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A COMPREHENSIVE REVIEW OF THE MEDICINAL CAPABILITIES OF THE HIBISCUS ROSA SINENSIS LINN PLANT

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ABSTRACT

Hibiscus rosa sinensis, the Chinese hibiscus, a flowering angiosperm from the Malvaceae an plant family. The species is extensively grown for its aesthetic appeal and aesthetic value. and recognized for its medicinal and nutritional properties. Originally endemic to East Asia, this species has been disseminated to numerous tropical and subtropical regions globally. The plant produces vibrant, large, trumpet-shaped flowers in a wide range of colors, which has contributed to its widespread adoption and utilization within the disciplines of landscape architecture and horticulture. Diverse plant components, including flowers, foliage, and subterranean structures, have been historically utilized in herbal medicine owing to their putative therapeutic advantages. This overview examines the historical significance, varied applications, and the increasing recognition of integrating herbal medicine with contemporary healthcare. This review explores the potential of hibiscus rosa sinensis in wound healing, highlighting its chemical structure, pharmacological properties, and underlying action mechanisms. Herbal interventions are utilized to oversee a variety of health concerns, comprising chronic ailments, digestive disturbances, and mental health concerns, frequently

providing a comprehensive approach to treatment. The plant exhibits a robust phytochemical profile, comprising flavonoids, phenolic compounds, and vitamins, which confer antioxidant, anti inflammatory, and antimicrobial functionalities. These properties are crucial in the wound healing process, as they facilitate tissue regeneration and mitigate oxidative stress, and prevent infection. This review aims to synthesize the existing scientific literature on the Characteristics of the hibiscus rosa sinensis plant, examining the underlying mechanisms and exploring its potential for application in modern health care.

KEYWORDS: Herbal, hibiscus, traditional medicine, hibiscus rosa sinensis, medicinal plants, natural healing agents.

1. INTRODUCTION

Herbal medicine is a long standing traditional healing practice millennia, using plants and plant based remedies from traditional medical systems utilize the inherent characteristics of herbs, roots, and leaves to address diverse health conditions and enhance overall wellness., and flowers to address various health concerns, from minor discomforts to chronic conditions. Practitioners of herbal medicines posit that compared with synthetic pharmaceuticals, these natural remedies can offer therapeutic benefits with fewer adverse effects. While some the efficacy of herbal treatments has been substantiated through scientific validation, others remain the subject of ongoing research and debate within the medical community. As interest in complementary and alternative medicine increases, herbal remedies remain a crucial component within healthcare systems globally. These constructs are frequently utilized as a complementary approach to conventional medical interventions to enhance overall well being. The term "medicine" originated from the Latin phrase "ars medicina," which translates to "the art of healing", today medicine refers to the science and art of human healing, encompassing a range of healthcare practices that prevent and treat illness, the global herbal medicine and product market, valued at over $100 billion, is projected to surpass $1 trillion within the next 20 years.[1] The Indian traditional medicine sector is estimated to comprise approximately 25,000 licensed pharmacies. Currently, around 1,000 single ingredient medicines and 3,000 compound formulations are registered in the country.[2] As more is discovered about the advantages and disadvantages of synthetic drugs, there's a rising demand for natural remedies. According to the WHO, herbal medicines serve as primary healthcare solutions for over 80% of the global population.[3] The utilization of herbal supplements has become increasingly widespread among individuals pursuing

alternative treatment approaches for a variety of health-related challenges within diverse national healthcare frameworks.[4] India is renowned as one of the world's primary biodiversity hotspots, boasting a remarkable diversity of over 45,000 plant species. This exceptional biodiversity can be attributed on account of the existence of 16 distinct agro-climatic regions, 10 vegetation zones, and 15 biotic provinces within the geographical confines of the country.[5] The earliest extant records of their application can be traced to ancient texts from the civilizations of India, China, Egypt, Greece, Rome, and Syria, dating back approximately 5,000 years. The venerated classical Indian literary works, including the renowned ancient Indian scriptural and medical works such as the Rigveda, Atharvaveda, Charak Samhita, and Sushruta Samhita, contain references to this long standing practice.[6] Approximately 250,000-400,000 plant species exist globally, but only 6% have been the subject of a systematic screening process for biological activity and 15% have undergone phytochemical investigation.[7] Herbal products are categorized as medicinal when they assert therapeutic or prophylactic claims, but are not regarded as medicinal products if they do not make such assertions.[8] Plant-derived pharmaceuticals have made outstanding contributions to modern therapeutic practices. The isolation of serpentine from the Indian plant Rauwolfia serpentina in 1953 was a groundbreaking development in the treatment of high blood pressure.[9] In the historical context, traditional Ayurvedic practitioners, known as vaidyas, would tailor their treatments and medicinal preparations to the individual needs of each patient. However, the current landscape has undergone a significant shift, with herbal medicines now being manufactured on a large scale within pharmaceutical companies. Herbal medicine, an element of traditional medicine, constitutes an accumulated corpus of knowledge and associated techniques for preventing, diagnosing, and treating physical, mental, and social imbalances.

Hibiscus rosa sinensis is a botanical specimen which is frequently observed grown as an ornamental flora indigenous to equatorial zones. The taxa was thought to have been named Rosa sinensis, indicating the plant colloquially known as the "Rose of China" by the influential Swedish naturalist Linnaeus in the mid-18th century.[10][11] The plant is recognized by a variety of names, such as “Japa” or “Japapushp,” “Arkapriya” in Sanskrit, “Shoe flower” in English, “Jasund” in Hindi, “Angharee-hind” in Persian, and “Wadamal” in Sinhalese.[12] The Mallow family, also known as the Malvaceae family, is recognized due to its economic importance, the plant has a long history of utilization in traditional medicinal practices, which covers 244 botanical taxa and 4225 taxa found globally. Hibiscus is a large genus with 550

indigenous biota. Hibiscus rosa sinensis is a plant that persists and regrows annually herbaceous flora. It originates from This plant is prevalent across tropical and subtropical climates, and is extensively cultivated for its ornamental aesthetic qualities and decorative properties purposes.[13] The plant has large blooms on dense shrubs. Currently, diverse new cultivars are generated through crossbreeding.[14] Floral phenotypes and hybrid derivatives present a diverse array of hues and shades other characteristics. Hibiscus rosa sinensis is used for treating numerous ailments.[15] The 250 species are extensively situated across tropical and subtropical domains, and they represent believed to exhibit a range of medicinal attributes, including purported antitumor effects. Additionally, these plant species have been employed as analgesic, antipyretic, antiasthmatic, and anti-inflammatory agents.[16][17] Numerous investigations have demonstrated the floral components of hibiscus rosa sinensis demonstrate antifungal and antimicrobial, antioxidant functionalities.[18] Academic exploration on hibiscus extracts has found that the plant's phytochemicals confer positive health outcomes for humans, including antioxidant activity that eliminates free radicals and prevents DNA damage.[19] Botanical materials may stimulate hair growth and facilitate ulcer healing[20][21], whereas flora have been shown to effectively treat arterial hypertension[22] and exert considerable antifertility effects.[23][24]

2. COMMON DIFFERENCES BETWEEN HERBAL AND CONVENTIONAL DRUG

In contrast to well-characterized synthetic pharmaceutical products, plant-derived therapeutic agents show notable variations, specifically[25]:

- Pharmacologically active molecules are often not known
- Standardization, reliability, and quality assurance can be achieved but are not simple
- There are frequently encountered problems associated with the supply and characteristics of unprocessed components
- There is a scarcity of robust, methodologically rigorous clinical and toxicological investigations that validate their effectiveness and tolerability
- The empirical employment of folk medicine is a crucial area of study
- They demonstrate a diverse array of therapeutic applications and are well-suited for chronic treatment modalities.
- The incidence of adverse effects appears to be lower with herbal treatments, though robust randomized experiments have demonstrated that they can still be evident
- Their costs generally fall below those of synthetic medications.

3. RELATIONSHIP BETWEEN HERBAL AND MODERN MEDICINE

Traditional databases of existing knowledge and experience can provide new ways to address the key challenges of time, cost, and toxicity in the domain of pharmaceutical research and investigation. These historical records possess substantial academic value, as these medicinal therapies have undergone extensive human testing for centuries. Initiatives are in progress to create pharmacoepidemiological evidence relating to the safety and utilization of conventional therapeutic approaches.[25] In the research, origination and advancement of new medications, the value of herbal medicine is too great to be dismissed. Despite its obscure nature, there are numerous contexts in which this concept is applied within non-Western medical practices or technologies. Herbal medicines frequently contain a range of phytochemical components, encompassing diverse classes such as alkaloids, terpenoids, flavonoids, and others. These chemical agents commonly function either individually or in combination to elicit the intended pharmacological result. Many plant-derived compounds currently utilized in clinical pharmacotherapy originated from traditional herbal medical practices. Moreover, a considerable number of valuable pharmaceutical compounds derived from plants have been identified through the investigation of their utilization in traditional medicinal systems.[26][27]

4. COMMON NAME

Table No. 1: Names of plant in different languages.[29],[30],[31],[32],[34]

Sr.No	Language	Local Name
1	English	Shoe flower plant, Chinese Hibiscus
2	Hindi	Jasut, Jasum, Java, Odhul, Gurhal, Arahul
3	Marathi	Jasavanda, Jassvandi
4	Sanskrita	Japa, Java, Rudrapuspa, Aundrapuspa, Trisandhya
5	Bengali	Joba, Jiwa, Oru
6	Gujarati	Jasvua, Jasunt
7	Kannada	Dasavala
8	Malayalam	Himbarathi, Ayamparatti, Chebarathi
9	Punjabi	Jasum, Jaipushpa, Gurhal
10	Tamil	Sapattuu, Semparutti
11	Assam	Joba
12	Oriya	Mondaro
13	Swedish	Hibiscus

5. SCIENTIFIC CLASSIFICATION

Table No- 2 List of biological classification of plant.[30][33][35][36]

Sr No	Classification	Scientific Name
1	Botanical Name	Hibiscus Rosa Sinensis L

2	Kingdom	Plantae
3	Subkingdom	Tracheobionta
4	Super Division	Spermatophyta
5	Division	Magnoliophyta
6	Class	Magnoliopsida
7	Subclass	Dilleniidae
8	Order	Malvaceae
9	Family	Malvaceae
10	Genus	Hibiscus
11	Species	Hibiscus Rosa Sinensis

6. DESCRIPTION OF THE PLANT

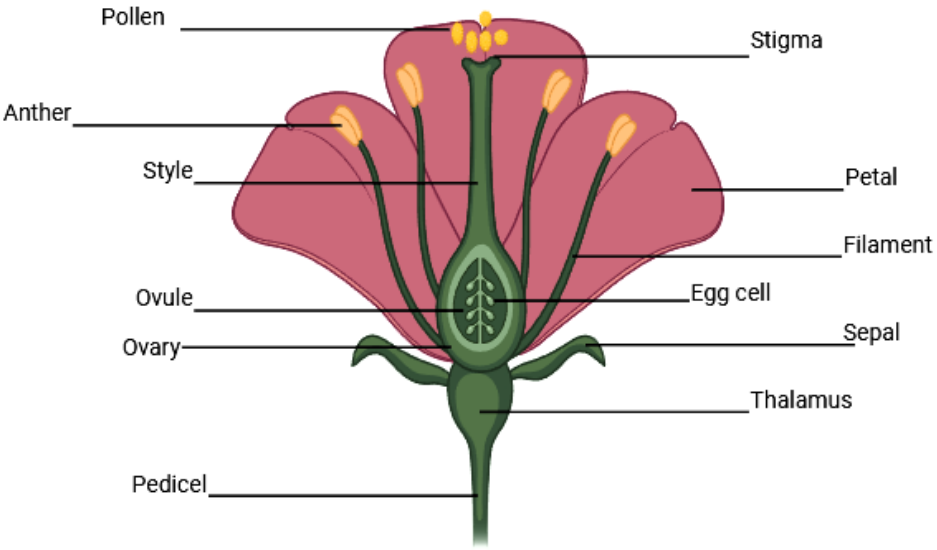

Fig. No- 1: LS of Flower.

Table No. 3: About the Morphological Description of the Plant Parts.[30],[33]

Sr No	Plant Part	Descriptions
1	Fruit	The fruit exhibits a capsular morphology with an approximate length of 3 centimeters.
2	Flowers	Flowers exhibit a pedicellate structure and are characterized by an actinomorphic, pentamerous, and complete floral arrangement. The corolla is composed of five petals, which are red in color and approximately 3 inches in diameter.
3	Leaves	The leaves display a simple ovate or ovate-lanceolate morphology. They exhibit an entire basal region and a coarsely toothed distal portion. Additionally, the leaves possess a mucilaginous organoleptic characteristic.
4	Roots	The specimen is a cylindrical structure measuring 5 to 15 centimeters in length and 2 centimeters in diameter. It exhibits an off-white coloration with light brown transverse lenticels. The specimen's fracture pattern is fibrous. Furthermore, the roots of the specimen possess a sweet and mucilaginous taste.

5	Soil	A sandy and loamy clay soil matrix with effective drainage characteristics is the preferred soil type.
6	Propagation	Horticultural techniques of severing, arranging, and fusing plant parts during the spring season.

7. PHYTOCHEMICAL CONSTITUENTS[30],[31]

Hibiscus rosa sinensis, a species of the genus Hibiscus, is a plant that exhibits significant research attention. The study identified the presence of tannins, steroids, alkaloids, total phenols, and total proanthocyanidins. Leaves, flowers, stems, and roots contain a range of phytochemical constituents, including phenolic compounds [e.g., phlobatannins], glycosides, saponins, and terpenoids, as well as additional compounds such as the vitamins thiamine, riboflavin, and niacin. Existing research indicates that the substance is predominantly composed of anthocyanins and flavonoids, including the specific compounds cyanidin-3,5-diglucoside, cyanidin-3-sophoroside-5-glucoside, quercetin-3,7-diglucoside, and quercetin-3-diglucoside. Other compounds include cyclic peptide derived natural products[28], cyanidin chloride, a flavonoid pigment; quercetin, a polyphenolic compound; hentriacontane, a long-chain alkane; and essential vitamins including riboflavin, ascorbic acid, and thiamine. The plant tissues, including the leaves and stems, were found to contain the phytosterols β-sitosterol and stigmasterol, the triterpenoid taraxeryl acetate, and a number of cyclopropane-based compounds along with their derivatives. The hibiscus flower is a rich source of cyanidin diglucoside, a type of flavonoid, as well as essential vitamins including thiamine, riboflavin, niacin, and ascorbic acid.

Flowers: Thiamine, riboflavin, niacin, and ascorbic acid; apiigenidin, citric acid, fructose, glucose, oxalic acid, pelargonidin, quercetin.

Leaves: Carbohydrates and/or glycosides, steroids and/or triterpenes, flavonoids, tannins, alkaloids and/or nitrogenous bases, saponins, coumarins.

Stem: Teraxeryl acetate, ß-sitosterol, and the cyclic acids sterculic and malvalic acids.

Roots: Glycosides, tannins, phytosterols, fixed oils, fats, proteins, amino acids, flavonoids, saponins, gums and mucilage.

8. NUTRITIONAL COMPOSITION[37][38]

Leaves

Table No. 4: About Nutritional Values of leave part of the plant.

Sr.No	Nutrition	Value of 1	Value of 2
1	Fibre	3.5g	15.5g
2	Fat	15.5g	3.5g
3	Calcium	1670mg	1.67g
4	Carbohydrate	69.7g	69.7g
5	Phosphorus	520mg	0.52g
6	Ash	11.4g	11.4g

Flower[dry]

Table No. 5: About the nutritional values of dried form of flower part of the plant.

Sr.No	Nutrition	Value of 1	Value of 2
1	Protein	3.9g	3.9g
2	Carbohydrate	86.3g	86.3g
3	Calories	353/100g	353/100g
4	Fibre	15.7g	15.7g
5	Fat	3.9g	3.9g
6	Calcium	39mg	39mg
7	Iron	1.7mg	1.7mg
8	Nitacin[B3]	5.9mg	5.9mg
9	Thiamine[B1]	0.29mg	0.29mg
10	Ascorbic Acid[C]	3.9mg	3.9mg
11	Riboflavin[B2]	0.49mg	0.49mg

Flower[fresh]

Table No. 6: About the nutritional values of fresh flower of the plant.

Sr.no	Nutrition	Values
1	Fat	0.4g
2	Water	89.8%
3	Fiber	1.56g
4	Protein	0.06g
5	Iron	1.7mg
6	Calcium	4mg
7	Phosphorus	27mg
8	Niacin[B3]	0.6mg
9	Thiamine[B1]	0.03mg
10	Ascorbic Acid[C]	4.2mg
11	Riboflavin[B2]	0.05mg

9. TRADITIONAL USES

In India, the hibiscus plant has found a multitude of diverse applications in medicinal applications, including as an abortifacient, antifertility agent, contraceptive, diuretic,

treatment for menorrhagia, bronchitis, emmenagogue, demulcent, and cough relief.[39] In China, the pigmented liquid originating from the flower petals is employed for the purposes of shoe polish and cosmetic applications.[40][41] The hibiscus plant demonstrates a multitude of practical applications in the fields of food, cosmetics, and medicinal science. Its extracted compounds are frequently utilized as flavoring agents across an array of food products, encompassing items such as jams, sauces, spices, and soups.[42] In the traditional medicinal systems of the Cook Islands, Haiti, Japan, and Mexico, the leaves of the hibiscus rosa sinensis plants have been employed for the management and mitigation of dysentery and diarrheal conditions, encourage the draining of abscesses, and serve as an analgesic.[43] The roots of hibiscus rosa sinensis demonstrate potential as an antitussive therapeutic.[33] Roots are considered a cure for gastrointestinal, sexual health issues, infectious diseases, and hemorrhagic vomiting. Roots are additionally employed to address specific ailments in bovine livestock. Extracts of leaves, both alcoholic and aqueous, possess anti-infective, anti-dandruff, and preventive properties for a range of skin conditions and immune hypersensitivity disorders. These chemical compounds are additionally employed to stimulate hair development and intensify hair pigmentation owing to their properties that counteract graying.[37] It possesses antitoxic, antibacterial, antifungal, anticancer, antifertility, and neuroprotective properties, supports wound healing, and shows anti-inflammatory, antipyretic, antihyperlipidemic, cardioprotective, and hepatoprotective activities.[41]

10. PHARMACOLOGICAL ACTIVITIES

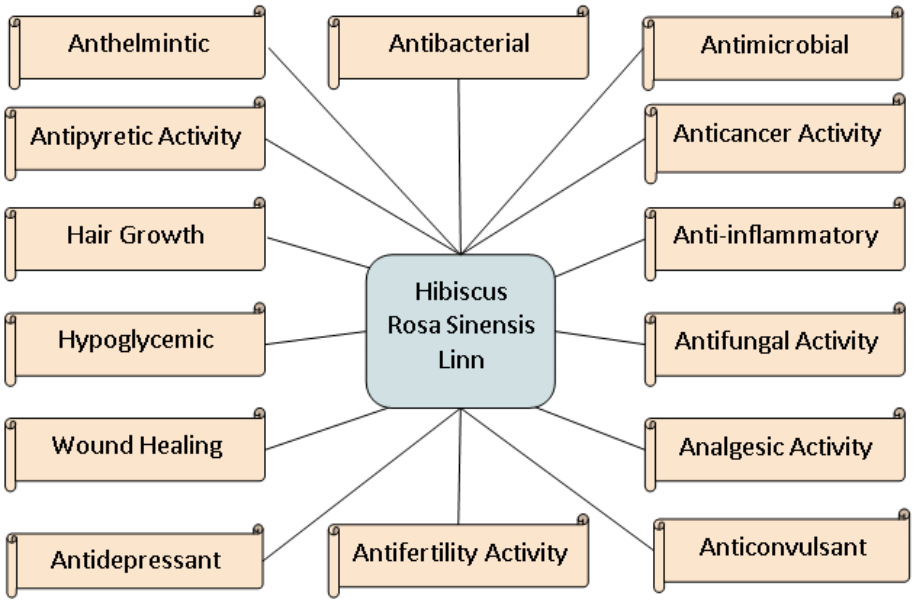

Fig. NO. 2: Different Pharmacological Activities of the Plant.

Antibacterial Activity: Ruban P and Gajalakshmi K explore the antimicrobial efficacy of hibiscus rosa sinensis floral extract. This research indicates that the floral extract of hibiscus rosa sinensis demonstrates efficacy against human pathogenic organisms. They assessed the antibacterial activity by employing the disc and agar diffusion technique. In the results, cold extraction shows the greatest growth inhibition of E. coli, Bacillus subtilis, while hot extraction demonstrates effectiveness against Escherichia coli and Salmonella sp. It was determined that the extract of hibiscus rosa sinensis demonstrates significant antibacterial properties.[41],[42]

Antifertility Activity: David Hoffman examined fertility and contraception using the extract of hibiscus rosa sinensis. Only the flower exhibits antifertility activity, which varies with the season. The antifertility effect is strongest in winter and weakest in summer.[43] The benzene extract of hibiscus rosa sinensis demonstrates antifertility effects in rats. The ethanol extract influenced the a higher proportion of male offspring at birth.[44] Flowers gathered during the winter season exhibited maximum postcoital anticonceptive properties.[45][46] Ethanol extract of dehydrated floral material, administered the oral administration of the substance to female human participants at a dose of 750.0 mg per person was found to be efficacious. The dosage was divided and taken three times daily during the 7th through the 22nd day of the menstrual cycle. The study population comprised 21 female participants, and 7 of them withdrew from the intervention due to unrelated health issues. During the follow up period of up to 20 months, no pregnancies were reported among the remaining 14 women.[47] According to Kholkute *et* al,. hot extracts of hibiscus rosa sinensis were responsible for the postcoital antifertility properties to prevent pregnancy, with the extract obtained from the flowers of hibiscus being 100% effective.[48]

Antipyretic Activity: Sawarkar *et* al,. investigated the effects of hibiscus rosa sinensis as a febrifuge in rats. The febrile response was assessed utilizing the foliage of hibiscus rosa sinensis and Wistar albino rats. The Hibiscus rosa sinensis extracts, both aqueous and alcoholic, were used to lower the elevated temperature. These results were compared to a control group.[49]

Hair Growth Activity: N.Adhirajan *et* al, reported that by the end of the second week, hair regrowth was observed in the denuded region, with the hair length continuing to increase throughout the duration of the treatment course. Compared in contrast to the control group, all the other experimental groups displayed full hair coverage over the entire denuded region

by the fourth week. Additionally, hair growth demonstrated a modest increase across the treatment conditions, except for the cohort that received the leaf extract, which exhibited no appreciable differences in hair characteristics. The groups treated with leaf and flower extracts showed a significant impact compared to the placebo and control groups. Nonetheless, in the group treated with the impact of leaf extract on hair length characteristics significantly exceeded that of the group treated with flower extract.[50]

Anti Diabetic Activity: According to MOQBEL et al,. The alcoholic extract of hibiscus rosa sinensis exhibited hypoglycemic properties when administered orally to non-obese type 1 diabetic mice. Utilizing specific dosages per kilogram of body weight, the blood glucose levels demonstrated a decrease in the treated mice compared to the insulin administered NOD mice, which served as the positive control group. The study found that after a 5 week period of oral administration, the investigated extract demonstrated notable reductions in the levels of triglycerides, blood urea, glycosylated hemoglobin, and cholesterol.[51]

Wound Healing Activity: A study[52] indicated that the analysis did not detect a statistically significant disparity observed between the water and ethanol extracts of hibiscus rosa sinensis leaves, showing that both extracts possess equal effectiveness in promoting the wound healing process. As far as known, this study report the efficacy of extracts from hibiscus rosa-sinensis leaves in the healing of incision wounds.[53] Consequently, this research may enhance the efficacy of the water extract in healing incision wounds. The investigation demonstrated that an ethanol-based extract derived from hibiscus rosa sinensis possesses attributes that facilitate enhanced acceleration of wound healing processes.[54] The improved wound contraction, reduced the formation of an epithelial tissue layer time, greater tensile properties and hydroxyproline levels endorse the wound-healing benefits of hibiscus rosa sinensis.[55]

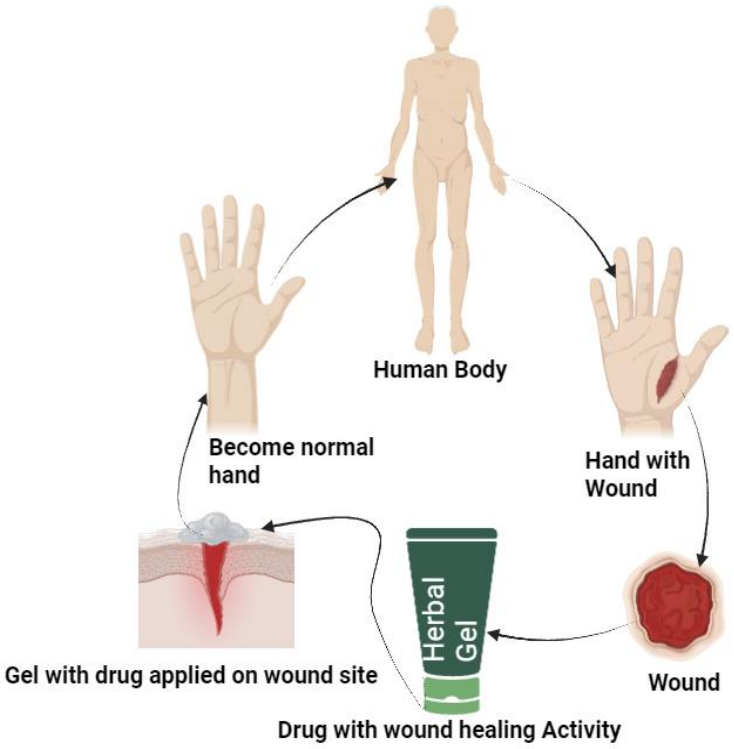

Fig. No-3: Process of wound healing.

Anticancer Activity: Durga *et* al,. demonstrated that the acetone extract of hibiscus rosa sinensis flowers, at a concentration of 1000 µg/mg, exhibited anti-cancer activity against HeLa cell lines.[56] Oral cancer cell line KB was treated with 75 µg and 125 µg concentrations of hibiscus rosa sinensis oil extract for a duration of 24 hours. DNA fragmentation analysis conducted via agarose gel electrophoresis revealed that the cell DNA samples from both concentrations displayed fragmentation in contrast with the control sample. The the study reveals that the hibiscus extract hindered the growth and multiplication of the oral cancer cells.[57] Similarly, Arullappan S *et* al,. the study discovered that the aqueous extract of hibiscus rosa sinensis flowers, administered at a concentration of 2 mg/mL, exhibited anti-neoplastic properties on the B16F10 melanoma cell line.[58]

Anti-inflammatory Activity: Vivek Tomar *et* al,. reported on the anti-inflammatory properties of hibiscus rosa sinensis. The study investigated the plant's efficacy in managing a range of inflammatory disorders, including blennorrhea, asthmatic bronchitis, and oral mucositis. Specifically, the researchers utilized methanolic extracts derived from hibiscus rosa sinensis leaves to evaluate the anti-inflammatory activities. They employed various animal models to assess the inflammatory responses, with indomethacin serving as the standard drug against carrageenan- and dextran-induced inflammation.[59]

Antifungal Activity: Prior studies have shown that the methanol extract derived from hibiscus rosa-sinensis leaves exhibits antimicrobial properties against Candida albicans, Aspergillus niger, Candida parasilosis, and Trichophyton rubrum. Through the application of the well diffusion technique and a 24 hour incubation period at 37°C, the maximum observed zone of inhibition was measured as 9.3 ± 0.57 mm against Aspergillus niger, and 6.6 ± 0.57 mm against Candida albicans, at a concentration of 80 µg/ml of the leaf methanol extract. The antifungal activity the observed effects may be attributable to the presence of plant based phytochemical compounds, including flavonoids, tannins, terpenoids, saponins, or alkaloids, as identified in previous studies.[60]

Analgesic Activity: Sawarkar *et* al,. conducted research on hibiscus rosa sinensis and determined its analgesic [pain-relieving] properties. In a recent investigation, the researchers obtained aqueous and alcoholic extracts from the dried leaves of the hibiscus rosa sinensis plant. These extracts demonstrated dose dependent analgesic activity. The extractability percentage of the compounds from the leaves was reported to be 20%.[61] The study by Singh *et* al,. examined the analgesic effects of various drugs against aconitine-induced writhing in mice. The results demonstrated that Withania somnifera, Hibiscus rosa-sinensis, and Plumieride exhibited significant analgesic activity in this test.[62]

11. SKIN

The skin represents a complex ecosystem spanning approximately 1.8 square meters, featuring a complex landscape of folded structures, recessed cavities, and specialized microenvironments that harbor a diverse assemblage of microorganisms. The skin's principal role is to function as a physical protective layer, safeguarding the body from potential threats, including foreign agents or harmful substances.[63] The physical barrier predominantly comprises the stratum corneum, however, the nucleated epidermis, particularly the intercellular junctions and the corresponding cytoskeletal proteins, contributes additional significant elements. The chemical and biochemical barrier, which encompasses antimicrobial characteristics and intrinsic immunity, is composed of lipids, acids, hydrolytic enzymes, antimicrobial peptides, and macrophages. The adaptive immunological barrier is constructed from both the humoral and cellular elements of the immune system.[64] Skin is a highly complex and multifaceted organ, with a greater diversity of cellular constituents compared to the brain. Although it is relatively accessible for research purposes, it nevertheless retains a substantial number of unresolved questions. One of the principal areas

of inquiry has been to elucidate the precise pathways through which compounds traverse the skin, and the extent to which these processes can be modulated by formulations.[65]

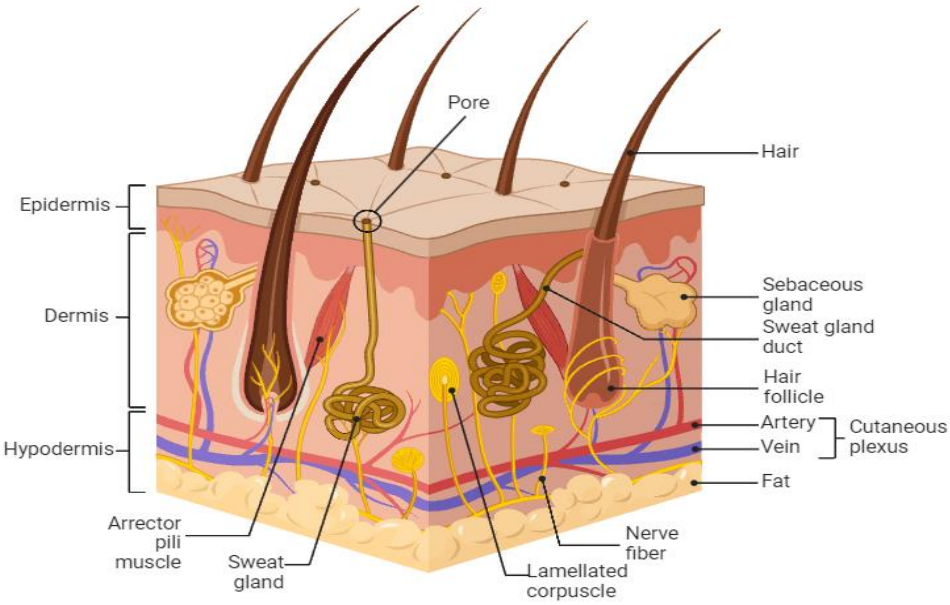

Fig. No. 4: Structure of skin.

12. WOUND

A wound denotes a disruption or compromise to the typical skin structure, with a range of potential severity and depth.[66] A wound signifies a disruption in the continuity of bodily tissues, stemming from traumatic or injurious factors. Several categories of wounds exist, including puncture wounds, abrasions, and lacerations.[67] For medical professionals, the terms "wound" and "injury" are often used interchangeably. However, the legal conceptualization of a wound specifically denotes the comprehensive disturbance of the skin's full depth.[68]

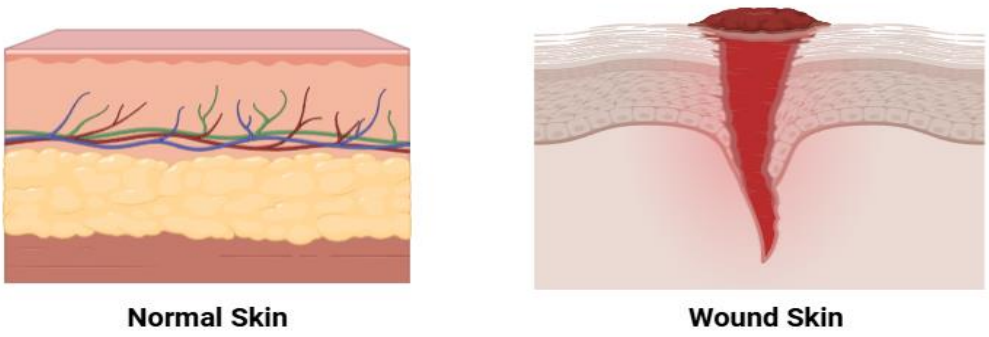

Fig No. 5: Visual Difference between normal and wound skin.

Classification of Wound

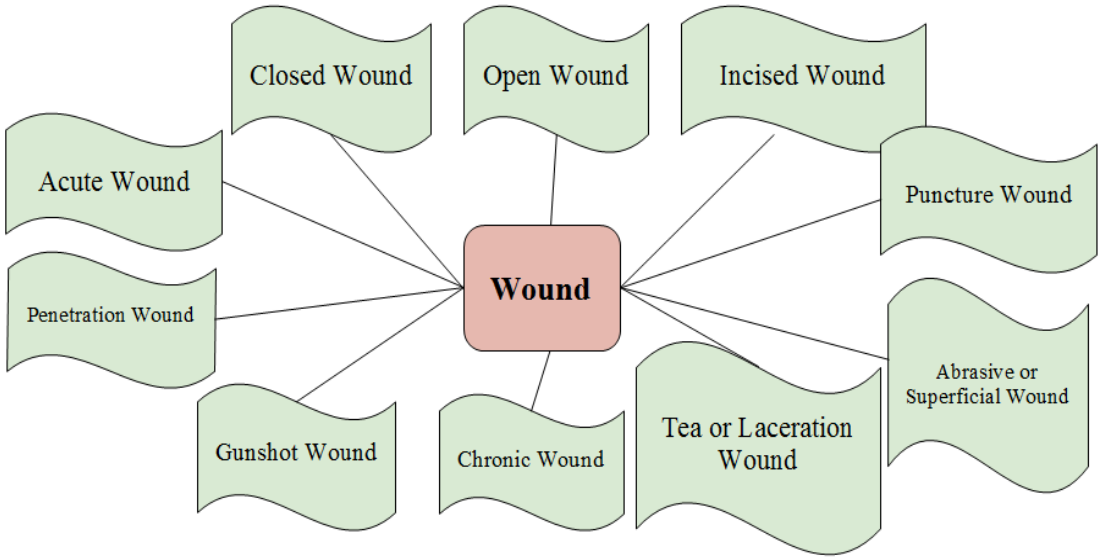

Fig No- 6 Different types of wounds

Acute Wound: Acute tissue injuries heal fully with minimal permanent damage within the anticipated time frame, typically 8-12 weeks in duration.[69] Acute wounds can be categorized into various classifications based on the environmental variables influencing the injury. Broadly, these wounds can be divided into two primary classifications: Traumatic Wounds and Surgical Wounds.[70]

Closed Wound: In the event of closed injuries, blood exits the circulatory system but is retained within the body. This internal bleeding becomes visually apparent through the formation of bruises.[71]

Open Wound: In the event of blood loss from the body, observable drainage becomes apparent. These bleeding injuries can be further categorized as: incised wounds, lacerations or tears, abrasions or superficial injuries, puncture wounds, penetrating wounds, and gunshot wounds.[69]

Chronic Wound: Chronic wounds are pathological lesions stemming from metabolic disturbances. In contrast to acute wounds, which heal in a balanced and timely manner, chronic wounds require significantly longer to mend. Chronic wounds are characterized by an imbalance in the production and breakdown of cells and extracellular matrix components.[70] Chronic wounds have failed to advance through a structured and temporally appropriate process to achieve anatomical and functional wholeness, or progressed through the repair

process without establishing a persistent anatomical and functional outcome.[72] These wounds can be differentiated into three distinct classifications: venous or vascular ulcers, diabetic ulcers, and pressure ulcers.

13. WOUND HEALING

Wound healing in the human body is a multifaceted biological process that is triggered by tissue injury. This process aims to restore the function and integrity of the injured tissues and involves a coordinated sequence of interactions between cells and the extracellular matrix. This intricate process of tissue repair comprises a series of coordinated events, including bleeding and coagulation, the migration and recruitment of inflammatory cells, the formation and expansion of granulation tissue, the formation of novel vascular structures and the production and accumulation of new extracellular matrix components, and the remodeling of the resulting scar tissue.[71]

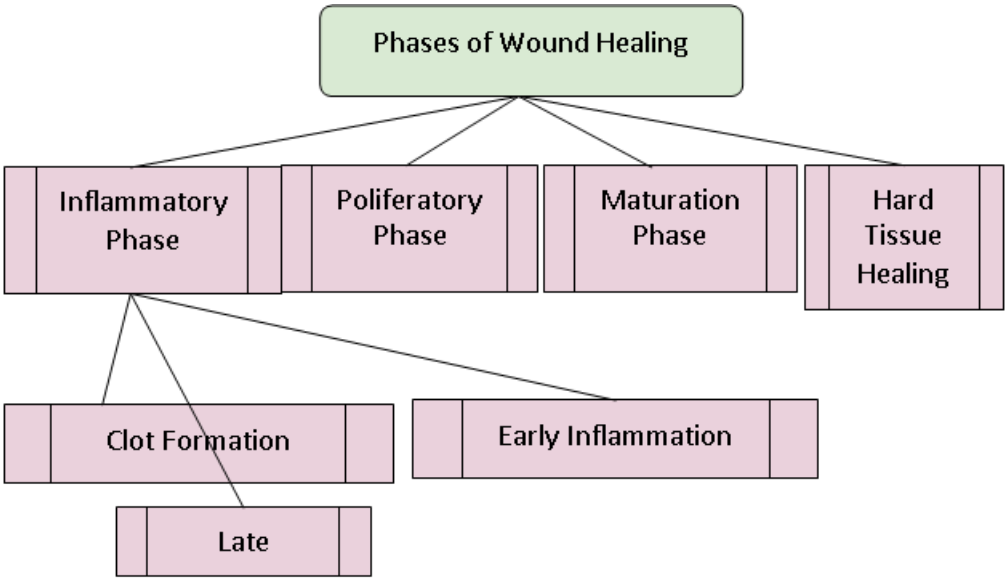

Fig No. 7: Different phases of wound healing.

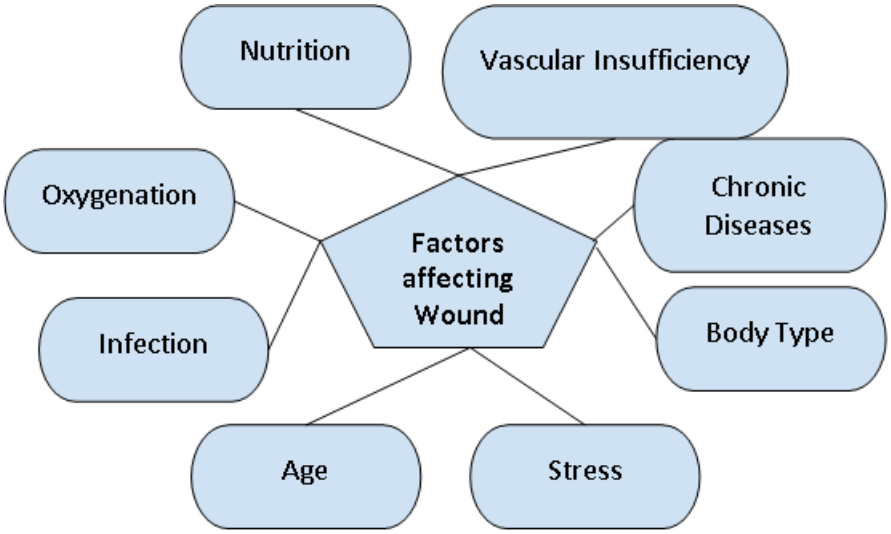

Fig. No. 8: Different factors that affect wound healing.

14. FORMULATION CONSIDERATIONS

GEL: The term "gel" was introduced in the late 1800s to provide a nomenclature for certain semisolid materials based on their physiological characteristics.[73] The Latin root terms "gelu," denoting "ice," and "gel," signifying "freeze" or "harden," are the etymological origins of the words "gel" and "jam," from which the terminology "gel" is derived.[74] Gels are a semi-solid dosage form employed for topical therapeutic applications. These gels comprise small or large inorganic particles encapsulated and dispersed within an aqueous medium. The gel matrix is composed of synthetic or natural polymers that form a three-dimensional network suspended in a dispersed phase and hydrophilic liquid.[75]

Classification of Gel

Gels can be classified based on various criteria[76]:

Nature of Colloidal Phase

- Inorganic gel
- Organic gel

Nature of Solvent

- Hydrogel
- Xerogel
- Organic gel

Rheological Properties

- Plastic Gel
- Pseudo plastic gel
- Thixotropic gel

Physical Nature

- Elastic Gel
- Rigid Gel

16. FORMULATION DESIGN

The topical gel preparation may consist of the following constituents[77]:

1] A gel-forming agent or polymer

- Natural Polymers
- Semi-synthetic Polymers
- Synthetic Polymers
- Inorganic Substances
- Surfactant

2] Pharmacologically active substances

- Physicochemical Properties
- Biological Properties

3] Permeation enhancers

Mechanism of Gel Formation

The formation of gels can be attributed to three primary mechanisms of cross linking[78]:

a] Chemical cross linking

b] Physical cross linking

c] Ionic cross linking

Methodology for the Preparation of Gel

Three approaches are employed for the preparation of gels[79]:

- Fusion method: In this approach, the vehicles, gelling agents, additives, and drug are combined and heated until a semi-solid texture is achieved.

- Cold method: In this method, all constituents excluding the pharmacological active substance are concurrently heated and combined, after which the temperature is reduced, the drug is incorporated, and additional blending is conducted until the gel is produced.
- Dispersion method: In this approach, the gelling agent is stirred with water until it swells, then the drug is dissolved in the medium and incorporated into the swollen gelling agent. If necessary, a buffer is incorporated to regulate the pH of the gel.

Evaluation parameters of gel

The assessment of a gel formulation involves the evaluation of the following parameters[80]:

- Measurement of pH
- Determination of drug content
- Assessment of viscosity
- Evaluation of spreadability
- Examination of extrudability
- Skin irritation testing
- In vitro dissolution studies
- In vivo dissolution studies
- Stability assessment
- Evaluation of homogeneity
- Examination of grittiness

17. USES OF GEL

The utilizations comprise the following[81]

- Polymers serve as versatile materials in various pharmaceutical and cosmetic applications
- As carrier matrices for orally administered drugs, facilitating controlled drug release.
- Topical formulations administered directly to the skin, mucous membranes, or the eye can offer prolonged drug release.
- Long-acting formulations for drugs administered by intramuscular injection or implanted in the body.
- Serving as binders to facilitate the granulation process of tablet formulations, functioning as protective colloids in suspension dosage forms, and acting as thickening agents in oral liquid preparations and suppository bases.
- In cosmetic products such as shampoos, fragrances, dentifrices, and skin and hair care preparations.

18. PAST AND PRESENT STUDIES

Historical research on Hibiscus rosa sinensis primarily focused on its traditional uses in folk medicine. Early studies adopted an observational and ethnobotanical approach, aiming to document the plant's diverse medicinal applications across cultures, such as for treating fever, inflammation, infections, and skin conditions. These researches were predominantly grounded in anecdotal evidence and empirical knowledge passed down through generations. Earlier laboratory based investigations typically concentrated on basic phytochemical analysis, identifying key compounds in the plant, including flavonoids, anthocyanins, alkaloids, and organic acids. These compounds were believed to contribute to the plant's therapeutic properties, but their exact mechanisms of action remained poorly understood. The analytical methods used in the past were relatively rudimentary, and clinical studies involving hibiscus rosa-sinensis were scarce. In contrast, modern research on hibiscus rosa sinensis has become more advanced and scientifically rigorous, reflecting the increased availability of sophisticated technologies and analytical techniques. Current investigations focus on understanding the bioactive compounds at a molecular level, utilizing advanced methodologies including high performance liquid chromatography, mass spectrometry, and other molecular studies. The existing research offers detailed and comprehensive understandings of the plant's chemical composition, pharmacokinetics, and mechanisms of action. Furthermore, contemporary studies have become increasingly clinical and experimental in nature, exploring the plant's potential across diverse clinical domains, such as cardiovascular medicine, wound healing, skin care, and diabetes management. Controlled clinical trials and preclinical investigations in animal subjects are currently underway to evaluate the safety profile, efficacy, and bioavailability of the hibiscus rosa sinensis extracts. Particularly, there is an emerging academic focus on formulating the plant into topical treatments, such as gels and creams, owing to there capacity to promote skin healing and mitigate inflammation. The evolution of studies on hibiscus rosa-sinensis reflects a transition from traditional knowledge to modern scientific inquiry. While past studies laid the foundation for understanding the plant's medicinal uses, present research has expanded upon this knowledge, providing more robust evidence of its therapeutic potential. Despite the differences in research methodologies and depth, both past and present studies recognize the plant's value in traditional medicine and its growing potential in modern therapeutic applications.

19. CONCLUSION

The Hibiscus rosa sinensis plant represents a promising natural source with substantial capacity for future therapeutic development and clinical utilization. Continued academic research and technological progress are anticipated to reveal expanded potentials for this multifaceted plant, establishing linkages between ancestral knowledge and contemporary medical practices. The utilization of herbal plants represents a valuable resource within the academic field of wound healing, as ongoing research continues to pave the way for more effective and accessible therapeutic interventions. Their prospective use in wound care, backed by scientific evidence and innovation, could lead to safer and more efficient healing methods, offering a natural alternative to conventional pharmaceutical options. Additionally, topical gels represent a dynamic and evolving segment of the skincare and treatment market. With sustained research and technological advancements, these offerings demonstrate substantial potential for providing more effective, personalized, and sustainable solutions across numerous skin concerns, positioning them as a cornerstone in the future of dermatological treatments.

20. CONFLICT OF INTEREST

The authors have no conflicts of interest regarding this investigation.

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