to minor wounds that don't need a full-size bandage. The cut is shielded from dirt, bacteria, friction, and harm by the sticky bandage. A 50%:50% bamboo cotton web was chosen for the bandage functional part's manufacture in this investigation. The eco-friendly natural leaves of *Azadirachta indica* and *Galinsoga parviflora* were used to finish the functional portion of the website. Both the antibacterial evaluation and the anti-allergy evaluation (in-house method) of the finished cloth contact allergy test were performed on the completed web. When compared to 50%:50% Bamboo cotton finished with *Galinsoga parviflora*, the test revealed that *Azadirachta indica* and 50%:50% Bamboo cotton finished with *Galinsoga parviflora* had superior wound-curing properties (Sumithra and Amutha, 2016).

Adhesive bandage; Anti-allergy; Antibacterial;

Azadirachta indica; Galinsoga parvi□ora

Herbal Bandage

Acute wounds can occasionally result in the development of chronic forms or microbial growth because they take longer to heal or remodel the tissues. Adhesive bandages known as bandaids are the main tool used to protect and promote quick wound healing. Herbal bandages can have a major impact on wound healing because plants and products derived from them have been utilised since prehistoric times. In addition to their demonstrated superior wound-healing qualities, these herbal forms may also exhibit pharmacological effects, including antibacterial, antipyretic, antifungal, antiseptic, anti-inflammatory, and antioxidative properties, for a more effective result. Based on the creation of these types of bandaids, organic herbal bandaids employing *Ocimum tenuiflorum* (tulsi), *Curcuma longa* (turmeric), and *Azadirachta indica* (neem) was developed under appropriate hygienic and sanitary conditions. Following conventional protocols, the herbal bandaids were created and subjected to a number of examinations. Herbal bandages were discovered to be a potentially superior substitute for conventional ones in terms of wound healing (Torkadi *et al.*, 2022).

Wound Dressings

Wound healing is a difficult and continuous process that is impacted by several factors in order to achieve rapid recovery. Examining the evolution of wound dressings from traditional to contemporary care approaches is our aim. To investigate the enhancement in when applied to a wound, these bandages help the wound heal and maintain cleanliness. It is used in combination with antibacterial medications to prevent post-dressing infection. Additional drugs must be used on a daily basis to manage pain and promote wound healing. The bandage's antimicrobial efficacy was evaluated during the antimicrobial study. Wound dressings: traditional and contemporary methods of treatment. In addition to biocompatibility, ease of removal, moisture retention, high absorption capacity for wound exudates, and superior permeability for oxygen and water vapour, a wound dressing should have antibacterial properties. For further research, the developmental prospective of the novel gene ratios of wound dressings is then provided. In both developed and developing countries, the usage of sanitary products is increasing. A modified disc diffusion assay was used to test cotton bandages containing silver and copper nanoparticles against *Escherichia coli*, *Bacillus cereus*, and *Staphylococcus aureus*. Because of its antibacterial and burn wound-healing qualities, the modified cotton material can be utilised in biomedical textiles. The best coverings for wounds should be pliable (Divya and Ragavi, 2023).

Plant Mediated Silver Nanoparticles Bandage

In addition to biocompatibility, ease of removal, moisture retention, high absorption capacity for wound exudates, and superior permeability for oxygen and water vapour, a wound dressing should have antibacterial properties. In order to create a stable and concentrated solution of silver nanoparticles (Ag-NPs) using the flexible one-pot green synthesis approach and the developmental viewpoint of the novel gene, tannic acid (a capping agent) was allowed to self-assemble. In addition to being a green dispersion and reductant, tannic acid (a hygienic capping agent) also functions as a self-assembly agent without the need of dangerous chemicals. The cotton textile substrate was then covered with the synthesised Ag-NPs. Several characterisation techniques, including Scanning Electron Microscopy (SEM), Dynamic Light Scattering (DLS), Fourier Transform Infrared Spectroscopy (FTIR), Energy Dispersive X-Ray Spectroscopy (EDS), and X-Ray Diffraction (XRD), were used to assess the surface morphologies of the textiles coated with metallic nanoparticles. The second phase involved using an exhaust dyeing method on the Ag-NPs coated fabric after a natural antibacterial dye was produced from pomegranate peel. CILAB was used to assess the dyed substrate's colour measurement characteristics. The dyeing process changed the light-toned silver-coated fabric into a comparatively dark-coloured fabric, as seen by the dyed sample's comparatively high K/S values (11.31) compared to the undyed fabric's 7.47. However, the dyed fabric's levelness L* value was comparatively lower (37.15) than that of the undyed cloth (55.35), suggesting that the dyed sample has a deeper shade (depth) than the undyed sample. Furthermore, all coated fabrics' antipathogenic performance—which includes antibacterial, antiviral, and antifungal effects—was assessed. The post-dyeing silver-coated fabric shown exceptional antibacterial qualities, eliminating 99.99% of germs (S. aureus and E. coli). Following washing, the antibacterial qualities of the coated cloth were measured to confirm its longevity. The post-dyeing silver-coated fabric shown exceptional antibacterial qualities, eliminating 99.99% of germs (S. aureus and E. coli). Following washing, the antibacterial qualities of the coated cloth were measured to confirm its longevity. Additionally, the created bandages' comfort properties (water vapour transmission permeability of 83 mm/s and air flow permeability of 935 mm/s) were also examined (Rashid *et al.*, 2025).

Liquid Bandages

Liquid bandages, also known as L-bandages, provide a novel method of wound care by covering wounds with a protective layer that promotes healing and guards against infection. Gallic acid (GA) is a promising natural wound-healing agent because of its anti-inflammatory, antibacterial, and antioxidant qualities. The purpose of this study is to create and assess a film-forming L-bandage that uses GA to promote efficient wound healing. Methods: With GA as the active ingredient, different formulations were made with film-forming agents such xanthan gum, pectin gum, and polyvinyl pyrrolidone. Physical attributes such as pH, viscosity, drying time, and film qualities like stickiness, washability, and flexibility were assessed for the formulations. To evaluate medication retention and skin penetration, in vitro experiments were carried out. Desired physical characteristics of the improved formulation included a pH of 5.6, suitable viscosity, and a quick drying time. The film had little stickiness, was pliable, and was simple to wash. Effective skin penetration and retention of GA were demonstrated in in vitro permeation tests, suggesting the possibility of long-term therapeutic benefit. In conclusion, the GA-based L-bandage shown encouraging outcomes as a wound-healing agent, providing a safe, all-natural remedy for minor skin wounds. The formulation's utility as a cutting-edge wound care solution is supported by its advantageous physical characteristics and capability for medication delivery (Desai *et al.*, 2024).

Anti-Bacterial Bandage

Bandaging remains a reliable but time-consuming aspect of wound care. It is necessary to replace bandages and control the danger of infection. Although they are effective substitutes, rapid-set liquid bandages are not long-lasting or have built-in infection prevention. Here, we demonstrate how antibacterial copper (Cu) and zinc (Zn) species significantly improve the barrier qualities of shellac, a naturally occurring waterproof, bioadhesive polymer. In ex-vivo experiments, the substance successfully locked in previously administered treatments and showed strong antibacterial contact qualities. In vivo, Zn/Cu-shellac attached quickly and firmly to pre-applied antibiotic when confronted with the polybacterial bovine wound infection known as "digital dermatitis." Despite the harsh circumstances (faecal slurry), the bandage appropriately self-degraded over the course of seven days. Animal mobility showed a clinical improvement and the treatment was well tolerated. This novel form of bandage holds promise for difficult topical scenarios in both humans and other animals, particularly when used outside of sterile, controlled clinical environments where wounds urgently need to be protected from bacterial and environmental contamination (Bastos *et al.*, 2020).

Herbal Bandage

Herbal medicinal bandages that would heal the wound site without the need for dressing materials and have antibacterial qualities. Extracts of Durba grass (*Cynodon dactylon*) and Bikash leaves (*Mikania micrantha*), two environmentally benign herbs, were used for this purpose. Following sample preparation, FTIR analysis, antibacterial activity, and an odour test were conducted. With the local veterinary department's approval, the samples were applied to a rabbit's wound site to demonstrate their healing qualities. Both plants performed exceptionally well in the odour test and received a rating of 2 (mild odour) on the odour rating scale. Regarding antibacterial activity, samples padded with *C.dactylon* had a zone of inhibition (ZOI) of 11 and 20 mm against Gram-negative and Gram-positive bacteria, respectively, whereas those padded with *M. micrantha* had a ZOI of 10 and 19 mm. The presence of phytochemicals on both fabrics treated with herbs was validated by the FTIR findings. Additionally, the wound-healing results were satisfactory. The area was fully healed after five days, when the bandages were removed (Ghosh *et al.*, 2021).

Liquid Bandage with Ginger Extract

Prepared a liquid bandage with ginger extract and assessed its chemical and physical properties. The formulation and physico-chemical characterization of the liquid bandage containing ginger extract (LBGE) were completed. Chemical properties like drug release at various time intervals and physical properties like pH, viscosity, drying time, and surface shape were evaluated. High Performance Liquid Chromatography (HPLC) was used to evaluate drug release experiments, while Scanning Electron Microscopy (SEM) was used to examine surface morphology. According to the data, the formed LBGE had a pH of 6, a drying time of 55 seconds, and a viscosity of 6 cps at 30 rpm. SEM pictures showed a consistent and even spray pattern. After a day, it was discovered that the liquid bandage film was still in place. After 24 hours, the cumulative medication dissolution rate was 3.67%. We can infer from the results that LBGE has adequate physical properties and drug release to produce the desired therapeutic effect (Komandur *et al.*, 2020).

Electro-Spun Bandage

With superior structural and biological advantages over traditional dressings, biodegradable electrospun bandages are a potential development in wound healing. By creating nano- and microfibrous scaffolds that closely resemble the extracellular matrix (ECM), electrospinning technology facilitates cell adhesion, migration, and proliferation for quicker tissue regeneration. These bandages are biocompatible and require fewer dressing changes since they are made of biodegradable polymers such sodium alginate, gelatin, chitosan, polycaprolactone (PCL), and polylactic acid (PLA). Bioactive substances, such as growth factors, antibacterial nanoparticles, and anti-inflammatory medications, can be added to functionalized electrospun bandages to provide regulated drug release and lower the risk of infection and inflammation. Their ability to retain moisture promotes the best possible healing environment, which is particularly advantageous for burn injuries, diabetic ulcers, and chronic wounds. To further increase their therapeutic potential, smart wound dressings are also being developed that incorporate stimuli-responsive polymers that respond to environmental cues like pH, temperature, or bacterial activity. Biodegradable electrospun bandages have great clinical utility because of their capacity to hasten wound healing, stop infections, and lessen patient suffering. Electrospun dressings are anticipated to become the gold standard for wound care in the near future as a result of ongoing research into bioactive and responsive materials (Gupta *et al.*, 2025).

Scaffold Bandage

Bandage is a substance that supports a dressing, splint, or other medical equipment. It can also be used to give a bodily component mechanical support. The element that is physically put to the wound and is in charge of encouraging wound healing is the dressing. The recruitment and activity of several cell types, including keratinocytes, fibroblasts, endothelial progenitor cells, and native immune response cells, are necessary for the healing process following a skin lesion. An apheresis unit got a platelet concentrate bag from a blood bank controlled by the Food and Drug Administration (FDA) three days before to expiration. The bag was transported to the lab at 4°C to 8°C using an ice pack, and it was stored at -80°C until it was used. The Bombyx mori silk cocoons were gathered at the Ram Nagar Silk Cocoon market and transported to the laboratory in sterile plastic bags at room temperature until they were processed. The platelet count was 109 cells/ml (18.5 ± 2.3). Using a digital pH meter, the pH values of sericin and human platelet lysate (hPL) were 6.8 ± 0.1 at 27°C and 6.9 ± 0.1 at 26.5°C, respectively. Similarly, the spread plate approach was used to determine the sterility of sericin and hPL. Using the Karl Fischer method, the moisture content of the hPL powder was determined to be 1.842% w/w. In contrast to the chemical technique, sericin was successfully separated using the non-chemical process and demonstrated good gelling properties, becoming soft and hydrophilic, indicating that it would be better appropriate for use as a scaffold (wound dressing) (Nandikolmath *et al.*, 2021).

Liquid Gel Bandage

In this work, tannic acid and polyethylene glycol (TAPE) were combined to create a liquid gel bandage for wound care. Based on the physical characteristics of the resultant product, agar was added as a stabilizer. Based on the resulting drying rate and mixing consistency, ethanol was selected as the solvent. The drying, adhesion, and swelling properties of the liquid bandage were evaluated. Its cytotoxic and antibacterial qualities were also assessed. The finished formulation exhibited a swelling ratio of 64%, a T-peel adhesion yield point of 591.6 Pa, and a drying duration of 5 minutes. Additionally, the gel was found to have cytotoxic effects and to be antimicrobial against both S. aureus and E. coli (Bautista *et al.*, 2020).

Plumbagin Based Dressing

To enhance patient compliance and the prolonged drug rele]ase activity of herbal medication, the matrix type transdermal patches containing plumbagin were created using the solvent evaporation process with varying ratios of polymers (HPMC 50cps, PVP K29-32, and EUDRAGIT RS-100), t. PEG (polyethylene glycol) was utilized as a plasticizer and DMSO (dimethyl sulfoxide) as a penetration enhancer in these matrix-type transdermal patches. Physicochemical characteristics such as thickness, weight variation, percentage of moisture content, percentage of moisture uptake, percentage of flatness, folding endurance, and medication content were assessed for the developed patches. The Franz diffusion cell was used for in vitro drug release experiments. The six batch formulations had cumulative drug release percentages of 95.66%, 94.2%, 97.33%, 90.13%, 83.75%, and 85.71% in 10 hours, respectively. The formulation (HE-2) was chosen for additional assessment, including antifungal activity and stability investigations, because it was determined to have superior in-vitro drug release compared to other formulations (Sharma and Agarwal, 2021).

Jernang Based Bandage

Research have been focused a lot of effort on the development of jernang (*Daemonorops draco*) and chitosan nanoparticles as materials for wound care. In this study, jernang ethanol extract and chitosan nanoparticles were mixed together. Malassezia furfur and Candida albicans inhibition tests were used to determine the materials' antifungal properties. The Wistar rat (*Rattus novergicus*) in vivo wound healing test was used to determine the wound healing activities. the substances used on the patch for wound treatment. Green mussel shell waste (Perna viridis L.) was used to create chitosan. According to the results, the degree of deacetylation (DD) was 69.53% and the chitosan yield was 64.67%. In the meanwhile, chitosan nanoparticles can be made using a ball mill. According to the results, the degree of deacetylation (DD) was 69.53% and the chitosan yield was 64.67%. In the meanwhile, chitosan nanoparticles can be made using a ball mill. The average particle size, according to the results, was 437.6 nm (nanoparticles range in size from 1 to 1000 nm). Ethanol organic solvents were used in the maceration process to produce jernang. The alkaloid, saponin, flavonoid, and triterpenoid tests were all positive, and the yield was 22.41%. According to test results for wound healing and antifungal activity, F3 exhibits the greatest levels (Nuraeni *et al.*, 2022).

Yashtimadhu Based Dressing

The purpose of this study was to create transdermal patches using the medicinally effective medication yashtimadhu and perform physical characterization on them. To make a methanolic extract of yashtimadhu and transdermal patches using extract from yashtimadhu The casting evaporation method was used to formulate the Yashtimadhu transdermal patches. Hydroxypropyl methylcellulose (HPMC) was used to make transdermal patches, which were then dried in various systems and subjected to physical characterization (weight uniformity, pH, folding durability, percentage of moisture content, and organoleptic qualities). The casting evaporation method can be used to manufacture Yashtimadhu transdermal patches, which have the organoleptic qualities of being transparent, menthol-smelling, dry, brown, and smooth. Folding endurance was 34, the pH ranged from 5.4 to 6, the moisture content percentage was 3.990 ± 0.70, and the weight uniformity was 6.08 ± 0.62. Every patch met the physical characterization requirements for the transdermal patch (Arathi chandran *et al.*, 2022).

Anti-Fungal Herbal Bandage

Fungi-induced skin infections are a widespread issue globally, and research into safe and efficient antifungal medications is still ongoing. The purpose of this study work is to use *Psidium guajava* leaves to develop and assess an antifungal patch. An overview of the issue, the methods used, observations of the antifungal activity against several fungi linked to skin illnesses, the findings, and a conclusion are all included in the study. As a possible natural antifungal medication, *Psidium guajava* leaves offer a prospective substitute for treating skin infections. Polyvinyl alcohol is the least expensive polymer that can be used to create an antifungal patch (PVA). PVA is a water-soluble polymer that is simple to work with to create patches or films. It has strong adhesive qualities and is non-toxic and biocompatible. Additionally, PVA can be utilized as a carrier for antifungal medications, enabling a regulated release of the medicament. PVA is also reasonably priced when compared to other polymers, which makes it an economical option for producing antifungal patches (Yunus *et al.*, 2024).

Herbal Based Dressing

Fungal diseases are quite common, impacting about 40 million people. In light of this, our study suggests a unique strategy for treating fungal infections: transdermal drug administration using herbal formulations to maximize effectiveness and reduce adverse effects. Seven extracts from Ayurvedic plants were chosen and combined in a 1:1 ratio. These herbal mixtures were added to dermal patches made of PEG and HPMC. Following that, tests such as UV spectrometry, folding endurance, thickness measurement, and surface pH testing were performed on the herbal transdermal patch. By calculating MIC and using the Agar Well method, the antifungal properties of these patches were assessed against *Candida albicans.* The produced patches had a thickness of 0.063 ± 0.01; a weight of 206 ± 5.1 mg; a surface pH of 5.7; and unique UV-visible spectra in the 200–800 nm range for the HPMC-based. While the Agar Well method showed considerable reduction of Candida growth, the transdermal drug delivery system showed strong fungal inhibition at a dosage of 2.5 mg/ml, as indicated by MIC. Transdermal medication patches show promise as a quick and effective treatment for fungal infections of the skin (Ramakrishna *et al.*, 2024).

Anti-Bacterial Herbal Bandage

Examine the phytoconstituents in *Wrightia tinctoria* leaf extracts in chloroform while transdermal patches are being developed. *Wrightia tinctoria* herbal extract transdermal patches made using the solvent casting method. Numerous formulation parameters, drug-polymer ratios, and permeation enhancers were adjusted based on a physicochemical and in vitro drug diffusion analysis. The best formulation was selected for optimization. The bactericidal activity of the best formulation will be examined. This illustrates the consistent dispersion of the medication throughout the 1:4 polymer ratio patch. information selected for formulation development based on the in-vitro diffusion profile. Greater understanding of the product diffusion and diffusion rate mechanism is indicated by higher correlation coefficients (r2) with different reaction kinetics. These results suggest that diffusion regulated medication release from this patch. The best formulation was found to be 1:4 ratios (formulation 2) based on physicochemical and in vitro diffusion studies. Formulation 2 was subsequently subjected to an examination of antimicrobial activity. The results of the antimicrobial test demonstrated that the patch successfully inhibited the development of bacteria. The findings show that the chloroform extract from the *Wrightia tinctoria* plant exhibits antibacterial activity against Staphylococcus aureus (Valiyaparambil *et al.*, 2023).

Curcumin Based Dressing

The transdermal drug delivery system for curcumin was created and assessed. Curcumin, the active ingredient of curcuma longa (haldi), belongs to the Zingiberaceae family and is being utilized in this audit as an anti-inflammatory specialist to treat arthritic joint discomfort. A range of polymer mixes are used in

Curcumin's transdermal patch to increase therapeutic efficacy and lessen unwanted effects. The detail concentrations for the medication were finished by the dissolvability, similarity, and depiction research. Twenty milligrams of curcumin were combined with various polymer concentrations of hydroxy propyl methyl cellulose (HPMC), methyl cellulose (MC), and ethyl cellulose (EC) to create three different formulations. Water, ethanol, phosphate buffer pH 7.4, DMSO, and tetrahydrofuran (THF) were used to assess solubility, accordingly. All evaluation tests revealed that the formulation F1 Batch had the best degree of compatibility. F1, F2, and F3 were the three plans that were explored (Alhat and Waghmare, 2023).

Herbal Bandage

In traditional Thai medicine, the ethnomedicinal plant Crinum asiaticum Linn. is used to treat musculoskeletal discomfort. Traditionally, C. asiaticum leaves are used for heat compression. One of the new methods for delivering C. asiaticum's active ingredients through the skin is a transdermal patch. The purpose of this study was to create and assess a transdermal patch containing an extract from C. asiaticum leaves. The transdermal patch's primary ingredients were extract from C. asiaticum leaves, polyvinyl alcohol (PVA) PEG-400, and hydroxypropyl methylcellulose (HPMC). The solvent evaporation process is used to prepare the transdermal patch. Physical characteristics like thickness, weight homogeneity, and moisture absorption were assessed in relation to HPMC, PVA, and PEG-400. High performance liquid chromatography was used to investigate lycorine, the primary phytochemical found in C. asiaticum. The Franz diffusion cell was used to conduct the patch's in vitro drug release investigation. Good physical qualities were demonstrated by the transdermal patch that contained PVA and PEG 400 as plasticizers. In formulations comprising 2% PVA and 1%–5% PEG 400, the drug release was more than 80%. Higuchi's diffusion process was used to fit the in vitro drug release data using kinetic equations. In summary, the transdermal patch with 2% PVA and 2% PEG 400 met the study's objectives because of its good drug release profile and tensile strength (Suwandecha and Changklang, 2023).

Tulsi Based Dressing

Tulsi, also known as Tulasi, is a highly valued herb that has culinary and medicinal uses. It is native to the Indian subcontinent and belongs to the Lamiaceae family. For almost three millennia, it has been an essential part of Ayurvedic treatment. Tulsi is generally regarded as the "Elixir of Life" in the Ayurvedic system due to its therapeutic properties and effectiveness in curing a variety of common medical ailments. Creating and testing transdermal patches using an aqueous extract of Ocimum sanctum Linn. leaves is the aim of this research project. To create raw extracts, which are subsequently utilized in the creation of transdermal patches, the leaves must be extracted and purified. After providing a comprehensive overview of the tools and chemicals utilized in patch production, the manuscript looks at phytochemicals to identify their bioactive components. The formulation process comprises the development of the transdermal drug delivery system (TDDS) and the use of UV spectrophotometry for extract calibration. The quality and efficacy of the patches are evaluated using physicochemical studies. Additionally, the research study incorporates antibiotic susceptibility testing using the disc diffusion method and stability testing in difficult conditions. With an emphasis on microbial strains, growth medium, and testing standards, the patches undergo antimicrobial and antifungal testing. FTIR study to analyze the hygroscopic qualities of the patches and to assess the compatibility of drugs and excipients. The outcomes show the created patches' efficacy and durability, underscoring their potential for application in transdermal drug delivery systems (Kumar *et al.*, 2024).

Plant Extract Based Dressing

Lysiphyllum strychnifolium stem extract was added to an improved polyvinyl alcohol (PVA) blended film as a matrix layer for regulated medication release in order to create herbal transdermal patches. Stems of L. strychnifolium were extracted using a microwave-assisted method. The Design-Expert® computer suggested that the ideal extraction parameters were 800 W of power, 80% ethanol solvent, 20 s extraction time, and one extraction cycle. The prediction had a minimal percentage error and was accurate. The herbal extract had 515.48 ± 43.08 mg CE/g of total phenolics and 59.78 ± 2.11 mg CE/g of total flavonoids. According to the DPPH and FRAP tests, the herbal extract's antioxidant activity was 1.85 ± 0.12 and 0.533 ± 0.056 µg/ml, respectively. The herbal extract's nitric oxide scavenging assay yielded an IC50 of 114.42 ± 22.39 µg/mL. The herbal transdermal patches and the blank optimized PVA mixed film had favorable qualities and blended substances that were compatible, uniform, smooth, and compact. Astilbin's release and skin penetration behavior from the matrix layer could be regulated by the herbal transdermal patches. The zero-order model and the Korsmeyer–Peppas model were used to fit the astilbin release and permeation kinetics, respectively. Therefore, L. strychnifolium extract-containing transdermal patches can be used in herbal medicine applications (Monton *et al.*, 2022).

Herbal Based Dressing

People with type I or II diabetes who develop wound infections are at risk for consequences including gangrene. A doctor must still dress the wound and keep an eye on it even if there are plenty of antibiotic ointments and creams available. Therefore, a combination of the transdermal drug delivery method and the use of herbal remedies helps to ensure a controlled release of medication with the fewest possible negative side effects, making it easier and more efficient. can aid in the self-medication of wound infections. The goal of this experiment is to create a transdermal patch that heals wounds in diabetics using tuber extract from Momordica cymbalaria. After analyzing the antioxidant content using a series of methods, the starch assay was conducted. Determine cytotoxicity utilizing artemia salina and zebra fish embryos using a tuber hexane extract in vitro to assess its healing effectiveness. The patch is prepared by the solvent evaporation method using an optimized combination, and its organoleptic and physico-chemical properties are then assessed. According to the results, the tuber extract exhibited strong antioxidant activity, although modest cytotoxicity toward fish embryo toxicity and brine shrimp lethality assay was seen at two concentrations (25 and 50 µg/ml). In a scratch assay employing human epidermal keratinocytes, a high migration rate was observed at 25 and 50 µg/ml. The patch's organoleptic and physico-chemical characteristics were evaluated, and the results were positive. The study's final finding was that the biocompounds in tuber extract improved wound healing and may eventually replace synthetic wound healing patches because they are natural, affordable, and eco-friendly. This is especially true for diabetic patients (Saundharya *et al.*, 2022).

CONCLUSION

Herbal based bandages can be a superior alternative for treating acute wounds because of their quicker onset of effect. Herbal remedies made from plants have been shown to have no side effects in addition to its therapeutic and antibacterial qualities. This review can be used as a database for researchers in this field to help them choose the best herbal based wound dressing material for the efficient administration of herbal remedies for wound care.

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