

Review On Herbal Medicine Help In Wound Healing

Akshay U. Ghorpade^{1*}, Manasi P. Bandawane², Aishwarya P. Nikam³, Vasim T. Pathan⁴, Atul R. Bendale⁵, Sushil Patil⁶, Laxmikant B. Borse⁷

^{1*,2,3,4,5,6,7}Sandip institute of pharmaceutical science, Mahiravani, Nashik- 422213, Maharashtra, India.
Email: aughorpade44@gmail.com

*Corresponding Author: Ghorpade Akshay

*Department of pharmaceutics, Sandip institute of pharmaceutical science, Nashik- 422213, Maharashtra, India.
Contact no: 8329786583, Email: aughorpade44@gmail.com
DOI: 10.47750/pnr.2023.14.S02.274

Abstract

Purpose: The current investigation was to check the efficacy of *Curcuma longa* rhizome and *C. ternatea* flower extracts for anti-inflammatory and wound healing properties.

Methodology: *Curcuma longa* extract contains various types of phytoconstituents including flavonol glycosides, anthocyanins, flavones, flavonols, phenolics acids, and cyclotides, Arachidonic acid induced ear inflammation. Butterfly pea, also known as *Clitoria ternatea*, is a significant ayurvedic medicinal plant with nootropic, anxiolytic, anti-inflammatory, analgesic, antipyretic, antibacterial, and immunomodulatory properties. methodology involved extraction of phytoconstituents by Soxhlet extraction assembly by ethanol as solvent and determining the significance of the unique phytochemicals present in this plant (Rhizome and flower) that shows anti-inflammatory, wound healing properties. Impacts of various mediators and arachidonic acid metabolism via the cyclo-oxygenase pathway, which results in prostaglandin formation, may be responsible for the inflammatory activity. The possibility for synergy between curcumin longa and *Clitoria ternatea* was identified. Topical use of *curcuma longa* rhizome extract and *Clitoria ternatea* (*Aparajita*) flower extract having anti-inflammatory and wound-healing properties.

Conclusion: There is significant anti-inflammatory and wound healing activity in ethanol extract. *Curcuma longa* is a biologically diverse medicinal plant and *Clitoria ternatea* is a mystical plant used to treat of microbial infections, inflammation, and wounds.

Keywords: Anti-inflammatory, *Clitoria ternatea*, Antimicrobial, *Curcuma longa*, arachidonic acid, antipyretics, flavonol glycosides, phenolic acids,

INTRODUCTION:

A perennial herb in the Zingiberaceae family is called *Curcuma longa*. It has historically been used as an anti-inflammatory. Numerous investigations have claimed that *Curcuma* medications have beneficial pharmacological effect like anti-inflammatory^[1], Anti-tumor^[2] and immunological effects^[3]. Historically, since studies on the pharmacological actions of curcuminoids, particularly curcumin, including radical scavenging^[4] and the suppression of nitric oxide (NO)^[5,6], Anti-tumor^[8], anti- allergy^[9], Anti- dementia^[10], Anti-inflammation^[7]. Due to the similar shape of the various *curcuma* species and the wide range of names generated from the various portions used the production areas, there have been very few pharmacological research of other *Curcuma* species. The current to reduce inflammation and promote wound healing. Instead of being used medicinally, *C. ternatea*, or Butterfly pea, is well recognized for its colouring abilities^[11]. It is a species of the Fabaceae family and is also known as Bunga Biru, Kacang Puki, Mentelang, Ang Chan, and Bikol in the Philippines and Malaysia^[12,13]. Additionally, powder and decoction made from the root, leaves, and flowers are used to treat illnesses^[15].

The plant's leaves are also used as a brain tonic since they are said to improve memory and intelligence as well as food colouring and wound healing^[12,16]. Additionally, there aren't many products made from these leaves, and they're typically only used directly to treat illnesses like diabetes, oedema, mental disorders, goitre, vitiligo, snake poisoning, toothaches, eye diseases, fever, asthma, and jaundice using their roots, leaves, or flowers in powder or decoction form^[11]. Additionally, there aren't many products made from these leaves, and they're typically only used directly to treat illnesses like diabetes, oedema, mental disorders, goitre, vitiligo, snake poisoning, toothaches, eye diseases, fever, asthma, and jaundice using their roots, leaves, or flowers in powder or decoction form^[17]. Primary component of this study, *C. ternatea* leaves, was chosen to emphasise the plant's potential application in medicine in addition to its use as a food colouring^[12].

Skin is cut in a wound, which is an injury to live tissue. Microbiological infections in wounds can hinder the healing process and cause complications that pose a threat to one's life if they are not treated properly. The process of healing a

wound has many different stages, starting with the coagulation cascade, inflammation, and buildup of radical substances, to proliferation, the formation of fibrous tissues and collagen, the contraction of the wound with the development of granulation tissue, and the formation of a scar. Due to a lack of medical facilities in the past, several phytotherapeutic substances were employed to treat wounds. Since they are antioxidants, many of the bioactive chemicals found secondary metabolites have the ability to fight infectious diseases ^[53-57].

Taxonomical classification

A) *Curcumin longa*

Kingdom: Plantae

Subkingdom: Tracheobionta

Superdivision: Spermatophyta

Division: Magnoliophyta

Subclass: Zingiberidae

Order: Zingiberales

Family: Zingiberaceae

Genus: *Curcuma*

Scientific name: *Curcuma longa*

B) *Clitoria tenatea* (aparajita)

Kingdom: Plantae

Order: Fabales

Family: Fabaceae

Genus: *Clitoria*

Species: *C. ternatea*

Binomial name: *Clitoria ternatea* L

Synonyms: *Clitoria principissae*

MATERIALS AND METHODS:

Preparation of extract:

50gm of air-dried herbs. Rhizome were ground to a fine powder and extracted in a Soxhlet device until all of the ethanol was used up (solvent). For a full extraction, the process takes ten hours to complete. The extracts were concentrated to a dry residue at a lower pressure. The extracts weight was notes. Herbs extract yield was discovered to be 8.5 % ^[18].

Anti-inflammatory, analgesic, and antipyretic effects:

Rat models were used in the study to determine the methanolic extract from the roots of *Clitoria ternatea* anti-inflammatory efficacy. The ethanolic extract was further tested for its ability to reduce pain in mice using tail clip method and an acetic acid- induced writhing reaction^[19]. In a different investigation, albino rats were used to test the methanol extract of CT for its anti-pyretic potential. The results showed that the extracts anti-pyretic impact was comparable to that of paracetamol, a common anti-pyretic drug ^[20].

Anti-oxidative studies:

It is well known that one of the primary causes of many chronic and degenerative diseases is oxidative stress ^[21]. It has been established that CT petals have antioxidant properties ^[22-25]. In Thailand, *Clitoria ternatea* flower extracts are utilised as a cosmetic ingredient, and based on their chemical makeup, it's possible that the flowers contain antioxidant properties. It was discovered that aqueous extracts had higher anti-oxidant action than ethanol extracts ^[26]. By measuring the amounts of enzymatic and non-enzymatic antioxidants, *Clitoria ternatea* leaf extracts' antioxidant capacity was assessed. Utilizing various assays, including the diphenyl picryl hydrazyl (DPPH) assay, ferric reducing power assay (FRAP), reducing activity assay, and hydroxyl radical scavenging activity, in vitro antioxidant capacity was also determined. The results were comparable to those of standard antioxidants like butylated hydroxyl toluene (BHT), ascorbic acid, and rutin ^[27].

Anti-microbial:

The antibacterial activity of *Clitoria ternatea*'s leaves and root methanolic extracts was evaluated against a variety of pathogenic drug-resistant Gram-positive and Gram-negative clinical isolates. Agar dilution technique was used in order to establish the lowest inhibitory concentration, and disc diffusion technique was used to estimate the zone of inhibition against the chosen strains. Comparisons were made with respect to the standard antibiotic ciprofloxacin. The leaf was discovered to have potent antibacterial activity against *S. aureus*, which causes fever, and *E. coli* and *V. cholera*, which are known to cause diarrhoea. The antibacterial activity of the leaf extract was greater than that of the root extract. Both extracts have been demonstrated to function in a bactericidal manner. Leaf extract's efficacy may be aided by quercetin ^[28]. In a different study, it was found that the callus extract had the highest zones of inhibition (16 mm) against *S. typhi* and the lowest zones (12 mm and 12 0.9 mm) against *E. coli* and *S. aureus*. The crude extract from CT Zones of inhibition were largest in seeds. (22 0.5 mm) against *E. coli* at 0.75 mg concentration and the lowest zones (14 1 mm) against *M. flavus* ^[29]. Agar well diffusion was used to investigate the antibacterial activity of alcoholic and aqueous extracts from in

vitro produced colli against Gram-negative bacteria. *Shigella* dysenteries and *Salmonella* spp., the two pathogens responsible for enteric fever, both exhibited antibacterial activity^[30]. The methanol crude extracts also demonstrated antibacterial action against *P. aeruginosa* and *K. pneumonia*^[31].

WOUND HEALING PROCESS:

skin acts as a natural barrier against the elements and performs numerous vital defensive tasks. The body starts a multistep, dynamic process at the wounded location when the integrity of skin is disrupted by either acute or chronic injuries. This process results in partial repair of the tissue restoration of the skin's barrier function. To achieve tissue integrity and homeostasis is the immediate aim of wound healing^[32]. Hemostasis, inflammation, proliferation, and remodelling are the four distinct but overlapping processes that make up the normal healing of a wound. Injury results in hemostasis, which causes platelet aggregation and, as a result, the formation of blood clots^[33]. A temporary extracellular matrix is provided by the blood clot for cell migration^[34]. Blood cells such as phagocytic neutrophils and macrophages move to the site of the wound during the inflammatory phase^[33]. As the inflammatory phase comes to a conclusion, the phagocytes release cytokines to encourage fibroblast migration and proliferation in addition to initially removing foreign particles^[35]. Within hours of damage, re-epithelialization of wounds commences and is a component of the proliferative phase^[34]. According to Topman et al. (2013), this phase is characterised by the formation of fresh blood vessels (angiogenesis or neovascularization), which restores perfusion to support the developing tissues, as well as the production and deposition of extracellular matrix protein fragments like collagen type III and granulation tissue. Fibroblasts are essential to the wound healing process because they develop the new extracellular matrix required to promote cell ingrowth utilising collagen as the building block^[34]. Scar tissue development and collagen remodelling are part of the final phase. shows the length of each step of wound healing after damage while also, and more crucially, showing how the process is overlapping^[34].

PATHOPHYSIOLOGY OF WOUND HEALING:

Wound healing activities of curcumin:

The repair of injured tissue is aided by an optimal wound healing dressing or agent that prevents bacterial infection, decreases inflammation, and stimulates cell proliferation^[36]. Since free radicals are thought to be the primary source of inflammation throughout the healing process of wounds, it would ideally also function as an antioxidant^[37]. The biochemical properties of curcumin, such as its anti-inflammatory^[38], anti-infectious^[39,40] and antioxidant^[41,42] activities, are thought to contribute to its ability to heal wounds.

Curcumin has also been shown to contribute to tissue remodelling, granulation, tissue creation, and collagen deposition, all of which promote cutaneous wound healing^[43]. Multiple investigations have shown that applying Q4curcumin to wounds also promotes epithelial regeneration, boosts fibroblast proliferation, and increases vascular density. This study critically assesses the literature on curcumin's current uses in wound healing, concentrating on its mechanisms of action, and providing evidence for its effects on the various stages of wound healing process. Precedence is given to the topical skin application of curcumin in vivo while also examining in vitro studies of curcumin in wound healing models.

Wound healing treatment through *clitoria ternatea* plant:

Over the last two years, there has been an increase in studies examining the effectiveness of plant extracts in promoting wound healing and learning more about the bioactive components that activate or control the healing mechanism^[44].

The following are the main effects of plant extracts' effective components in healing wounds:

- Phytochemical elements that support antibacterial action.
- Phytochemical components that act as free radical scavengers and antioxidants.
- Angiogenesis, collagen synthesis, DNA replication, and mitogenic activity—which promotes faster cell division—are all important components^[45].

Active chemicals found in plant extract should be anticipated to compete with one or more stages of the wound healing system in a constructive manner, in the true sense, and at an appropriate time (fig.1) in order to demonstrated greater potency^[46].

Recently, researchers have looked into the possibility that secondary metabolites found in plant extracts could interact with cellular receptors near the site of a wound and activate the regulation of the healing process. Proanthocyanidins, polyphenolic flavonoids, and polyphenols found in the plant are thought to aid in the healing process by lowering superoxide anions and subsequently increasing the expression in terms of vascular endothelial growth factor (VEGF), which enhances angiogenesis and blood flow as the repair progresses^[47]

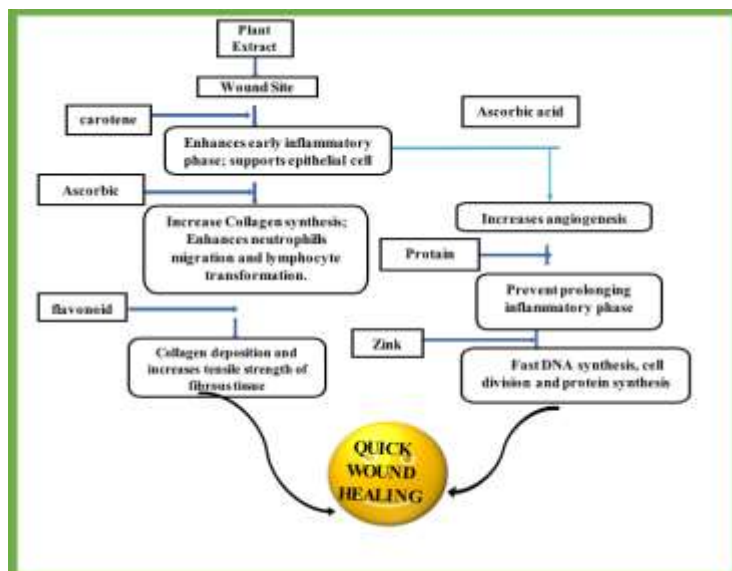


Figure 2 Wound healing mechanism of *Clitoria Ternatea*

Preliminary phytochemical screening:

The qualitative chemical tests performed for identifying the various phytoconstituents contained in the powdered crude medicine are part of the chemical evaluation. Researchers conducted preliminary phytochemical analyses of *Curcuma longa* rhizome extracts in aqueous, acetone, ethanolic, chloroform, and methanolic forms using commonly used precipitation and coloration reactions, revealing the presence of substances like carbohydrates, proteins, alkaloids, glycosides, terpenes, steroids, flavonoids, tannins, and saponins [48-50, 57-59]. The corresponding tests conducted by various researchers were compiled from the below-mentioned standard published literatures.

TEST FOR ALKALOIDS:

The extract was thoroughly filtered after being combined with 3 ml of diluted hydrochloric acid. The filtrate conducted the following test [50] with great care: Table no 1.

Tests	Observations
A) Test for Alkaloid	
Mayer's test	A few drops of Mayer's reagent are added to 1 or 2 ml of filtrate by the side of the test tube. A positive test result was indicated by the white or creamy precipitate. [48,49,51,52]
Wagner's test	A few drops of Wagner's reagents are added to 1 or 2 ml of filtrate was treated. A positive test result was indicated by the brown reddish precipitate. [48,49,51]
Dragendorff's Test	Dragendorff's reagent was applied to a few ml of filtrate, and the presence of a noticeable yellow precipitate indicated the presence of alkaloids. [49,51]
B) Test for Glycosides	
Fehling's test	Fehling's solutions A and B were added in equal amounts to the 2 ml test solution, and after the solution was heated, glycoside was detected. A precipitate that was brick red was seen. [49]
Legal's Test	Pyridine and alkaline sodium nitroprusside were added to a 2 ml or 1 ml test solution, and the presence of a blood red or pink colour indicated the presence of glycoside [48,49,50].
Keller-Killani Test	to 2 ml of glacial acetic acid that has a drop of extract-treated FeCl ₃ in it. The development of a brown colour ring denotes glycoside presence [48,50].
Borntrager's Test	First, the extract was heated with weak sulphuric acid, filtered, and then chloroform was added and vigorously mixed into the filtrate. After separating the organic layer, ammonia is gradually added to it. Additionally, the ammoniacal layer's pink to red coloration indicates a successful outcome [51].
C) Test for Flavonoids	
Shinoda test	H ₂ SO ₄ was added dropwise while a 2 ml test solution containing a few pieces of magnesium ribbon was added. The outcomes have a pink scarlet or crimson red colour [48,49].
Alkaline Reagent Test	Sodium hydroxide solution was used to treat the test solution, which results in a yellow or red colour [48,49].
Zn Test	After combining 2 ml of the extract with Zn dust and concentrated HCl, a red colour was noticed, which indicates the presence of flavonoids [48,49].
D) Test for Triterpenoids	
Salkowski test	2 ml of chloroform and 3 ml of concentrated sulfuric acid were added to the test solution and thoroughly mixed. The formation of a reddish brown colour at the lower layer indicates the presence of steroids, while the presence of triterpenoids is indicated by a yellow colour [49].
E) Test for Phenol	
Ferric Chloride Test	The test extract received 4 drops of an alcoholic FeCl ₃ solution. The presence of phenol is indicated by the appearance of a bluish black colour [50, 52].
F) Test for Proteins and Amino Acid	
Millon's test	When Millon's reagent is applied to 2 ml of test solution, a white precipitate results that turns red when heated [48,49,51,52].
Ninhydrin Test	Ninhydrin solution was treated and then boiled to create a 2 ml test solution. Blue colour formation shows the presence of an amino acid. Once more, a 2ml test solution containing a 0.2% ninhydrin solution was treated with proteins and amino acids before being boiled [48,49].

Table 1 Preliminary Phytochemical Screening

CONCLUSION:

There is significant anti-inflammatory and wound healing activity in ethanol extract and cream formulations. *Curcuma longa* is a biologically diverse medicinal plant that can be used to create a variety of formulations in order to treat of microbial infections, inflammation, and wounds.

Clitoria ternatea is a mystical plant in and of itself because of its important Ayurvedic functions. The food colourant and cosmetics sectors have previously acknowledged its necessity. This review's methodology involved determining the significance of the unique phytochemicals present in this plant (root, shoot, leaves and flower). We anticipate continuing development of this plant's unique treatment for several other diseases not currently mentioned. We believe that the phytochemicals and enzymes that were isolated from this plant will stimulate additional study on diseases that are related.

ACKNOWLEDGEMENT:

The authors are thankful to Sandip institute of pharmaceutical sciences, Nashik for constant support and providing all facilities.

CONFLICT INTREST: NIL

REFERENCE:

1. Ahmed S, Anuntiyo J, Malemud CJ, Haqqi TM. Biological basis for the use of botanicals in osteoarthritis and rheumatoid arthritis: a review. Evidence-Based Complementary and Alternative Medicine. 2005 Sep 1;2(3):301-8.
2. Ozaki Y. Antiinflammatory effect of *Curcuma xanthorrhiza* ROXB. and its active principles. Chemical and pharmaceutical bulletin. 1990 Apr 25;38(4):1045-8.
3. GONDA R, Tomoda M, OHARA N, Takada K. Arabinogalactan core structure and immunological activities of ukonan C, an acidic polysaccharide from the rhizome of *Curcuma longa*. Biological and Pharmaceutical Bulletin. 1993 Mar 15;16(3):235-8.
4. Sreejayan N, Rao MN. Free radical scavenging activity of curcuminoids. Arzneimittel-forschung. 1996 Feb 1;46(2):169-71.
5. Pan MH, Lin-Shiau SY, Lin JK. Comparative studies on the suppression of nitric oxide synthase by curcumin and its hydrogenated metabolites through down-regulation of IκB kinase and NFκB activation in macrophages. Biochemical pharmacology. 2000 Dec 1;60(11):1665-76.
6. Onoda M, Inano H. Effect of curcumin on the production of nitric oxide by cultured rat mammary gland. Nitric Oxide. 2000 Oct 1;4(5):505-15.
7. Banerjee M, Tripathi LM, Srivastava VM, Puri A, Shukla R. Modulation of inflammatory mediators by ibuprofen and curcumin treatment during chronic inflammation in rat. Immunopharmacology and immunotoxicology. 2003 Jan 1;25(2):213-24.
8. Khar A, Ali AM, Pardhasaradhi BV, Begum Z, Anjum R. Antitumor activity of curcumin is mediated through the induction of apoptosis in AK-5 tumor cells. FEBS letters. 1999 Feb 19;445(1):165-8.
9. Ram A, Das M, Ghosh B. Curcumin attenuates allergen-induced airway hyperresponsiveness in sensitized guinea pigs. Biological and Pharmaceutical Bulletin. 2003;26(7):1021-4.
10. Lim GP, Chu T, Yang F, Beech W, Frautschy SA, Cole GM. The curry spice curcumin reduces oxidative damage and amyloid pathology in an Alzheimer transgenic mouse. Journal of Neuroscience. 2001 Nov 1;21(21):8370-7.
11. Lijon MB, Meghla NS, Jahedi E, Rahman MA, Hossain I. Phytochemistry and pharmacological activities of *Clitoria ternatea*. International Journal of Natural and Social Sciences. 2017 Jan;4(1):1-0.
12. Lim TK. *Clitoria ternatea*. In Edible Medicinal And Non-Medicinal Plants 2014 (pp. 773-787). Springer, Dordrecht.
13. Kaisoon O, Siriamornpun S, Weearpreeyakul N, Meeso N. Phenolic compounds and antioxidant activities of edible flowers from Thailand. Journal of functional foods. 2011 Apr 1;3(2):88-99.
14. Wetwitayaklung P, Phaechamud T, Limmatvapirat C, Keokitchai S. The study of antioxidant activities of edible flower extracts. In International Workshop on Medicinal and Aromatic Plants 786 2007 Jan 15 (pp. 185-192).
15. Neda GD, Rabeta MS, Ong MT. Chemical composition and anti-proliferative properties of flowers of *Clitoria ternatea*. International Food Research Journal. 2013 Jul 1;20(3).
16. Mukherjee PK, Kumar V, Kumar NS, Heinrich M. The Ayurvedic medicine *Clitoria ternatea*—from traditional use to scientific assessment. Journal of ethnopharmacology. 2008 Dec 8;120(3):291-301.
17. DeFilipps RA, Krupnick GA. The medicinal plants of Myanmar. PhytoKeys. 2018(102):1.
18. Kumar A, Chomwal R, Kumar P, Sawal R. Anti-inflammatory and wound healing activity of *Curcuma aromatica* salisb extract and its formulation. Journal of Chemical and Pharmaceutical Research. 2009;1(1):304-10.
19. Devi BP, Boominathan R, Mandal SC. Anti-inflammatory, analgesic and antipyretic properties of *Clitoria ternatea* root. Fitoterapia. 2003 Jun 1;74(4):345-9.
20. Parimaladevi B, Boominathan R, Mandal SC. Evaluation of antipyretic potential of *Clitoria ternatea* L. extract in rats. Phytomedicine. 2004 Jan 1;11(4):323-6.
21. Vadlapudi V, Naidu KC. In vitro Bioevaluation of some Indian Medicinal plants. Drug Invention Today. 2010 Jan 1;2(1).
22. Kähkönen MP, Hopia AI, Vuorela HJ, Rauha JP, Pihlaja K, Kujala TS, Heinonen M. Antioxidant activity of plant extracts containing phenolic compounds. Journal of agricultural and food chemistry. 1999 Oct 18;47(10):3954-62.
23. Zheng W, Wang SY. Antioxidant activity and phenolic compounds in selected herbs. Journal of Agricultural and Food chemistry. 2001 Nov 19;49(11):5165-70.
24. Shan B, Cai YZ, Sun M, Corke H. Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. Journal of agricultural and food chemistry. 2005 Oct 5;53(20):7749-59.
25. Hinneburg I, Dorman HD, Hiltunen R. Antioxidant activities of extracts from selected culinary herbs and spices. Food chemistry. 2006 Jul 1;97(1):122-9.
26. Kamkaen N, Wilkinson JM. The antioxidant activity of *Clitoria ternatea* flower petal extracts and eye gel. Phytotherapy Research. 2009 Nov;23(11):1624-5.
27. Rao DB, Kiran CR, Madhavi Y, Rao PK, Rao TR. Evaluation of antioxidant potential of *Clitoria ternatea* L. and *Eclipta prostrata* L.
28. Mazumder A, Roy P, Mazumder R. In Vitro Antibacterial Activity of Leaf and Root Extracts of *Clitoria ternatea* Linn. Ethiopian Pharmaceutical Journal. 2007;25(2).
29. Mhaskar AV, Prakash K, Vishwakarma KS, Maheshwari VL. Callus Induction and Antimicrobial Activity of Seed and Callus Extracts of *Clitoria ternatea* L. Current trends in biotechnology and pharmacy. 2010;4(1):561-7.
30. Shahid M, Shahzad A, Anis M. Antibacterial potential of the extracts derived from leaves and in vitro raised calli of medicinal plants *Pterocarpus marsupium* Roxb., *Clitoria ternatea* L., and *Sanseveiria cylindrica* Bojer ex Hook. Advances in Traditional Medicine. 2009;9(2):174-81.
31. Shekhawat N, Vijayvergia R. Evaluation of antimicrobial potential of some medicinal plants against plant and human pathogens. J. Pharm. Res.

- 2010 Apr;3(4):700-2.
32. Eming SA, Brachvogel B, Odorisio T, Koch M. Regulation of angiogenesis: wound healing as a model. *Progress in histochemistry and cytochemistry*. 2007 Dec 10;42(3):115-70.
 33. Enoch S, Grey JE, Harding KG. Recent advances and emerging treatments. *Bmj*. 2006 Apr 20;332(7547):962-5.
 34. Singer AJ, Clark RA. Cutaneous wound healing. *New England journal of medicine*. 1999 Sep 2;341(10):738-46.
 35. Topman G, Lin FH, Gefen A. The natural medications for wound healing—Curcumin, Aloe-Vera and Ginger—do not induce a significant effect on the migration kinematics of cultured fibroblasts. *Journal of biomechanics*. 2013 Jan 4;46(1):170-4.
 36. Kulac M, Aktas C, Tulubas F, Uygur R, Kanter M, Erboga M, Ceber M, Topcu B, Ozen OA. The effects of topical treatment with curcumin on burn wound healing in rats. *Journal of molecular histology*. 2013 Feb;44(1):83-90.
 37. Mohanty C, Das M, Sahoo SK. Sustained wound healing activity of curcumin loaded oleic acid based polymeric bandage in a rat model. *Molecular pharmaceuticals*. 2012 Oct 1;9(10):2801-11.
 38. Liang G, Yang S, Zhou H, Shao L, Huang K, Xiao J, Huang Z, Li X. Synthesis, crystal structure and anti-inflammatory properties of curcumin analogues. *European journal of medicinal chemistry*. 2009 Feb 1;44(2):915-9.
 39. Mun SH, Joung DK, Kim YS, Kang OH, Kim SB, Seo YS, Kim YC, Lee DS, Shin DW, Kweon KT, Kwon DY. Synergistic antibacterial effect of curcumin against methicillin-resistant *Staphylococcus aureus*. *Phytomedicine*. 2013 Jun 15;20(8-9):714-8.
 40. Singh RK, Rai D, Yadav D, Bhargava A, Balzarini J, De Clercq E. Synthesis, antibacterial and antiviral properties of curcumin bioconjugates bearing dipeptide, fatty acids and folic acid. *European journal of medicinal chemistry*. 2010 Mar 1;45(3):1078-86.
 41. Ak T, Gülçin İ. Antioxidant and radical scavenging properties of curcumin. *Chemico-biological interactions*. 2008 Jul 10;174(1):27-37.
 42. Meng B, Li J, Cao H. Antioxidant and antiinflammatory activities of curcumin on diabetes mellitus and its complications. *Current pharmaceutical design*. 2013 Apr 1;19(11):2101-13.
 43. Joe B, Vijaykumar M, Lokesh BR. Biological properties of curcumin-cellular and molecular mechanisms of action. *Critical reviews in food science and nutrition*. 2004 Mar 1;44(2):97-111.
 44. Jamil N, Zairi MN, Nasim NA, Pa'ee F. Influences of environmental conditions to phytoconstituents in *Clitoria ternatea* (butterfly pea flower)—A review. *Journal of Science and Technology*. 2018 Aug 1;10(2).
 45. Priprem A, Damrongrungruang T, Limsithichaiakoon S, Khampaenjiraroach B, Nukulkit C, Thapphasaraphong S, Limphirat W. Topical niosome gel containing an anthocyanin complex: a potential oral wound healing in rats. *Aaps Pharmscitech*. 2018 May;19(4):1681-92.
 46. Srinivas BK, Shivamadu MC, Siddappaji KK, Krishnappa DK, Jayarama S. Angiosuppressive effects of bio-fabricated silver nanoparticles synthesis using *Clitoria ternatea* flower: an in vitro and in vivo approach. *JBIC Journal of Biological Inorganic Chemistry*. 2019 Oct;24(7):1115-26.
 47. Adisakwattana S, Pasukamonset P, Chusak C. *Clitoria ternatea* beverages and antioxidant usage. In *Pathology 2020 Jan 1* (pp. 189-196). Academic Press.
 48. Pawar MA, Patil SS, Nagrik DM. Phytochemical and physicochemical investigation of *Curcuma longa* Linn. rhizome. *Int. J. Chem. Phys. Sci*. 2015;4:458-63.
 49. Chanda S, Ramachandra TV. Phytochemical and pharmacological importance of turmeric (*Curcuma longa*): A review. *Research & Reviews: A Journal of Pharmacology*. 2019;9(1):16-23.
 50. Sawant RS, Godghate AG. Qualitative phytochemical screening of rhizomes of *Curcuma longa* Linn. *International Journal of Science, Environment and Technology*. 2013;2(4):634-41.
 51. Anusha A, Kumar R, Shaik R. Phytochemical Evaluation *Curcuma Longa* and Curcumin. *International Journal Of Pharmaceutical And Chemical Sciences*. 2016;5(4):5005-2277.
 52. Duraisankar M, Ravindran AD. Identification of *Curcuma longa* rhizomes by physicochemical and TLC fingerprint analysis. *Int. J. Pharm Tech. Res*. 2015;8:198-205.
 53. Cahyana AH, Kam N. Study on the stability of antioxidant and anti α -glucosidase activities using soaking treatment in Okra (*Abelmoschus esculentus* L.) mucilage extraction. *Chemistry International*. 2016 Jun 1;3(3):202-11.
 54. Dagnaw W, Mekonnen A. Preliminary phytochemical screening, isolation and structural elucidation of chloroform leaf extracts of *Maesa lanceolata*. *Chem. Int*. 2017;3(4):351.
 55. Hailu YM, Atlabachew M, Chandravanshi BS, Redi-Abshiro M. Composition of essential oil and antioxidant activity of Khat (*Catha edulis* Forsk), Ethiopia. *Chem. Int*. 2017;3(1):25.
 56. Hamid AA, Oguntoye SO, Alli SO, Akomolafe GA, Aderinto A, Otigibe A, Ogundare AM, Esinniobiwa QM, Aminu RO. Chemical composition, antimicrobial and free radical scavenging activities of *Grewia pubescens*. *Chem Int*. 2016 Aug 15;2(4):254-61.
 57. Borse M, Bagade S, Bendale A, Borse L, Jadhav A. Pharmacoevidence of yellow trumpet flower. *IP Int J Comprehensive Adv Pharmacol* 2022;7(1):5-11.
 58. Rudrapal M, Mishra AK, Rani L, Sarwa KK, Zothantluanga JH, Khan J, Kamal M, Palai S, Bendale AR, Talele SG, Pathan VT, Borse LB, Neharkar VS, Sahoo PK. Nanodelivery of Dietary Polyphenols for Therapeutic Applications. *Molecules*. 2022; 27(24):8706. <https://doi.org/10.3390/molecules27248706>
 59. Naphade, V.D., Parihar, G., Jain, D., & Bendale, A. R. (2021). *Bulletin of the Karaganda University. Biology. Medicine. Geography series*. Учредители: Карагандинский университет им. акад. ЕА Букетова, 104(4), 97-103.
 60. Igwe OU, Friday C. Volatile constituents of hydrocolloids isolated from *Azela africana* and *Detarium microcarpum* seeds. *Chemistry International*. 2017;3(4):286-91.