Formulation Development and Evaluation of Herbal Drug Effective Against Acne

A Thesis
Submitted towards the Requirements for the Award of Degree of

Doctor of Philosophy

In

Pharmacy
Under the Faculty of Pharmacy

By
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Under the Supervision of

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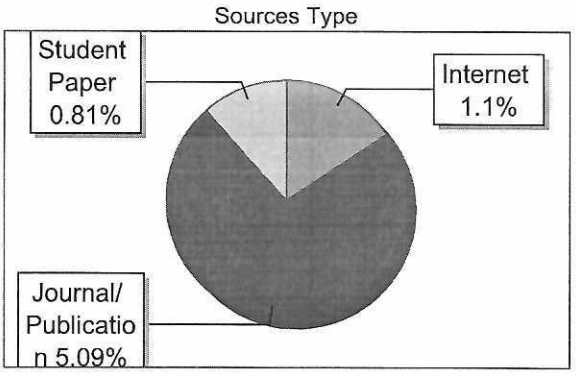
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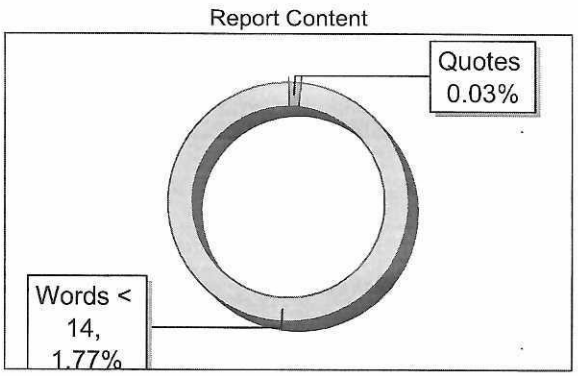
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Date: **(SHIVANGNI RATHORE)**

Place:

1. INTRODUCTION

The outermost organ of the human body is the skin. People are very sensitive to their skin appearance. Skin has aesthetic significance as well. A centuries-old quest for human beings has been the need to have beautiful and healthy looking skin. Skin with a smoother surface and lighter complexion tends to be considered healthier and more desirable (Igarashi et al., 2005). The skin's most important function is to shield the organism from the outside world and to establish homeostas is between the body inside and outside (Celleno&Tamburi2009).The skin, by surface area and weight, is a cutaneous membrane and is the largest organ of the body. It surrounds the body. The human skin spans approximately

1.7 square metres in surface area and has a mass ranging from 4.5 to 5 kilograms, representing roughly 10 percent of an individual's total body mass. The skin's thickness varies considerably across different body regions, measuring between 0.5 to 4 millimeters, with the most delicate areas found around the eyelids and the most robust sections located on the heels. The typical thickness averages 1 to 2 millimeters throughout the body (Williams, 2003).

Human skin is mainly divided into three layers: Epidermis, Dermis, and Hypodermis

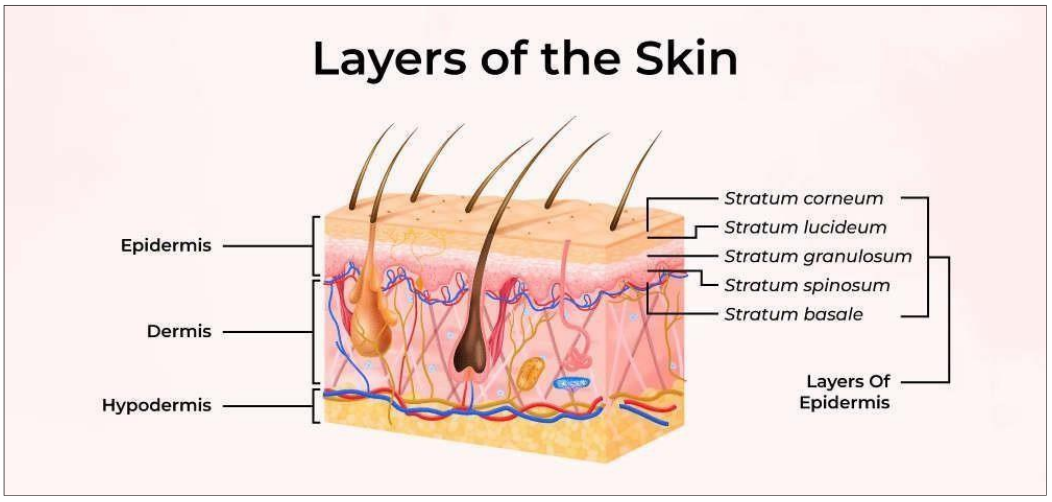


Figure1.1: Skin Structure

Epidermis:

The epidermis is the skin's outermost layer. This layer does not include veins and capillaries. On average, its thickness is around 0.2 mm and this thickness differs depending on the position of the body. There is further division of the epidermis into five sub layers. Those sub layers are from the bottom (innermost)

- Stratum basale (basal cell layer)
- Stratum spinosum (prickle cell layer)
- Stratum granulosum (granular cell layer)
- Stratum lucidum (clear layer)
- Stratum corneum (horny cell layer)

Dermis:

The dermis consists primarily of fibrous tissue components and maintains a thickness of 1-2 millimeters. This layer features an extensive vascular network that facilitates the absorption of pharmaceutical compounds into systemic circulation (Samantha Andrews et al., 2012). Various skin appendages, including sebaceous glands, sweat glands, and hair follicles, emerge from their origins in the dermal and subcutaneous layers and extend toward the epidermal surface (Chein & Banga, 1989). Research indicates that each square centimeter of human skin typically accommodates between 10-70 hair follicles and approximately 200-250 sweat glands (Keleb et al., 2010).The following sub layers of the dermis are:

a) Papillary layer
b) Reticular layer

Hypodermis:

It is under the dermis, the third layer. Sub cutis is an elastic layer which contains a large number of fat cells that a ctas a blood vessel and nerve ending shock absorber. On average, the thickness of this layer is 4 to 9 mm. The actual thickness, however, varies from person to person an distal so depends on the area of the body (Igarashiet al., 2007).

Skin Problems:

The skin is a very sensitive organ and can be easily affected by diseases and infections. Due to different factors uchasair pollution, overexposure to UV rays, age of individuals, harmful microorganisms, eating habits, stress, chemicals, etc., skin problems can occur. Skincare and treatment is important, not just for a healthy skin, but also for the individual's overall well- being (Gross art& Sherman, 2009).

Acne vulgaris, eczema and dermatitis, scars, uneven pigmentation, under eye circles, sunburns and wrinkles are different facial skin issues. While facial skin problems are painless and stressful because they are easily observable, and trust and quality of lifecan be seriously affected. The psychological effect of issues with facial skin is very strong and severe depression may be associated with non-cystic facial acne (Gupta & Gupta, 1998).

Acne vulgaris and wrinkles are the most common and serious skin issues. The development of wrinkles is a noticeable result of skin ageing, and acne vulgaris is a prevalent adolescent skin disease. These two skin problems play a major role in influencing the self-approval and trust level of an individual as they specifically target the face and alter the appearance of the individual.

Acne vulgaris is a prevalent disease in developing nations, one that has mainly increased in regularity among adult women over the past half century. Acne vulgaris (acne) is a common skin disease involving the follicular canal, hair follicle and sebaceous glands of the pilose baceous unit, including (Bloom D.F, 2004). The term acne derives from Actius Amidennus' writings from the Greek word 'acme'. In the sense of skin eruption, he used the word "acme" and vulgaris indicates the "common" definition (http: www. acnepen.com).

Acne, oracne vulgaris, is a skin issue that be gins when skin pores are obstructed by oil and dead skin cells. Blackheads, blemishes, whiteheads, pimples, or zits are also present. Pimples covering the face, neck, chest, and back can indicate serious acne. Orit may be larger, heavier, red lumps that are painful (cysts). Acne develops most often during puberty, affecting an estimated 80-90% of adolescents (Taylor et al., 2011).

Acne vulgaris is a multifactorial cutaneous disorder which manifests in the pilosebaceous follicle. Open and closed come done and inflammatory lesions, such as papules, pustules and nodules, define it (Date et al., 2006). Microorganisms such as Propionibacterium acnes, Staphylococcus aureus and Staphylococcus epidermidis are rapidly proliferating, leading to acne development (Coillieret al., 2008). The follicular channel is colonised by the bacterial species Propionibacterium Acnes. This triggers the development of cytokines, which eventually contributes to inflammatory lesions forming. Granulomatous lesions and scarring also arise when the follicle walls are broken (Kurokawa et al.,2009).

Sebum usually flows up the follicle to the surface of the skin. Hormones can increasethedevelopmentofsebumandcausehyperproliferationoffollicularcellsandblock the follicular opening, creating a comedo (Smolinski& Yan 2004). Total follicle blockage results in closed "whiteheads" comedones, while partial blockage results in open "blackheads" comedone formation usually occurs over the "whiteheads" come done formation (Cunliffe B; 2001).

Acneisusually seen on the ears upper chest, and back, which have a greater number of oil glands (Bettoli et al., 2015). Acne may be caused by excess development of oil, bacteria, hair follicles that are unusually shed, and excess activity of androgynous hormones, such as test osterone. Age, skin friction, genetics, and working near fryer vats can all lead to acne (website. mayoclinic.org).

It can leave emotional and physical wounds, while acne is not a dangerous disease. Anxiety, diminished self-esteem, depression, and thoughts of suicide may have emotion alsequelae. With hyper pigmentation, permanent physical effect scan vary from mild to severe scarring (Feldman et al., 2004).

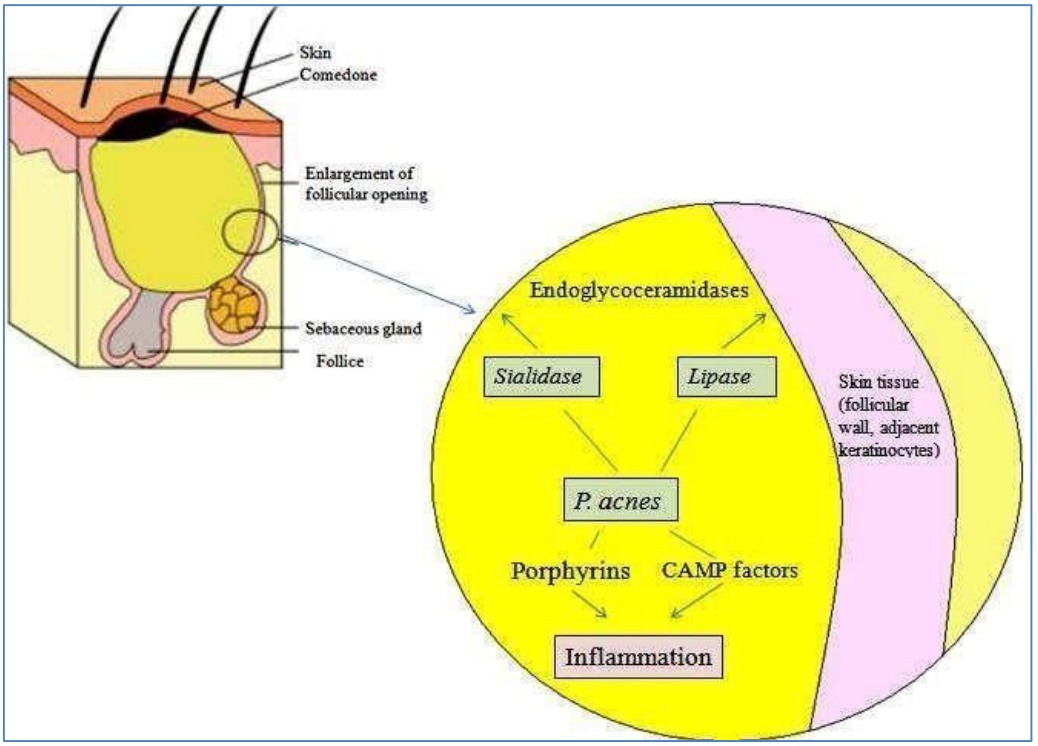


Figure1.2: Propionibacterium Acne Role in Acne Pathogenesis

Classification of Acne:

Acne Vulgaris Classification System in India

Acne vulgaris represents a significant dermatological concern within the Indian population. Traditional Indian dermatological practice employs a straightforward classification framework that categorizes acne vulgaris severity into four distinct levels:

Grade I (Mild Acne):

This represents the least severe form of acne vulgaris, characterized by minimal inflammatory response. Clinical manifestations include come done (blackheads and whiteheads) and minor papular lesions. This grade typically responds well to non- prescription therapeutic interventions.

Grade II (Moderate Acne):

This classification involves an increased presence of comedonal lesions, with both open (blackheads) and closed (whiteheads) comedones being prevalent. Inflammatory papules and pustules are frequently observed at this stage. Treatment with over-the-counter medications remains viable for Grade II presentations.

Grade III (Severe Acne):

This category represents a more advanced form of acne vulgaris, featuring extensive papular and pustular lesions. The condition exhibits pronounced erythema and inflammatory responses as defining characteristics of Grade III acne.

Grade IV (Very Severe Acne):

Also referred to as nodulocystic acne, this represents the most advanced form of the condition. The skin demonstrates multiple inflammatory lesions including pustules, nodules, cysts, and various types of comedones. The inflammatory process and lesions may extend beyond facial areas to involve other body regions, including the auricular area. Additional specialized grading methodologies may be necessary for comprehensive assessment of acne vulgaris severity.

- One or more of the pathophysiologic causes are imply cate dinallty pes of acne:
- Follicular epithelium hyper keratinization with come done formation
- Increased sebum generation
- Propionibac teriumacnesum bacterial proliferation (P. acnes)
- Local hyper sensitivity to immunity that causes in Flammarion (Raoetal.,2003)

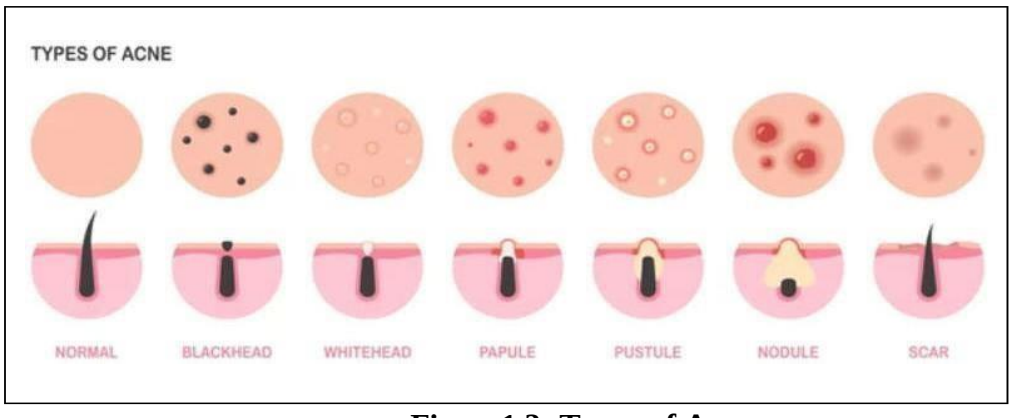


Figure1.3: Types of Acne

Types of Acne Lesions

Blackheads

Blackheads represent a form of non-inflammatory acne that occurs when hair follicles become clogged with a combination of sebum and dead skin cells. These lesions are classified as open comedones because the pore remains accessible to air, causing the trapped material to oxidize and develop a characteristic dark appearance ranging from brown to black. This mild form of acne commonly manifests on facial areas, as well as the shoulders, arms, neck, chest, and back regions.

Whiteheads

Whiteheads constitute small, non-inflammatory acne formations that emerge when pores become completely obstructed by a mixture of bacteria, sebaceous secretions, and cellular debris. These lesions are termed closed comedones due to their sealed nature and pale coloration. While whiteheads can develop on various body parts, they predominantly occur within the T-zone region, encompassing the forehead, nose, and chin areas.

Papules

Papules represent inflammatory acne lesions characterized by the body's immune response to bacterial infection, excessive sebum production, and hormonal influences. These formations serve as an intermediate stage between non-inflammatory and inflammatory acne types. Papules manifest as small, pink-colored elevations on the skin surface, typically measuring less than 5 millimeters in diameter and generally lacking purulent content.

Pustules

Pustules are inflammatory acne lesions that develop when pores become blocked with accumulated sebum and dead skin cells, subsequently becoming infected. These formations are distinguished by their central collection of pus or fluid, typically presenting as white or yellow-centered bumps surrounded by inflamed, reddened skin. Although pustules can appear on anybody area, they most frequently occur on the face, neck, chest, back, shoulders, underarms, pubic region, and along the hairline.

Nodules

Nodular acne represents a severe inflammatory condition that develops when bacterial infection, excessive oil production, and cellular debris create deep blockages within hair follicles. While these blockages may initially resemble typical comedones, the infection can penetrate deeper skin layers, causing significant inflammation and swelling in surrounding tissues. Nodular lesions typically exceed 5-10 millimeters in diameter, can persist for extended periods, and commonly appear along the jawline and chin area. These formations require professional treatment as they rarely respond to standard over-the-counter remedies.

Cysts

Cystic acne represents the most severe form of inflammatory acne, developing deep within the skin when pores become severely obstructed by oil, dead skin cells, and bacteria. This condition primarily affects individuals with naturally oily skin across all age groups. Cystic lesions appear as large,

painful, pus-filled formations that may be white or red in color and have significant potential for causing permanent scarring. While cystic acne can occur anywhere on the body, it most commonly affects the face, arms, shoulders, back, chest, and neck regions. Individuals with cystic acne often experience a combination of both inflammatory and non-inflammatory symptoms.

Fungal acne (pityrosporum folliculitis): This kind happens when there is too much yeast growing in the hair follicles. They may become irritated and irritating.

Salient Causes for the Development of Acne:

Acne occurs when either oil, dead skin, or bacteria obstruct the pores of the skin, or both. Each pore is an opening to a follicle consisting of hair and a gland of sebaceous oil. The oil glandre leases an atural sub stance called sebum that lubricates and protects the skin through the pores and skin, which passes to the hair root. Acne is spread out at this stage because of one or more issues that occurred in this lubrication process due to increased development of oil and follicular pore cork. The cork either Tends to be whit eheadifit is protected by at inlayer of skin, or if it is exposed to the sunlight, the darker exposed part of the cork is considered a blackhead.

The crooked hair folli clean ergeda bump gradually. The wall becomes rupture as the follicle spreads, allowing normal skin bacteria to penetrate the deeper layers of the skin, properly inducing inflammation as a result of which the skin surface develops a pustule and deeper inflammation becomes pimple and A cyst that can leave incurable permanent marks on the skin is produced fit penetrates more deeply. Due to excess oil production, the formation of pimples is caused by a pore blocked by dead skin cells and bacteria (Ravishankar et al., 2015).

Other Causes of Acne:

Hormones:

Many hormones, including androgen testosterone, dihydro testosterone (DHT) and dehydroepi and roster one (DHEA), have been associated with acne; elevated growth hormone(GH) and insulin-like growth factor1 (IGF-1)level shave also been associated with worsening acne (Hoeger P.H. et al., 2011).

Picking or squeezing:

Touching the lesions of acne will make them worse and increase the risk of permanent scarring. Squeezing or popping pimples can cause sebum and bacteria to erupt into the surrounding skin tissues, resulting in further swelling, redness and possibly infection (Ray Chanda et al., 2013).

Environmental Factors:

This involves various factors such as high humidity, excessive wearing, increased skin hydration, exposure to soil or vaporized cooking oil, or certain chemicals such as petroleum derivatives (Fuster et al., 2006).

Anxiety and Stress:
Your levels of certain hormones, such as cortisol and adrenaline, could be impaired by mental stress, which may make your acne worse. Stress will, again, make certain
Individuals binge-eat. Experts think that hormone levels are more likely to be the culprits, rather than binge-eating.

Oil Based Makeup's:
The blocking of your pores will speed up moisturising creams, lubricating lotions and all oil-containing cosmetics.

Greasy Hair:
Some hair products are very greasy and may have the same impact as cosmetics based on oil. Examples of hair products with cocoa butter or coconut butter.

Squeezing the Pimples:
Your acne is more likely to get worse if you decide to pinch pimples, plus you risk scarring.

Make-up and Hair Care Products:
The pores can clog. Look for acne-friendly words on food labels while shopping: oil- free, non-come do genic, or non-acne genic.

Physical Pressure:
Chin strap strain, telephone receiver, sports helmet, headband, guitar strap, bra strap and other tight clothing can lead to localized acne that develops at the point of contact with the skin.

Sweating:
Acne in some individual scan worsen. It is most likely because sweating, particularly if caught under clothes, tends to clog pores.

Over washing:
For acne-prone skin, washing your face twice daily with a mild cleanser is recommended. More regular washing, scrubbing/exfoliating or using powerful cleansers or astringent products (i.e. alcohol toners) can irritate the skin, leading to more acne.

Medications:
Some drugs, such as oral corticosteroids, some contraceptive pills (progestin only), and anti-convulsant medicines, may cause acne to flame up.

Dietary Contribution:
As there is no strong proof of consistency, the relationship between diet and acne is uncertain. However, it has been shown that a high level of glycemic diet is associated with the worsening of acne vulgaris. A strong correlation has also been proposed between the use of milk, chocolate so salt and animprovementin the incidence of acne vulgaris. However, since they can be made with varying quantities of sugar, with or without milk, the contribution of chocolates is contested. A correlation

between acne and obesity has also been documented (Melnik B.C. 2011).

Sign and Symptoms of Acne:

Papules, nodules (large papules), seborrhea (increased secretion of oil sebum), comedones, pustules and scarring are included (Thappa D. et al., 2009). Acne appearance varies with skin tone and is also correlated with psychological and social issues (Dawson & Dellavalle., 2013).

Epidemiology:

Approximately 80 percent of young adults aged 12 to 24 years are affected by Acne vulgaris or popular acne. At 18 years of age, the incidence of acne increases and normally lasts for four to five years. 80 percent of adults aged 25 to 34 years and 3 percent of adults aged 35 to 44 years are affected by acne as well. Experts agree that acne supremacy Amon Golder individuals is growing, though the reasons for this remain unclear (Purdy & Berker., 2009).

Path physiology of Acne:

Four etiological factors are associated with acne patho physiology, including: increased sebum production, abnormal pilosebaceous duct keratization, follicular micro flora (Propionibacteriumacnes) colonization, and body inflammatory and immune response. The principal micro organ is mfoundin side the pilosebaceousg Landis Propionibacteriumacnes. Its function in acne pathogens is may be associated with its ability to generate and exist as a biofilm within the pilose baceousunit (JamesK.A.et al., 2009; Burkhart & Burkhart., 2003).

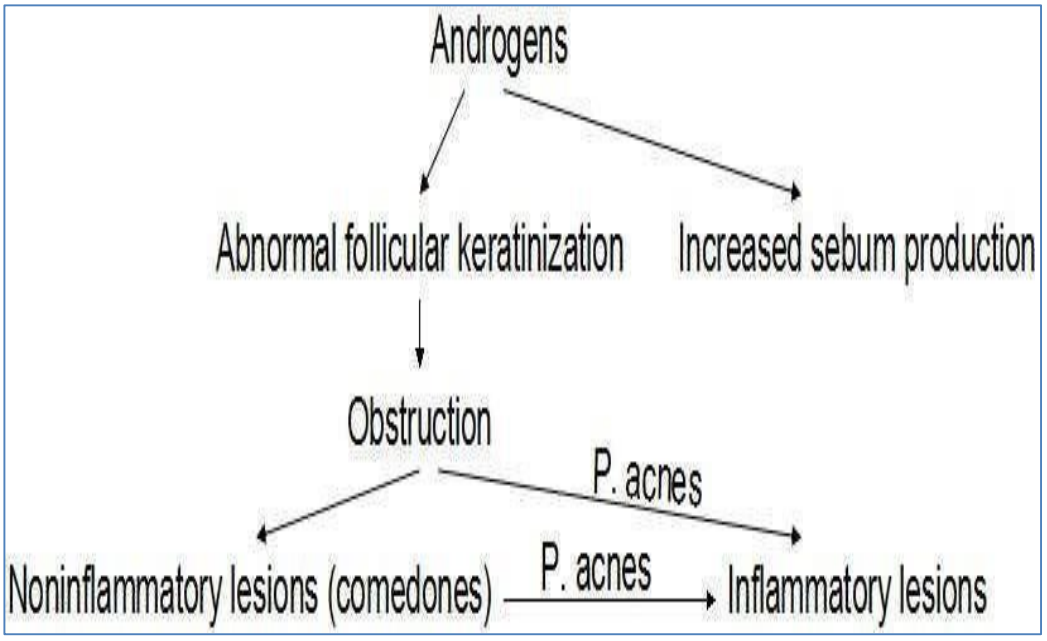


Figure1.4: Basic Mechanism Involves in the Acne Pathogenesis

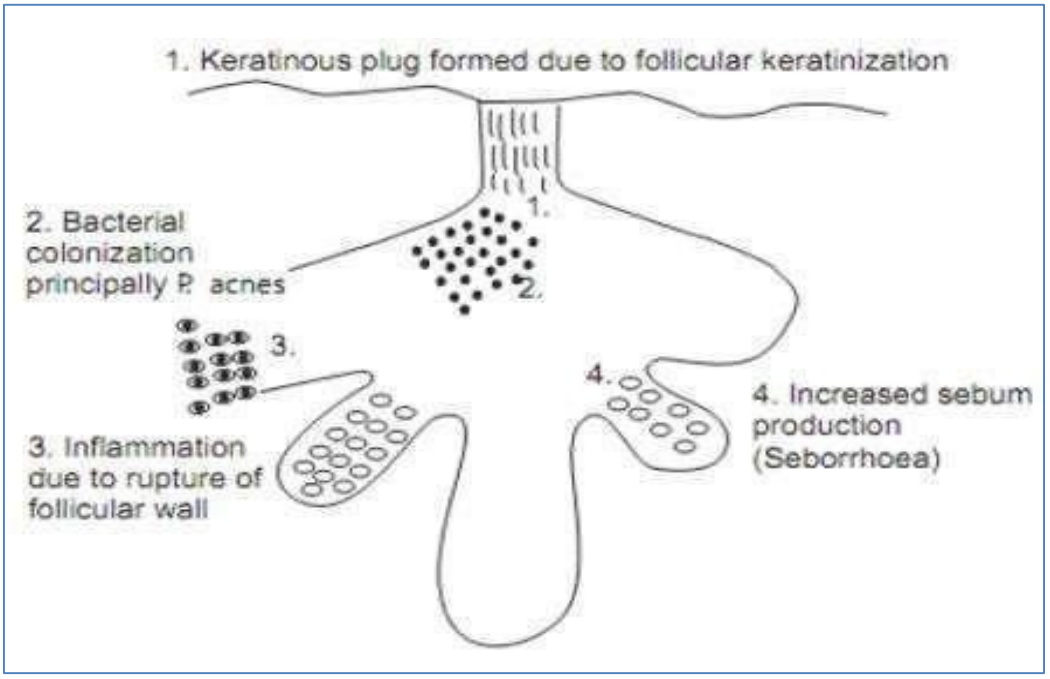


Figure1.5: Pathophysiology of acne involving sebaceous follicles

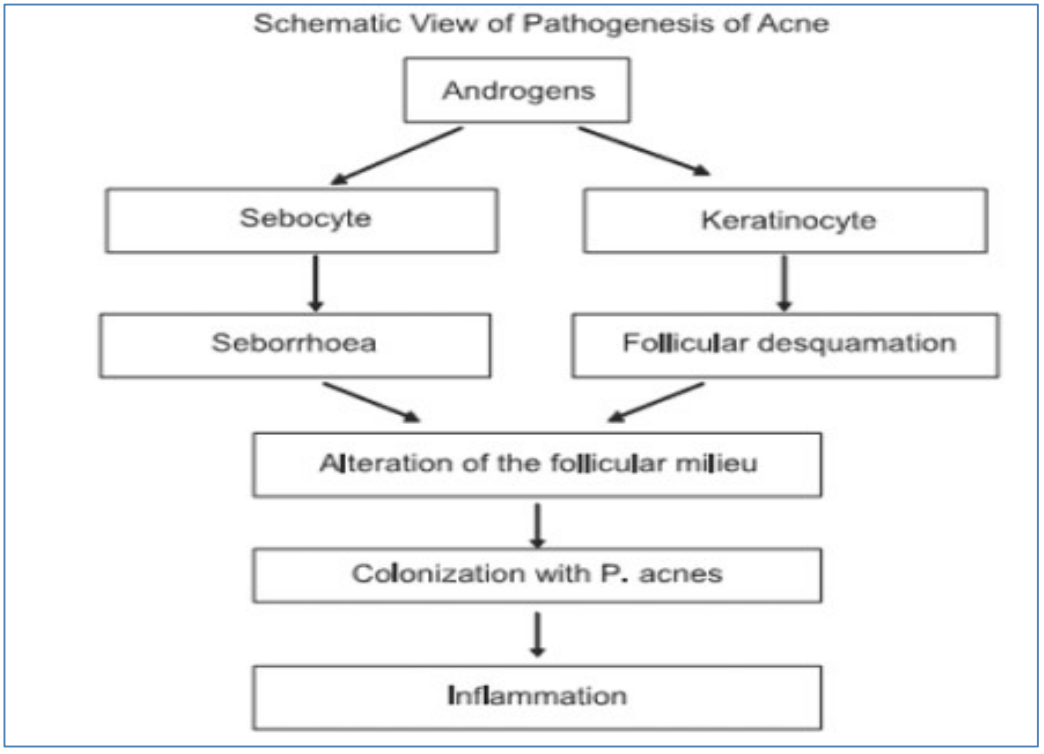


Figure1.6: Pathophysiology of acne involving sebaceous follicles

Treatment Available

Rewritten Text (Plagiarism-Free Version)

Comparative Approaches to Acne Treatment:

Allopathic vs. Traditional Medicine Overview of Treatment Paradigms

Contemporary acne management encompasses two primary therapeutic philosophies: the modern allopathic system and traditional medicine approaches. The fundamental difference between these methodologies lies in their treatment focus and underlying philosophy. Traditional medicine systems adopt a holistic approach, addressing the underlying causes of acne development, whereas allopathic medicine concentrates on managing visible symptoms such as inflammation and erythema. Modern medical interventions typically employ topical and systemic pharmaceuticals containing synthetic compounds and antimicrobial agents.

Efficacy and Limitations of Allopathic Treatments

While allopathic medications demonstrate considerable success in managing acne symptoms by reducing inflammatory responses and preventing new lesion formation, they frequently present significant tolerability challenges. Common adverse effects include skin irritation, gastrointestinal disturbances (nausea, vomiting), neurological symptoms (headaches, sedation), behavioral changes (aggressiveness), and motion-related discomfort. Additionally, compliance with natural treatment approaches can be challenging due to their extended treatment duration. Nevertheless, traditional medicine systems are experiencing increased demand due to their superior safety profile and minimal adverse effects (Pochi P. E., 1990).

Antibiotic Resistance: A Growing Concern

Antimicrobial therapy has been a cornerstone of acne treatment for decades. However, the dermatological community has observed an alarming increase in antibiotic resistance patterns. The development of resistance involves multiple factors, including the specific bacterial-antibiotic interaction mechanisms, antimicrobial usage patterns, host characteristics, and environmental influences. To address this challenge, researchers have extensively investigated medicinal plants as viable alternatives to conventional antimicrobial therapy. The primary objective is to develop safe and effective polyherbal formulations for comprehensive acne management (Kushwaha A. et al., 2017).

The Role of Herbal Medicine in Modern Healthcare

Historical Context and Holistic Approach

Medicinal plants have served as therapeutic agents for human ailments throughout history, contributing significantly to health maintenance and disease management through comprehensive healthcare approaches (Sen and Samanta, 2015). These botanical remedies, grounded in traditional theories, spiritual beliefs, and generations of indigenous wisdom, provide alternatives to costly allopathic treatments that may carry significant side effects. In economically disadvantaged and developing regions, where conventional medical care may be inaccessible or unaffordable, herbal remedies often serve as the primary healthcare resource (Khan and Ahmad, 2019).

Industrial Applications and Research Importance

The increasing commercial demand for plant extracts across cosmetic, food, and pharmaceutical industries highlights the critical need for systematic medicinal plant research (Talalay and Talalay,

2001). Through the identification and utilization of novel bioactive compounds, scientists strive to develop effective therapeutic interventions for diverse medical conditions. Furthermore, the emergence of pathogenic resistance to conventional
medications has rekindled interest in herbal remedies as alternative healthcare solutions (Dar et al., 2023).

Global Utilization and Cultural Acceptance

In developed countries, herbal medications are extensively utilized for primary healthcare, with approximately 80% of the worldwide population depending on these natural remedies. Their perceived efficacy, cultural acceptance, and minimal adverse effects contribute to their widespread popularity. Herbal medicines are considered more biocompatible with human physiology, as their chemical constituents closely align with natural biochemical processes (Karunamoorthi et al., 2013).

Traditional Medicine Systems and Scientific Validation

Ancient Knowledge and Modern Applications

Historical texts contain extensive knowledge regarding herbal treatments for various age- related conditions, including cognitive decline, bone disorders, diabetic complications, immunological diseases, and hepatic disorders. Countries like India maintain comprehensive traditional medical systems such as Ayurveda, Unani, and Siddha, offering complete healthcare frameworks encompassing diverse local therapeutic practices (Adams et al., 2007). Ayurveda alone documents over 8,000 herbal medicinal preparations, while Siddha, Ayurveda, Amchi, and Unani systems collectively prescribe approximately 2,700 therapeutic methods. Despite India's remarkable diversity of medicinal plants, only a small percentage has undergone scientific investigation (Babu, 2010).

Bioactive Compounds and Therapeutic Properties

Natural plant-derived compounds, including flavonoids, terpenes, and alkaloids, have attracted considerable attention for their medicinal properties, particularly their anti- inflammatory, antipyretic, analgesic, and wound-healing capabilities. The growing demand for herbal products has resulted in increased plant material volumes both domestically and internationally (Arora et al., 2023). Modern drug development frequently involves isolating active molecules from medicinal plants and purifying them for therapeutic applications. Many established pharmaceuticals, including strychnine, quinine, and taxol, originated from plant sources. Semi-synthetic drugs derived from natural products further demonstrate the medicinal potential of herbal compounds (Ramawat et al., 2009).

Healthcare Value and Future Prospects

Herbal medicines represent valuable healthcare resources, offering effective and often safer alternatives to conventional treatments. Continued research and development in this field hold significant promise for addressing numerous health challenges and improving global healthcare outcomes (Ekor, 2014).

Global Plant Resources and Pharmaceutical Applications

Biodiversity and Medicinal Utilization

Throughout human history, plants have served as essential resources for both nutrition and medicine, with approximately 250,000 species of higher plants evolving and thriving globally. Various cultures have utilized an estimated 35,000 to 70,000 organisms for medicinal purposes at different historical periods (Tuxill, 1999). In both developed and developing nations, herbal drugs play crucial roles in meeting healthcare requirements. Particularly in rural and impoverished communities, where access to conventional medical treatment may be restricted or prohibitively expensive, herbal medicines serve as the primary healthcare source (Payyappallimana, 2010).

Contemporary Interest and Market Demand

Recent years have witnessed a remarkable surge in herbal remedy interest, even in regions where mainstream medical services are readily accessible. This growing interest reflects a broader transition towards holistic and natural healthcare alternatives (Pan et al., 2014). Pharmaceutical processing of medicinal herbs represents a crucial aspect of modern medicine, with a substantial portion of the pharmaceutical industry relying on medicinal plants and herbal products. For example, in China, pharmaceutical demand for medicinal plants and their derivatives represented 33.1% of the industry in 1995. Similarly, Malaysia projects an annual demand of 1 billion Malaysian ringgit for conventional medicine. This underscores the enduring importance of herbal medicine in meeting global healthcare needs and highlights the potential for continued growth and innovation in this field (David et al., 2015).

World Health Organization Position on Herbal Medicine

WHO Recognition and Policy Framework

The World Health Organization (WHO) recognizes herbal medicines and their constituents as significant healthcare components across all Member States (Newall, 1996). In 1978, the WHO governing body, the World Health Assembly, adopted a Resolution on narcotics policy and medicinal plant management, acknowledging the pivotal role of medicinal plants in healthcare systems. Subsequent resolutions in 1987, 1988, and 1989 emphasized the necessity for efforts to recognize, assess, cultivate, and regulate medicinal plants (Tilburt and Kaptchuk, 2008).

WHO Guidelines and Recommendations

The WHO's position on herbal medicine, shaped by these resolutions, includes the following key points:

Resource Recognition: Herbal medicinal products are acknowledged as valuable and accessible resources that contribute to the health of a substantial portion of the global population.

Systematic Development: To promote proper utilization of medicinal plants, systematic programs for their development, assessment, training, and cultivation should be established, ensuring their recognition and utilization as beneficial resources.

Quality Assurance: Comprehensive inventory and review processes, including pre-clinical and clinical evaluations, are essential for medicinal plants. Quality monitoring measures, including modern methodologies, relevant standards, and good manufacturing practices, must be implemented

to govern herbal medicinal products effectively.

Integration: Herbal medications should be integrated into national guidelines or pharmacopoeias.

Conservation: Recognizing the extinction threat faced by many plants that provide conventional and novel medicines, the WHO advocates for international collaboration and coordination in establishing preservation systems for medicinal plants, ensuring adequate supply for future generations (Dias et al., 2012).
These principles underscore the WHO's commitment to promoting responsible and effective use of herbal medicines worldwide, while also safeguarding the preservation of medicinal plant resources for generations to come (Adams et al., 2004).

Plants that contain anti-acne compounds:

Plants with Anti-Acne Potential The drive to create strategies for acne treatment remains a significant focus in the pharmaceutical and personal care sectors (Kapoor & Saraf 2011). The prolonged use of antibiotics poses the risk of developing resistant bacteria, which is self- evident. The development of antibiotic resistance is multifaceted, involving the specific nature of the contact between bacteria and antibiotics (Chomnawang et al., 2005). Consequently, there are adequate reasons for exploring alternate medicines that effectively address and overcome these issues. To address antibiotic resistance and the elevated costs of therapy, medicinal plants have been investigated as alternative therapies for ailments. As an alternate method, multiple research have demonstrated the potential of utilizing medicinally strong plant actives to inhibit bacterial growth and inflammatory responses. Traditional herbal medicines offer a fascinating and mostly untapped resource for the creation of novel pharmaceuticals. Traditional therapies and natural products have significant potential in the discovery of bioactive lead compounds and their advancement into pharmaceuticals for the treatment of acne vulgaris. It was generally believed that certain plants possessed curative characteristics, including what we now recognize as antibacterial principles, even prior to humanity's understanding of the existence of germs. Common infectious diseases have been treated with plants, and some of these ancient medicines are still utilized today to address various ailments. Medicinal plants are rich in antimicrobial properties. A substantial array of phytoconstituents, including alkaloids (caffeine, theobromine), proteins, enzymes, carbohydrates, lipids, polyphenols, catechins (epicatechin, epicatechin-3-gallate, epigallocatechin, and epigallocatechin-3-gallate), tannins, vitamins, and minerals, has been documented in plants (Graham HN, 1992). The majority of the phytochemicals examined in acnewere belong to the polyphenol category, including resveratrol, myricitrin, schisandrin, terchebulin, alpha-mangostin, curcumin, ellagic acid, and epigallocatechin 3-gallate. Furthermore, alkaloids and terpenoids, including barberry, ursolic acid, and lupeol, were assessed in acne vulgaris with diminished prevalence. Various molecular mechanisms were implicated in the effects of phytochemicals, including antioxidant activity (via downregulation of H2O2, MDA, and ROS, and upregulation of SOD), anti-inflammatory effects (through the reduction of pro-inflammatory cytokines such as IL-1ß, IL-6, IL-8, TGF-β, TNF-α, and NF-κB), immunomodulation, antibacterial properties (against Propionibacterium acnes and Propionibacterium granulosum), antiandrogenic effects, reduction of sebum production, and inhibition of lipogenesis. Consequently, phytochemicals appear to be a valuable resource for

discovering novel treatments for acne vulgaris (Soleymani et al., 2020).

Medicinal Plants Used for the Treatment of Acne:

Tea Tree Oil:

Tea tree oil, also known as melaleucaoil, is amonoterpene-rich, lipophilic, essential oil obtained from the Australian plant Melaleuca alternifolia by steam distillation (Myrtaceae) (Carson C.F et al., 2002). In a number of superficial diseases, including acne, oral candidiasis, tinea, onychomycosis and molluscum contagiosum, clinical studies with tea tree oil products have shown efficacy (Carson C.F. et al., 2002;Markum & Baillie., 2013).



Figure1.7: Tea Tree

Neem:

Biological source: *Azadirachtaindica* Linn

Neem has been extensively utilized in Unani, Ayurveda, and homeopathic treatment, as well as in modern medicine, referred to as a "wonder tree" (Laxmi T et al., 2015). Chemical components like Azadirachtin, Nimbidin, Nimbinin, Gallic acid, Epicatechin, Margolone, and Catechin are reported to possess antioxidant, anti-inflammatory, and antibacterial properties, potentially offering an alternative treatment for bacterial acne (Matasyoh&Maiyo 2009).



Figure1.8: Neem Leaves

Mulethi

Biological name: *Glycyrrhiza glabra Linn*
Family: Leguminosae
It is frequently referred to as Mulethi. Licorice roots are particularly rich in flavonoids (Khare C. P. 2004). The root comprises 5-10 percent glycyrrhizin, glabridin, glbrene, and licochalcone, exhibiting antibacterial activity (Saeedi M, et al., 2003). It is utilized for skin irritation, acne, and sunburn in cosmetics (Ammosov & Litvienko, 2003).



Figure1.9: Mulethi

Green tea

Biological source: *Camellia sinensis*
Family: Theaceae
Three forms of flavanoids, known as kaempferol, quercetin, and myricetin, are additional components Commonly known as green tea, it contains several polyphenols such as epigallocatechin gallate (EGCG), epicatechin gallate, epicatechin, and various flavonoids (Khar & Mukhtar, 2013). Among these flavonoids, kaempferol, quercetin, and myricetin are notable constituents.



Figure1.10: Camellia sinensis

Barberry:

The primary active compound found in barberry is the alkaloid barberry, which is known for its anti-inflammatory, antibacterial, and anti-androgenic effects. Early research suggests that barberry may inhibit the cellular mechanisms involved in comedone formation associated with acne. Additionally, studies in animal models indicate that barberry can reduce sebum production by more than 60%. Laboratory analyses have also revealed that other barberry-derived alkaloids—berine and jatrorrhizine—possess antibacterial activity against various pathogens, including Propionibacterium acnes (P. acnes). When used appropriately, barberry is generally considered safe; however, excessive intake may lead to serious, potentially fatal toxicity. It is strongly advised that pregnant or breastfeeding women and newborns avoid barberry-containing herbs due to the risk of severe neonatal jaundice. Other herbs with barberry include goldenseal and yellow root. Although topical application of barberry may occasionally result in skin irritation, formulations containing barberry have been applied for up to 20 days in studies without significant side effects (Yarnell & Abascal, 2006).



Figure1.11: Barberry

Bittersweet nightshade (Solanum dulcamara):

Bittersweet nightshade has traditionally been used orally as a remedy for various skin disorders, including acne. Its stems contain steroidal alkaloids such as solasodine and soladulcine, which possess anti-inflammatory, astringent, and antimicrobial properties. Due to these effects, Germany's Commission E—the regulatory body for herbal treatments—has approved its use in topical formulations for acne. When used appropriately, the stems (not the leaves or berries) of bittersweet nightshade are generally regarded as likely safe for non- pregnant adults. However, oral consumption is not advised for children, pregnant, or breastfeeding individuals. Animal studies have linked the oral intake of these alkaloids to congenital abnormalities, and there is currently insufficient evidence to confirm the safety of topical use during pregnancy (Reuter et al., 2010).



Figure1.12: Nightshade

Brewer's yeast (Saccharomyces cerevisiae):

Brewer's yeast has demonstrated antimicrobial and immune-enhancing properties and is officially recognized by Germany's Commission E as a systemic treatment for acne. In clinical research, Saccharomyces boulardii, a strain of brewer's yeast, led to significant healing or marked improvement in acne symptoms in more than 80% of participants over a five-month period. Notably, no serious side effects were reported during the course of the study.



Figure1.13: Brewer's yeast

This strain of brewer's yeast is typically administered as a live, non-disease causing probiotic. Do not take Brewer's yeast if you take monoamine oxidase inhibitors (MAOIs) because it can cause increased blood pressure (Weber et al., 1989).

Burdock (Arctium lappa):

In Ayurveda bur dock is considere danalt ergative and cleansing herb, with antimicrobial and anti-inflammatory properties that may be beneficial for acne.



Figure1.14: Burdock

Chaste berry (Vitex agnus-castus):

Early studies indicate that burdock possesses antioxidant, anti-inflammatory, and antibacterial properties, and may also exert hormonal effects. In controlled animal experiments, burdock extract was shown to reverse skin cell hyperproliferation, a key feature in conditions such as acne and psoriasis. This therapeutic effect is thought to be linked to its high linoleic acid content. Low linoleic acid levels in sebum are associated with acne development, and clinical use of topical linoleic acid has been found to reduce the size of acne lesions. Thus, burdock's rich linoleic acid profile may make it a valuable agent in acne management (Fulton & James, 2010). While burdock root is generally regarded as likely safe, there is insufficient safety data for use during pregnancy or lactation. Additionally, individuals with allergies to plants in the Asteraceae family, such as ragweed, should avoid oral consumption due to the risk of allergic reactions.



Figure1.15: Chaste berry

Guggul (Commiphora mukul):

Guggul extract sapper to have anti-inflammatory and anti-bacterial properties that may benefit acne patients. Research suggests guggulipid reduces sebum secretion and blocks bacterial metabolism of triglycerides that promote the development facne. The cholesterol- lowering effects of guggul appear to work best when combined with a non-Western, Indian diet. Those patients with oily skin responded much better to the Guggul sterone treatment.



Figure1.16: Guggul

Early studies indicate that burdock possesses antioxidant, anti-inflammatory, and antibacterial properties, and may also exert hormonal effects. In controlled animal experiments, burdock extract was shown to reverse skin cell hyper proliferation, a key feature in conditions such as acne and psoriasis. This therapeutic effect is thought to be linked to its high linoleic acid content. Low linoleic acid levels in sebum are associated with acne development, and clinical use of topical linoleic acid has been found to reduce the size of acne lesions. Thus, burdock's rich linoleic acid profile may make it a valuable agent in acne management (Fulton & James, 2010). While burdock root is generally regarded as likely safe, there is insufficient safety data for use during pregnancy or lactation. Additionally, individuals with allergies to plants in the Asteraceae family, such as ragweed, should avoid oral consumption due to the risk of allergic reactions.

Saw palmetto (Serenoa Repens):

Saw palmetto is considered an anti- and rogenic substance because it inhibits the enzyme necessary to convert testosterone to dihydrotestosterone (DHT). DHT influences sebum production by the sebaceous glands, and lowering DHT levels may help reduce the excess oils that contribute to the development of acne. In fact, when excessive androgen hormones are suspected in acne cases (e.g., in females with polycystic ovary syndrome) herbal clinicians often Look to saw palmetto as a first-line regimen. Oral use of saw palmetto is generally considered safe. Based on one report of excessive bleeding during surgery in a patient who used saw palmetto, there is a concern that it may have anticoagulant properties. Those having elective surgery should discontinue use several weeks prior to any surgical procedure, and people on anticoagulant drugs (e.g. Aspirin and warfarin) should be cautious about using saw palmetto (Melnik et al., 2009). Saw palmetto is considered an anti- and organic substance because it

. Based on one report of excessive bleeding during surgery in a patient who used saw palmetto, there is a concern that it may have anticoagulant properties. Those having elective surgery should discontinue use several weeks prior to any surgical procedure, and people on anticoagulant drugs (e.g., aspirin and warfarin)should be cautious about using saw palmetto (Melnik et al., 2009).



Figure1.17: Saw Palmetto

MINT (Calamintha Graveolens)

Lemon balm, a perennial herb in the mint family, is widely used in aromatherapy, topical formulations, homeopathic remedies, and culinary applications. Research indicates that its essential oils contain bioactive compounds with antibacterial, calming, and sedative effects. When inhaled through aromatherapy, lemon balm vapors allow polyphenols to enter the lungs and cross the blood-brain barrier, where they help reduce anxiety by modulating neurotransmitters such as GABA. In addition to its calming properties, lemon balm may also support acne relief when consumed orally. Laboratory studies highlight its antioxidant activity, and animal research suggests that oral intake of lemon balm can lessen oxidative skin damage caused by high-fat diets. Furthermore, studies in rats have demonstrated that lemon balm can ease symptoms of anxiety and depression. These findings imply that lemon balm could mitigate both acne and associated mood disorders, particularly when oxidative stress and diet are contributing factors. However, dermatologists advise against applying peppermint oil topically, especially on sensitive or inflamed skin. Lemon balm should also be avoided by pregnant women and individuals with hypothyroidism. Due to its mild sedative effects, it should be used cautiously alongside other sedatives or alcohol, and it is recommended to discontinue its use at least two weeks prior to undergoing anesthesia (Naghibi et al., 2005).



Figure1.18: Mint plant

Willow Bark:

Willow bark contains salicin, a natural compound that is converted into salicylic acid by the liver. While salicylic acid shares a chemical relationship with aspirin—its acetylated form—it does not cause the same gastrointestinal irritation associated with aspirin use. The salicylic acid derived from salicin provides willow bark with its well-known antiseptic and anti-inflammatory properties, making it valuable in the treatment of acne. Classified as an alpha-hydroxybenzoic acid, salicylic acid not only reduces inflammation but also aids in dissolving comedones. Unlike water-soluble treatments, salicylic acid's fat solubility enables it to effectively penetrate the pilosebaceous unit, enhancing its effectiveness in targeting acne at its source.



Figure1.19: Willow Bark

When taken orally willow bark hasbeensafelyusedforupto12weeks.However, there is insufficient information to recommend its use in pregnant women. Lactating women should avoid using willow bark since it contains salicylates which have been linked to adverse side effects on nursing infants (Graber et al., 2010).

Some Herbal Drugs:

Latin binomials Common names

- Achillea mille folium flowering top Yarrow
- Aloe barbadensis gel Aloevera
- Arctium lappa root Burdock
- Artemisia absinthium leaf Wormwood
- Azardirachta indica leaf Neem
- Berberis vulgaris root Barberry
- Chamaelirium luteum root False unicorn
- Coptis chinensis root Goldthread
- Commiphora mukul resin Guggul
- Embelia ribes fruit Vidanga
- Curcumalongarhizome Turmeric
- Emblica officinalis fruit Amalaki
- Eucalyptus globules leaf Eucalyptus
- Eucalyptus maculate leaf Eucalyptus
- Eucalyptus viminalis leaf Eucalyptus
- Gentiana lutea root Gentian
- Hemidesmus indicus root Indian Saras parilla
- Holarrhena antidysenterica stem bark Kutaj
- Hydrastis Canadensis root Goldenseal

- Mahonia aquifolium root Oregon grape
- Medicago sativa flowering tops Alfalfa
- Melaleuca alternifolia leaf Tea tree
- Mitchella repens leaf Partridgeberry
- Ocimum basilicum leaf Basil
- Piper longum fruit Long pepper
- Scutellaria baicalensis root Asian skullcap, scute
- Serenoa repens fruit Saw palmetto
- Taraxacum officinale leaf and root Dandelion
- Terminalia chebula fruit Chebulic myrobalan
- Terminalia arjuna stem bark Arjun
- Verbena spp. Flowering tops Vervain
- Vitex agnus-castus fruit Chaste tree, vitex
- Xanthorrhiza simplicissima root Yellow root
- Zingiber officinale rhizome Ginger
- Withania somnifera root Ashwagandha

Topical and Systemic Treatment for Acne

A wide range of topical and systemic therapies are currently available for managing acne. Topical treatments commonly include antibiotics, comedolytic agents, and anti-inflammatory drugs, while systemic options often involve antibiotics, hormonal therapies, zinc supplements, and laser interventions. Despite significant advancements, the core of acne treatment has relied on pharmacological agents for over four decades.

Commonly prescribed topical and oral medications include clindamycin, salicylic acid, isotretinoin, erythromycin, triclosan, tetracycline, minocycline, and metronidazole. However, extended use of these drugs can lead to bacterial resistance, reducing their long-term effectiveness (Kumar et al., 2008). Although topical applications remain the first line of treatment, systemic therapies—such as isotretinoin, oral antibiotics, and contraceptive pills— are widely employed, particularly for moderate to severe acne (James, 2005).

Treatment strategies primarily aim to eliminate microcomedones—the early lesions in acne. Topical retinoids help prevent follicular hyperkeratinization by targeting keratinocytes in the hair follicle, thereby reducing comedone formation and inflammatory lesions by 40% to 70% (Haider & Shaw, 2004). They also inhibit the release of pro-inflammatory cytokines. However, adverse effects like erythema and skin scaling are common, especially in early use. Therefore, patients are often advised to begin with small doses, with optimal therapeutic outcomes typically observed after 12 weeks (Webster, 2002).

Toxicity and side effects—such as dry skin, nausea, and headaches—are additional limitations of existing treatments, underlining the urgent need for more affordable, safer, and sustainable options. In this context, plant-based and herbal remedies are gaining traction for their potential as future anti-acne agents (Kumar et al., 2008).

Among combination therapies, a gel containing adapalene 0.1% and benzoyl peroxide 2.5% has shown superior efficacy and a faster onset of action compared to monotherapies (Tan et al., 2011; Thiboutot, 2007). Benzoyl peroxide, however, must be used consistently, as its effects diminish after discontinuation. It does not reduce sebum production or significantly alter the follicular keratinization process (WebMD).

Salicylic acid, known for its keratolytic and antibacterial effects, helps clear blocked pores and promotes exfoliation of dead skin cells. Nonetheless, it may cause hyperpigmentation, particularly in individuals with darker skin tones (Benner & Sammons, 2013).

Tazarotene, a newer synthetic retinoid, is a prodrug converted into tazarotenic acid within keratinocytes. It influences epithelial cell proliferation and has anti-inflammatory properties. Though effective in acne management, it may also cause irritation in sensitive individuals (Akhavan & Bershad, 2004; Gollnick, 2003; Feldman et al., 2004).

2. REVIEW OF LITERATURE

Megha Pateletal2024 is prepared to gel extracts that were generated using a standardized manner. Various gel batches (G1–G5) were created using varying concentrations of Carbopol 934 and 1% alcoholic extracts of Centellaasiatica, Curcuma longa, and Terminalia arjuna. These formulations were tested for physical parameters such as pH, viscosity, spreadability, drug content, and in vitro release profile. Based on the evaluation results, batch G3, which included 1.2% Carbopol 934, was selected for additional antioxidant testing. Two more formulations (R1 and R2) were prepared for antioxidant testing, with 1% and 2% alcoholic extracts of the same herbs, respectively, and 1.2% Carbopol 934. In vitro antioxidant activity was measured utilizing the DPPH radical scavenging and ferric reducing antioxidant power (FRAP) assays.

Palak et al 2024 considerd three medicinal plants with strong anti-inflammatory potential Cynodondactylon (L.) Pers., Cassia toraLinn., and Cassia alata Linn. were chosen for this study and will be combined into polyherbal gel. The dried metabolic extracts of Cynodondactylon (L.) Pers., Cassia tora Linn, and Cassia alata Linn were used to create the gels. Studies on skin irritation, viscosity, spreadability, pH, and homogeneity of polyherbal gel formulations were assessed. Rat paw edema produced by formalin and carrageen an were used to measure the anti-inflammatory effects. In both acute and chronic settings, it was discovered that the individual and polyhedral gel of Cassiaalata Linn, Cacciatore Linn, and Cynodondactylon(L.) Pershadan anti-inflammatory effect. Comparing polyherbal gel to separate gels, which likewise demonstrated a synergistic effect.

In a study by **Anjali Chopade et al. (2024),** the primary objective was to formulate and evaluate a pharmaceutical gel for the treatment of mouth ulcers, also known as canker sores, utilizing the natural therapeutic properties of aloe vera, curcumin, and *Glycyrrhiza glabra*. The investigation into this herbal formulation was driven by the widely held belief that natural remedies offer a safer therapeutic alternative with fewer adverse effects compared to synthetic drugs. The study acknowledges the complex nature of these ulcers, which can be triggered by numerous factors such as food allergies, hormonal imbalances, poor dental hygiene, infections, and stress. Additionally, mechanical injuries and nutritional deficiencies, including a lack of iron, vitamin B12, or vitamin C, are also common culprits. To develop an optimal formulation, the researchers systematically tested varying concentrations of the active herbal extracts alongside essential excipients and preservatives, including Carbopol 934, PEG 400, and methyl paraben. To ensure the final product's safety and efficacy, the prepared gel underwent a comprehensive series of evaluations. These critical assessments included measuring key physicochemical parameters such as pH, viscosity, spreadability, mucoadhesive strength, and the in-vitro drug release profile.

Tastan Z. et al., (2024) conducted an investigation into the antioxidant activity and cytotoxic effects of *Aloe vera* gel on both the HepG2 liver cancer cell line and the L929 healthy fibroblast cell line. The cytotoxic potential was evaluated using the MTT assay, while the antioxidant capacity was determined through the total antioxidant status (TAS) and DPPH free radical scavenging methods. Their findings revealed a concentration- and time-

dependent cytotoxic effect on the HepG2 cancer cells, with mean IC50 values calculated to be 60.47 mg/mL at 24 hours and decreasing to 44.64 mg/mL at 48 hours. In contrast, the gel exhibited a proliferative or stimulatory effect on the healthy L929 fibroblast cells, showing the most significant impact at 48 hours with a calculated EC50 value of 21.98 ± 18.87 µg/ml. Furthermore, the antioxidant analysis determined the TAS value to be 0.2 mmol/L and the free radical scavenging activity to be 21.58 mg/mL. Based on these results, the authors concluded that *Aloe vera* gel's ability to exert a cytotoxic effect on cancer cells while simultaneously promoting the proliferation of healthy cells, combined with its antioxidant capacity, suggests its potential as a valuable supportive agent in therapeutic treatments.

P. Joyruth et al., 2024 conducted a comprehensive study examining the antimicrobial properties of aloe vera and its practical applications in medical contexts. Through preliminary phytochemical analysis of aloe vera gel powder, researchers identified multiple bioactive compounds including steroids, phenolic compounds, glycosides, alkaloids, flavonoids, saponins, and tannins. The research team performed in-vitro antibacterial testing using leaf extracts against clinically significant bacterial strains, specifically Bacillus subtilis and Candida albicans, employing the agar disc diffusion methodology for accurate assessment. The experimental design incorporated four distinct extract concentrations (25µl, 50µl, 75µl, and 100µl) to evaluate dose-dependent antimicrobial efficacy. The antibacterial assay findings demonstrated significant inhibitory effects against all examined pathogenic microorganisms, indicating the therapeutic potential of aloe vera extracts as natural antimicrobial agents for medical applications.

In a 2024 study, **Swapnil Shinde and ShrinivasMohite** explored the antipsoriatic potential of *Aloe vera* Linn gel. Their investigation began with the formulation of a polyherbal gel, which demonstrated favorable physical characteristics, including good homogeneity, spreadability, and high scores for extrudability (90%) and quality (80%). *In vitro* testing on HaCaT cell lines revealed that the herbal component had minor inhibitory effects when compared to the positive control, 5-fluorouracil (5-FU). More significant findings emerged from the *in vivo* assessment using the Perry scientific mouse tail method, where an aqueous extract of the gel (500mg/kg) resulted in a 59.26% improvement in orthokeratotic regions, showing significant therapeutic activity. Based on these results, the study concluded that *Aloe vera* Linn leaf extracts possess promising antipsoriatic functions, though the authors emphasized that further research is necessary to fully understand their complete therapeutic potential.

In a 2024 study by Phrompanya et al., researchers investigated the therapeutic potential of *Miliusavelutina* extracts, focusing on their antioxidant, anti-inflammatory, and antibacterial properties against acne-causing bacteria12. After preparing crude methanolic and aqueous extracts from the plant's leaves and stem bark through maceration, they found that the methanolic bark extract showed the most potent antioxidant effects, demonstrating a strong ability to scavenge ABTS and DPPH radicals and exhibiting significant iron-reducing power25. For anti-inflammatory activity, the methanolic leaf extract was the most effective, presenting the best ability to inhibit nitric oxide production with a half-maximal inhibitory concentration (IC50) of 7.20 ± 1.92 µg/mL2. Additionally, the study confirmed that *M. velutina* extracts possess broad antibacterial activity against several key acne-related

pathogens, including *Cutibacterium acnes*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, and methicillin-resistant *S. aureus* (MRSA), with minimum inhibitory and bactericidal concentrations ranging from 0.49 to 62.50 mg/mL

S. D. Panday et al. (2023) developed and assessed a novel polyherbal gel formulation incorporating hydroalcoholic extracts from Trigonellafoenum-graecum (fenugreek) and Glycyrrhizaglabra (licorice)1. The gel was prepared using Carbopol 934 and Sodium CMC as gelling agents, along with the herbal extracts, ethanol as a solvent, Propylene Glycol 400 as a humectant, methylparaben and propylparaben as preservatives, and distilled water to achieve the desired consistency1. To ensure skin compatibility, the pH was adjusted to a range of 6.8-7.0 through the careful addition of triethanolamine1. Evaluations included physical appearance, pH testing, spreadability, high-performance thin-layer chromatography (HPTLC) for chemical profiling, and skin irritation studies to detect any adverse reactions1. The gels demonstrated favorable visual appeal and uniformity, with spreadability results indicating easy application under low shear force1. Viscosity was measured using a Brookfield viscometer, revealing consistent rheological properties1. Formulation F4 emerged as optimal, showing superior spreadability, viscosity, and pH stability1. Accelerated stability testing confirmed that F4 retained a clear appearance with no notable changes in spreadability or pH, supporting its long-term viability1. As a result, the F4 variant, containing 0.3% hydroalcoholic extract of Trigonellafoenum-graecum and Glycyrrhizaglabra, was deemed the most promising due to its robust physicochemical characteristics1. This work aligns with broader research on polyherbal gels incorporating extracts like Glycyrrhiza glabra for potential therapeutic applications, such as wound healing or anti-inflammatory effects.

A comprehensive study was conducted by **Somnath S Davkhar and colleagues in 2023** to develop a multi-functional herbal cream designed to provide moisturizing, nourishing, whitening, and therapeutic benefits for various skin conditions. The research team carefully selected five basic drugs known for their therapeutic properties to formulate this innovative skincare product. The cream incorporated *Curcuma longa* (turmeric powder), *Carica papaya* (papaya), *Aloe barbadensis* (aloe vera leaves), *Azadirachtaindica* (neem leaves), and *Ocimum sanctum* (tulsi leaves). Each of these botanical ingredients was chosen for their established benefits in traditional medicine and their proven efficacy in skin care applications. The formulated cream underwent rigorous evaluation using various parameters to thoroughly assess its efficacy, safety, and overall therapeutic properties, ensuring that the final product met the required standards for topical skin care applications.

Patel Vani Jatinkumar et al. (2023) conducted a focused study in 2023 aimed at developing effective herbal digestive tablets using a combination of five well-established Ayurvedic herbs. The formulation included Nishoth, Curcumin, Cinnamon, Fennel, and Ginger, each selected for their traditional use in digestive health and their scientifically validated therapeutic properties. The tablets were manufactured using the wet granulation method, which is a standard pharmaceutical technique that ensures proper binding and uniformity of the active ingredients. Following production, the tablets underwent comprehensive evaluation against established standard parameters for oral tablet formulations. The research

findings demonstrated that the herbal digestive tablets successfully met all standard pharmaceutical requirements and exhibited satisfactory general characteristics including proper hardness, friability, and disintegration time. Additionally, the formula proved to be highly acceptable in terms of both taste and odor, making it suitable for patient compliance and indicating strong potential for large-scale commercial production.

Onuoha U. Nsofor et al. (2023) carried out a thorough examination to assess the antibacterial capabilities of Aloe vera gel extracts against multiple pathogenic bacteria, employing both water-based and alcohol-based extraction techniques. Their research highlighted clear variations in antibacterial performance, with the alcohol-derived extract displaying markedly stronger suppressive outcomes than the water-based version. In particular, the ethanolic extract produced the highest levels of inhibition against Escherichia coli (spanning 11.3±1.52 to 21.6±2.08), Pseudomonas aeruginosa (15.6±1.15 to 23.6±0.58), and Bacillus cereus (15.6±1.52 to 19.3±1.52), whereas the aqueous extract yielded lower inhibition for these same organisms, including E. coli at 8.6±1.24 to 13.3±1.53, B. cereus at 12.6±0.41 to 16.3±0.59, and P. aeruginosa at 11.51±1.00 to 17.7±1.52. Additional confirmation came from minimum inhibitory concentration (MIC) assessments, which indicated that the ethanolic extract was effective at lower levels of 6.25 to 12.5 mg/ml, compared to 12.5 to 25 mg/ml needed for the aqueous extract. In a similar vein, minimum bactericidal concentration (MBC) evaluations revealed that the ethanolic form achieved bacterial elimination at 12.5 to 25 mg/ml, while the aqueous required higher amounts of 25 to 50 mg/ml. Taken together, these detailed observations point to the ethanolic Aloe vera gel extract as a highly effective antibacterial option, offering substantial promise for use in medical therapies, beauty products, and food safety measures to counter a variety of disease-causing microbes affecting humans.

Ezugwu et al. (2023) examined the neuroprotective effects of aqueous Aloe vera extract in male adult Wistar rats subjected to nicotine-induced oxidative stress and hippocampal damage123. The study involved thirty rats weighing 185-222 g, divided into six groups of five each12. Group I served as the normal control receiving only food, Group II was administered 1.5 mg/kg nicotine, Group III received 120 mg/kg Aloe vera, Group IV was treated with 60 mg/kg Aloe vera plus 1.5 mg/kg nicotine, Group V received 120 mg/kg Aloe vera plus 1.5 mg/kg nicotine, and Group VI (standard) was given 25 mg/kg imipramine plus 1.5 mg/kg nicotine. Results showed a statistically significant increase ($p < 0.05$) in serum malondialdehyde (MDA) levels with decreased superoxide dismutase (SOD) and catalase in nicotine-treated rats without Aloe vera pretreatment, compared to those pretreated with Aloe vera or imipramine123. Aloe vera pretreatment significantly ($p < 0.05$) reduced MDA levels while elevating SOD and catalase. Histological evidence supported these biochemical changes, revealing preserved hippocampal structure in Aloe vera-treated groups versus damage in untreated ones. The authors concluded that Aloe vera's antioxidative properties likely contribute to hippocampal protection.

Emeka J. Iweala et al. (2023) reviewed the ethnomedicinal potential, phytochemical composition, and pharmacological activities of Curcuma longa (turmeric), drawing from in vitro and in vivo studies. The plant and its primary bioactive compound, curcumin, exhibit a

range of properties including anticancer, antidiabetic, anti-osteoarthritic, antidiarrheal, cardioprotective, antioxidative, neuroprotective, hepatoprotective, antimicrobial, renoprotective, and anti-inflammatory effects4. These benefits are linked to diverse bioactive compounds within C. longa, though the review notes that their full therapeutic potential remains underexplored for optimized drug development4. Additionally, the specific applications and mechanisms of action for individual compounds have not been thoroughly investigated, limiting their clinical translation**.**

Roshni Prajapati and Pallavi Rai (2023) explored the antifungal potential of Curcuma longa (L.) rhizome extracts against fungal pathogens Penicillium sp. and Fusarium sp. Their analysis demonstrated that the extracts exhibited clear inhibitory properties, with the rhizome samples showing the strongest effects. Notably, the maximum zone of inhibition was observed against Fusarium sp., where higher extract concentrations led to larger inhibition zones. The results underscored a direct relationship between concentration and efficacy, indicating that increasing the dose enhanced the antifungal impact. This suggests Curcuma longa could serve as a natural agent for controlling fungal growth in agricultural or medical contexts.

Ansong et al. (2023) developed and tested herbal-based gels for anti-acne purposes, incorporating plant extracts with confirmed phytochemical profiles. The extracts contained alkaloids, flavonoids, tannins, triterpenoids, and coumarins, which were analyzed for their role in antimicrobial activity. Using the microbroth dilution method, the minimum inhibitory concentrations (MIC) of both extracts and gels were determined against pathogens like Staphylococcus epidermidis, Staphylococcus aureus, Escherichia coli, Candida albicans, and Pseudomonas aeruginosa. The gels' physicochemical attributes—including homogeneity, color, texture, odor, grittiness, spreadability, extrudability, viscosity, pH, and drug content—were thoroughly assessed, showing generally positive results. A standout formulation was the 5% Aloe vera-Allium cepa (1:1) combination gel, which displayed excellent activity with MIC values of 12.50 mg/mL against S. epidermidis, 25.00 mg/mL against S. aureus, 6.25 mg/mL against E. coli, 25.00 mg/mL against P. aeruginosa, and 12.50 mg/mL against C. albicans. The study concluded that the phytochemicals in these extracts drive the gels' antimicrobial effects, positioning them as viable options for acne treatment in cosmetics and medicine.

Mishra et al. (2023) investigated the anti-acne potential of Cassia angustifolia leaf extracts, identifying various phytochemicals such as flavonoids and phenols as key contributors to its efficacy. The research measured acne-like inflammation through ear thickness in an experimental model, where ethanolic extracts significantly reduced swelling. This reduction was attributed to the extracts' ability to counteract biochemical mediators like kinins, histamine, and 5-HT that trigger inflammation and increased thickness. The presence of these bioactive compounds in the hydroalcoholic extracts confirmed notable anti-acne effects, suggesting Cassia angustifolia as a promising natural remedy for inflammatory skin conditions.

Asnaashari et al. (2023) evaluated various useful natural sources for the prevention and treatment of acne vulgaris. The application of plant oils and aromatherapy holds significant

potential, making it important to investigate the identification and purification of active components that demonstrate excellent anti-acne properties, as well as to elucidate the mechanisms underlying their actions.

Summary of Recent Studies on Plant-Based Antimicrobial and Therapeutic Agents

This report synthesizes findings from several 2022-2023 studies on the antimicrobial, antifungal, and pharmacological properties of various plant extracts and formulations. It covers anti-acne gels, polyherbal preparations, Aloe vera's effects on fungi and skin health, and broader medicinal applications. Each section rephrases the original research for clarity, incorporating key results and implications.

Anti-Acne Gel Formulation from Bidara Arab Leaves

Asri and Safitri (2023) developed an innovative gel dosage form using ethanolic extract from Bidaraarab leaves and tested its antibacterial activity against Propionibacterium acnes, a common acne-causing bacterium. The gel was formulated to optimize stability and efficacy, with evaluations focusing on physical properties and inhibitory effects. Results demonstrated that the preparation effectively suppressed bacterial growth, suggesting its potential as a natural anti-acne treatment. The study concluded that such herbal gels could serve as safe alternatives to synthetic products, particularly for skin conditions driven by microbial overgrowth.

Table 1: Key Outcomes of Bidara Arab Leaf Gel against P. acnes

ASPECT	FINDINGS	IMPLICATIONS
Formulation Stability	Optimized for gel consistency	Ensures long-term usability
Antibacterial Efficacy	Significant inhibition of growth	Potential for acne management
Safety Profile	No reported irritation	Suitable for topical application

Ranjith Kumar Pasuparthi et al. (2022) prepared and evaluated a polyherbal formulation based on VedanasthapanaGana, as described in the Charaka Samhita (fourth chapter of Sutra Sthana). The mixture included ingredients such as Shala, Katphala, Kadamba, Padmaka, Mocharasa, Tumba, Shirisha, Ashoka, Vanjula, and Elavaluka. Qualitative phytochemical tests identified the presence of sugars, proteins, alkaloids, flavonoids, and tannins. Thin-layer chromatography (TLC) confirmed the abundance of these compounds, validating the formulation's chemical richness. This work highlights the potential of ancient Ayurvedic recipes in modern herbal medicine, emphasizing their diverse bioactive components.

Bhatnagar Nupur et al. (2022) assessed the antifungal properties of Aloe vera gel using ethyl acetate and methanol extracts against Aspergillus species. Fungi were isolated on potato dextrose agar and identified through morphological and biochemical tests. Gas chromatography-mass spectrometry (GC-MS) analyzed the gel's chemical composition in both extracts. The methanol extract yielded higher amounts of active compounds and showed greater inhibition of fungal growth, as measured by the colony-forming unit (CFU) method, compared to the ethyl acetate version. The authors recommended additional research on Aloe vera with alternative solvents to explore its role as a pharmacological agent in treating fungal

infections.

Aisha Saleem et al. (2022) reviewed the skin benefits and broader pharmacological effects of Aloe vera gel. It is widely used in cosmetics as a moisturizer, in toothpastes for flavoring, and as a preservative for fresh produce. The gel serves as an active ingredient in lotions, sunscreens, and other products, offering treatments for wounds, burns, insect stings, and skin inflammation. Its properties include anti-inflammatory, antiseptic, antimicrobial, antitumor, skin-protective, antidiabetic, antibacterial, and antiviral effects, all vital for wound healing. Additionally, Aloe vera promotes new hair growth by enhancing scalp blood circulation and supplying essential minerals and vitamins, making it a versatile natural remedy.

Raichurkar Amruta et al. (2022) conducted a review on the medicinal attributes of Aloe vera, emphasizing its extensive therapeutic potential. The plant contains numerous bioactive compounds contributing to antibacterial, antioxidant, anti-inflammatory, anti-helminthic, antiseptic, aphrodisiac, and antimicrobial effects. Through exploration of pharmacological and biological activities, the study consolidated evidence of Aloe vera's beneficial roles in health care, including cosmetic applications. This underscores Aloe vera's value as a multifaceted natural resource for various medical and wellness purposes.

Zhang et al., 2022 investigated the bioactivities of O. basilicum L. water extract (OBWE) for its application in anti-acne cosmeceutical. The inhibition zone of OBWE to Cut bacterium (C.) acnes was18.71 mm diameter, which was significantly larger than10.87 mmof0.1%salicylicacid. Thus, OBWE showed two-fold benefit for acne treatment by inhibiting proliferation of C. acnes and suppressing the bacterial- induced in Flammarion. In summary, results suggested OBWE as natural product with potential anti-acne effects.

Silvaetal.,2022 evaluated the photo protective, antioxidant, anti-glycation, and anti-acne Activiti esofcru deextract (CESs) and triter penesapon in fraction(TSSs) of Sapindussaponaria. Sapindussaponaria fruit extracts show strong antioxidant potential and ant glycation activity against bovine serum albumin glycation and AGE formation. Besides, the ypresentedantib acterialactivity against Cut bacterium acnes and photoprotective effect against UV-A and UV-B.

Masdar et al. (2022) explored the antibacterial effects of Swietenia macrophylla seed oil, which is abundant in bioactive compounds, targeting acne-associated bacteria such as Propionibacterium acnes, Staphylococcus aureus, and Staphylococcus epidermidis. Seed powder was processed via Soxhlet extraction using three different solvents over a six-hour period with ten cycles to obtain the oil. The extracts underwent gas chromatography-mass spectrometry (GC-MS) for compound identification and disc diffusion assays to measure antibacterial activity. Additionally, inductively coupled plasma-optical emission spectroscopy (ICP-OES) was employed to analyze heavy metal content, ensuring the oil's safety for potential use. Results indicated bioactive compound yields ranging from 37% to 72%, with eugenol and isoeugenol emerging as the primary constituents at 98% and 97% purity levels, respectively. These compounds exhibited strong inhibitory effects against all tested bacteria, producing zones of inhibition between 11 and 22 mm when compared to 30 µg tetracycline control discs. Even without further isolation, the compounds maintained

effective inhibition, with zones spanning 11 to 21 mm across the bacterial strains. The study underscores the oil's concentration-dependent antimicrobial activity, suggesting its viability as a natural alternative for combating skin infections.

Dalavi et al., 2022 work aimed were produce to development and evaluation of the herbal antiacne gel containing extract of root of radish (Raphanus sativus L.), turmericisa antibacterial agent, sandal wood as flavoring agent, lemon juice as a preservative, honey as humectant through to make pure herbal formulation. The plants have been described in literature having good anti-acne, anti-microbial, anti-oxidant, antiseptic,and anti-inflammatory activity. Prepared formulation was evaluated for numerous parameters like colour, appearance, pH, stability studies, biological activities. It wasvery great attempt to begin the herbal anti acne face wash contain extracts of herbal products.

Arti Jain et al. (2022) conducted a comprehensive review on the anti-infective properties of the *Ocimum sanctum* (Tulsi) plant, with a specific emphasis on its antibacterial and antifungal activities. Relevant literature was retrieved from major scientific databases including PubMed, Scopus, and Web of Science. Out of an initial pool of 350 publications, 27 articles were selected through a combination of online searches and snowballing techniques. Among these, 20 were original research articles and 7 were systematic reviews. Each study was critically evaluated for the quality of reporting, and the findings were synthesized using descriptive analysis.Given the high incidence of bacterial infections in developing nations such as India—compounded by the rise of multi-drug resistant (MDR) pathogens—there is an urgent need to identify alternative preventive and therapeutic options. The study underscores the untapped antimicrobial potential of bioactive phytochemicals present in traditional medicinal plants like Tulsi, proposing them as viable alternatives in the management of infectious diseases.

Suraj Kishan Ghodke et al. (2021) aimed to develop a gel formulation incorporating herbal ball extracts for improved and user-friendly application in acne treatment. The herbal ball was composed of the traditional Benchalokawichian remedy along with stem bark powder.

Following steaming and manual extraction, the herbal ball extract was incorporated into carbomer-based gels at concentrations of 0.1%, 1%, and 5% w/w.The extract demonstrated notable antioxidant and antimicrobial properties, with the 5% w/w gel formulation exhibiting significant antibacterial activity against *Propionibacterium acnes* as indicated by a measurable inhibition zone. These findings suggest that the gel-based delivery system not only retains the efficacy of the traditional herbal preparation but also offers enhanced practicality and convenience in clinical and personal care settings.

Rahul R. Borsle et al. (2021) formulated and evaluated an herbal anti-acne gel using ethanolic extracts of *Azadirachtaindica* (Neem) and *Allium sativum* (Garlic). Three formulations (F1, F2, F3) were developed using Neem, Garlic, and their combination. These were assessed based on physical appearance, pH, drug content, spreadability, extrudability, and anti-acne efficacy against *Staphylococcus aureus*. Among all, formulation F3—containing the combined extracts—was found optimal across parameters, demonstrating a synergistic antimicrobial effect. The results confirmed the potential of combined Neem and

Garlic extracts in treating *Acne vulgaris* effectively.

Sachin Jalindar Fartade et al. (2020) developed a polyherbal handwash gel incorporating extracts from *Manilkarazapota*, *Trigonellafoenum-graecum*, and *Carica papaya* seeds, aiming to provide a safer alternative to synthetic antimicrobials. Antimicrobial efficacy was evaluated using the disc diffusion method against common skin pathogens. The formulated herbal gel outperformed commercial antiseptic soaps in microbial reduction. In vitro evaluations confirmed the gel's superior cleansing capability and minimal side effects, establishing it as a promising herbal antiseptic agent.

Puja Saha et al. (2021) focused on the formulation and evaluation of a polyherbal cosmetic cream with *Krishna Tulsi* as the primary active ingredient. Five oil-in-water (O/W) cream formulations (F1–F5) were developed using varying concentrations of stearic acid, cetyl alcohol, lanolin, propylene glycol, and potassium hydroxide. The formulations were assessed for pH, stability, spreadability, and antimicrobial efficacy. Notably, F2 and F3 displayed no signs of irritation, redness, or inflammation during irritancy tests. The study concluded that polyherbal creams are safer than synthetic alternatives and offer added benefits such as antioxidant activity and skin protection.

Jose Elseena et al. (2021) reviewed the biological activities of *Aloe vera* (*Aloe barbadensis Miller*), a well-known medicinal plant from the Liliaceae family. Aloe vera gel and latex contain bioactive polysaccharides responsible for numerous therapeutic effects, including wound healing, burn relief, anti-inflammatory, antidiabetic, anticancer, and antioxidant properties. Its applications span pills, ointments, drinks, and sprays. The review highlights Aloe vera's potential in managing various health conditions, such as skin disorders, diabetes, cancer, and gastrointestinal issues.

Riyanto and Wariyah (2021) investigated the antioxidant stability of instant Aloe vera powder during storage. The Aloe extract, reconstituted at a 1:120 ratio with 2.5% maltodextrin, was processed via spray drying. Samples stored in polyethylene packaging were tested weekly for moisture content and antioxidant parameters including DPPH radical scavenging activity (RSA) and lipid peroxidation inhibition. RSA declined from 16.34% to 3.63%, while lipid peroxidation inhibition dropped from 39.33% to 22.31% over 12 weeks. The study recommended a 12-week shelf life under controlled conditions for optimal antioxidative efficacy.

Fareeha Iqbal and Ambreen Ahmed (2021) explored the antibacterial properties of *Aloe vera* ethanolic extract and its fractions. The methanol, aqueous, and dichloromethane fractions demonstrated significant antibacterial activity. Qualitative and quantitative phytochemical analyses confirmed the presence of phenolics, flavonoids, and alkaloids, which contribute to its therapeutic potential. The results support *Aloe vera*'s use as a natural antimicrobial agent with broad-spectrum efficacy.

Thi Sinh Vo et al. (2021) reviewed the chemical constituents and clinical applications of *Curcuma longa* (Turmeric), particularly focusing on curcumin, its principal polyphenol.

Despite curcumin's documented biological activities—such as anti-inflammatory, anticancer, and antioxidant effects—its clinical use is limited due to bioavailability issues. Nonetheless, ongoing studies advocate its integration into therapeutic applications, suggesting that with appropriate dosing and formulation, curcumin can serve as a potent agent in disease management.

Nafiu M. Wada et al. (2021) assessed the antimicrobial activity of ethanolic and aqueous extracts of *Curcuma longa* (Turmeric) and *Allium sativum* (Garlic) against clinical bacterial isolates. Phytochemical screening confirmed the presence of steroids, flavonoids, terpenoids, alkaloids, anthraquinones (only in turmeric), tannins, and saponins (in garlic). Garlic's ethanolic extract exhibited inhibition zones of 12 mm (*S. aureus*), 10 mm (*E. coli*), and 7 mm (*K. pneumoniae*). Similarly, turmeric extracts also demonstrated significant antibacterial activity. Combined extracts proved effective against both Gram-positive and Gram-negative bacteria, supporting their use as potent natural antimicrobials.

Rahul R. Borsle et al. (2021) conducted a study aimed at formulating and evaluating a herbal anti-acne gel comprising ethanolic extracts of Neem (*Azadirachtaindica*) and Garlic (*Allium sativum*). Three formulations—F1, F2, and F3—were developed using Neem, Garlic, and their combination. These formulations were assessed on parameters such as physical appearance, pH, drug content, spreadability, extrudability, and anti-acne activity against *Staphylococcus aureus*. Among the tested batches, F3 demonstrated optimal results across all parameters, indicating that the synergistic effect of Neem and Garlic extracts holds promise in treating acne vulgaris.

Sachin Jalindar Fartade et al. (2020) focused on the development of a herbal handwash utilizing extracts of *Manilkarazapota*, *Trigonellafoenum-graecum*, and *Carica papaya* seeds. The formulated polyherbal gel was evaluated for its antimicrobial efficacy using the disc diffusion method and was benchmarked against a commercial antiseptic product. The results demonstrated superior antimicrobial efficiency of the herbal gel, along with a favorable safety profile, supporting its use as a potent and less harmful alternative to synthetic antiseptics.

Puja Saha et al. (2021) explored the formulation and evaluation of a polyherbal cosmetic cream incorporating Krishna Tulsi as a key bioactive. The formulations (F1 to F5) were oil-in-water emulsions, prepared with varying concentrations of stearic acid, cetyl alcohol, lanolin, propylene glycol, and potassium hydroxide. Evaluations included pH, stability, spreadability, and antimicrobial activity. Formulations F2 and F3 exhibited no signs of skin irritation and showed improved stability, suggesting that polyherbal creams can serve as safe and effective alternatives to synthetic cosmetic products.

Jose Elseena et al. (2021) presented a comprehensive review on *Aloe vera* and its biological activities. Known for its historical medicinal usage, *Aloe barbadensis miller* (commonly known as *Aloe vera*) is recognized for its wound healing, anti-inflammatory, and anti-diabetic properties. The biologically active components, mainly polysaccharides found in the leaf gel, confer a wide spectrum of therapeutic effects, including antioxidant, anti-cancer, and

immunomodulatory activities. The plant's applications span across various pharmaceutical and cosmetic domains.

Riyanto and Wariyah (2021) investigated the stability of the antioxidant properties of instant *Aloe vera* during storage. The aloe gel was reconstituted with water, mixed with 2.5% maltodextrin, and processed using spray drying. Samples were stored at 25°C and 75% RH, and antioxidant activities were monitored weekly via DPPH radical scavenging assay. Initially, the formulation exhibited high radical scavenging and lipid peroxidation inhibition activities, which gradually decreased, stabilizing at a moisture content of 12%. The study concluded that the optimized shelf life of instant *Aloe vera* is approximately 12 weeks when stored in 0.08 mm polyethylene packaging.

Fareeha Iqbal and Ambreen Ahmed (2021) conducted phytochemical and antibacterial evaluations of ethanolic and fractionated extracts of *Aloe vera*. Methanolic and aqueous fractions demonstrated significant antibacterial activity. The phytochemical screening confirmed the presence of phenolics, flavonoids, and alkaloids across various extract fractions. The findings endorse the potential use of *Aloe vera* extracts in herbal remedies for microbial infections.

Thi Sinh Vo et al. (2021) reviewed the chemical composition and therapeutic applications of turmeric (*Curcuma longa*), emphasizing the pharmacological potential of curcumin. Despite its proven biological efficacy in animal models—such as anti-inflammatory, anti-cancer, and antioxidant activities—its clinical application remains limited due to bioavailability concerns. However, with ongoing research, curcumin and turmeric extracts continue to demonstrate immense potential for future medical innovations.

Nafiu M. Wada et al. (2021) assessed the antimicrobial efficacy of turmeric (*Curcuma longa*) and garlic (*Allium sativum*) extracts against clinical bacterial isolates. Both ethanolic and aqueous extracts displayed notable antibacterial properties, particularly against *Staphylococcus aureus, Escherichia coli*, and *Klebsiella pneumoniae*. The phytochemical profile of these extracts revealed constituents such as steroids, flavonoids, terpenoids, tannins, and alkaloids. The study highlighted that individual and combined forms of turmeric and garlic possess effective broad-spectrum antibacterial activity, supporting their application as natural antimicrobial agents.
Below is the professionally rewritten, paragraph-wise summary of the cited studies for inclusion in a scientific review or academic document:

Santhosh Kumar et al. (2011) investigated the immunomodulatory activity of saline extracts derived from the leaves of *Aloe vera* Linn. The extract was orally administered to mice, with dosage calibrated to their body weight. The study evaluated both specific and non-specific immune responses, particularly under conditions of immunosuppression induced by pyrogallol. Results demonstrated that the *Aloe vera* extract significantly attenuated the suppression of humoral and cell-mediated immunity. The immunostimulatory efficacy was comparable to that observed in the Vitamin E-treated control group. Additionally, administration of *Aloe vera* extract at a dose of 100 mg/kg significantly suppressed delayed-

type hypersensitivity reactions induced by sheep red blood cells (SRBCs) and increased haemagglutination titers, indicating enhanced antibody production. Preliminary phytochemical screening revealed the presence of alkaloids, which are likely contributors to the observed immunostimulatory effects. The findings affirm the potential of *Aloe vera* as a dual-acting immunomodulator with both specific and non-specific immune enhancement properties.

Saritha V. et al. (2010) examined the antioxidant and antibacterial efficacy of various *Aloe vera*gel extracts prepared using solvents such as methanol (MEAG), 95% ethanol (EEAG), hexane (HEAG), acetone (AEAG), and chloroform (CEAG). The antioxidant activity was assessed using multiple in vitro assays, including DPPH radical scavenging, superoxide anion neutralization, metal ion chelation, reducing power evaluation, hydroxyl radical scavenging, and total antioxidant capacity in a linoleic acid emulsion system. Notably, MEAG and AEAG exhibited strong iron chelation capacity, and AEAG demonstrated superior reducing power relative to MEAG. The antibacterial efficacy of the methanolic gel extract was tested against a spectrum of pathogenic bacterial strains, showing significant zones of inhibition comparable to conventional antibiotics. These findings highlight the potential of *Aloe vera* gel extracts as a novel source of natural antioxidants and antibacterial agents suitable for application in food preservation and pharmaceutical formulations.

S. Neha et al. (2009) conducted a pharmacological evaluation to determine the analgesic and antipyretic properties of rhizome extracts of *Curcuma longa* in Wistar rats. Both aqueous and alcoholic extracts were administered orally at dosages of 100 and 200 mg/kg over a seven-day treatment period. The analgesic efficacy was assessed through reaction time measurements, which showed statistically significant improvements ($P < 0.05, 0.01$) relative to baseline and were comparable to the standard drug analgin (10 mg/kg). However, the extracts did not significantly reverse brewer's yeast-induced pyrexia, suggesting limited antipyretic efficacy. Solvent extraction yielded approximately 20% of the total mass, with the extracts displaying dark brown to reddish-brown coloration and varying in consistency from solid to semi-solid. The findings support the potential analgesic utility of *Curcuma longa* rhizome extracts.

Ramachandra and Srinivasa Rao (2008) conducted an in-depth study on the processing methods of *Aloe vera* leaf gel, given the increasing commercial interest in its pharmaceutical and nutritional benefits. Although *Aloe vera* is widely acclaimed for its medicinal properties, the study noted that most end-products contain minimal amounts of active constituents due to suboptimal processing techniques. The review emphasized the need for adopting standardized, scientifically validated processing methodologies to retain the bioactivity of the gel. Furthermore, the authors advocated for intensified research to demystify the full spectrum of *Aloe vera*'s biological activities and ensure its effective exploitation in health and wellness sectors.

3. AIM & OBJECTIVE

Acne vulgaris, commonly referred to as acne, is a widespread dermatological condition affecting millions globally, and it is classified among the most prevalent infectious disorders of human skin. This condition is characterized by a diverse range of lesions that include seborrhea (scaly, reddened skin), non-inflammatory comedowns such as blackheads and whiteheads, and inflammatory papules, pustules, nodules, and, in severe cases, cysts and scarring. These manifestations primarily occur due to functional and structural changes in the pilosebaceous unit, which consists of hair follicles and their associated sebaceous glands. Acne typically arises during adolescence due to hormonal fluctuations but can persist or emerge in adulthood, particularly under the influence of genetic, environmental, hormonal, dietary, or lifestyle-related factors.

There are two predominant therapeutic systems used in the management of acne: modern allopathic medicine and traditional systems of medicine. The allopathic approach primarily targets the outward symptoms of acne, such as inflammation, bacterial colonization, and excessive sebum production. This system employs a variety of pharmacological agents, including comedolytic substances (e.g., retinoids), antimicrobial agents (such as tetracycline, clindamycin, and erythromycin), anti-inflammatory drugs, hormonal treatments (including oral contraceptives and anti-androgens), and mineral-based adjuncts like zinc. These agents function either by reducing bacterial load (especially *Cutibacterium acnes*), modulating inflammatory pathways, or regulating sebaceous gland activity. However, despite their efficacy, the prolonged or indiscriminate use of these pharmacological interventions, particularly antibiotics, has led to the emergence of resistant bacterial strains. This growing issue of antimicrobial resistance significantly diminishes the long-term effectiveness of conventional therapies and presents a substantial challenge in acne management. Furthermore, the extended administration of systemic drugs may result in a spectrum of adverse effects including, but not limited to, autoimmune conditions such as lupus erythematosus, serum sickness-like reactions, hepatotoxicity, hyperpigmentation of the skin, and drug-induced pneumonitis, particularly affecting the alveolar structures.

In contrast, traditional systems of medicine—encompassing Ayurveda, Siddha, Unani, and other ethnomedicinal frameworks—have garnered increasing attention due to their holistic and patient-centric approach to disease management. These systems aim to address the underlying causes of acne, rather than merely treating surface-level symptoms. Traditional remedies, especially those derived from medicinal plants, focus on rebalancing the internal physiological processes believed to contribute to acne formation, such as detoxifying the blood, regulating hormonal imbalances, and strengthening the digestive and immune systems. One of the most compelling advantages of traditional medicine lies in its affordability, minimal side effect profile, and cultural acceptability among patients. The

The rapeutic agents used are typically in the form of decoctions, powders, oils, or pastes prepared from herbal, mineral, and occasionally animal-derived ingredients. They are often multifunctional, offering antibacterial, anti-inflammatory, antioxidant, and immunomodulatory effects simultaneously.

In recent years, medicinal plants have emerged as promising alternatives or complementary options for acne treatment, particularly in addressing the limitations associated with allopathic therapies. The resurgence of interest in phytotherapy stems from a need to discover safer, sustainable, and more effective solutions to combat both the symptoms and root causes of acne. Numerous studies have demonstrated the antimicrobial potential of plant extracts against acne-associated pathogens, as well as their efficacy in modulating inflammatory responses and reducing sebum production. Furthermore, herbal formulations are less likely to induce microbial resistance and systemic toxicity. Plants such as *Azadirachtaindica* (neem), *Curcuma longa* (turmeric), *Aloe vera*, *Ocimum sanctum* (tulsi), and *Melaleuca alternifolia* (tea tree) have shown significant anti-acne potential in preclinical and clinical studies. These botanicals exhibit a range of bioactive compounds like flavonoids, alkaloids, saponins, and phenolics that contribute to their therapeutic effects.

Given the limitations of conventional treatments and the advantages posed by plant-based alternatives, the development of standardized polyherbal formulations presents a viable path forward in acne management. Polyherbalism—the strategic combination of multiple plant extracts—offers synergistic effects, wherein the combined therapeutic activity exceeds the sum of individual components. This multi-targeted approach is particularly suitable for acne, a multifactorial disorder involving microbial, inflammatory, and hormonal components. Moreover, integrating scientific validation techniques such as in vitro assays, clinical trials, and phytochemical standardization with traditional knowledge can enhance the credibility and acceptance of herbal acne therapies in the broader healthcare community.

The primary objective of current research initiatives in this domain is to formulate and evaluate novel polyherbal products that are not only effective but also safe for long-term use. These formulations should ideally mitigate the risk of microbial resistance, minimize adverse effects, and offer comprehensive skin health benefits. By leveraging the vast pharmacopoeia of medicinal plants and applying modern scientific methodologies, it is possible to develop innovative, cost-effective, and sustainable solutions for acne vulgaris. Such efforts can significantly contribute to the global dermatological therapeutics landscape and improve the quality of life for patients suffering from this distressing skin condition.

Collection of Raw Materials

The leaves of *Azadirachtaindica, Aloe vera (L.),* and *Ocimum sanctum Linn.*were procured from the local market. Meanwhile, the foliage of *Nyctanthes arbor-tristis* was sourced from Kush Nursery, situated along the Jhansi road in Gwalior, Uttar Pradesh. Additionally, rhizomes of *Curcuma longa Linn.*were purchased from a nearby commercial outlet.

Extraction Process

Extraction serves as the initial and critical step in isolating desired bioactive constituents from plant-based raw materials. Depending on the principles of separation, several extraction techniques may be employed, such as solvent extraction, distillation, pressing, and sublimation. Among these, solvent extraction remains the most widely adopted approach due to its efficiency and versatility.

The process typically proceeds through four sequential stages:

- Penetration of the solvent into the solid matrix,
- Dissolution of target compounds within the solvent,
- Migration of solubilized constituents from the solid matrix to the solvent,
- Collection of the resulting extract.

Efficiency of this process is governed by multiple variables, including the **nature of the solvent**, **particle size of the raw material**, **solvent-to-solid ratio**, **temperature**, and **duration of extraction** (Li et al., 2008; Yi et al., 2012; Zhou et al., 2012; Du et al., 2011).

The **choice of solvent** is paramount. Ideal solvents should offer high selectivity, optimal solubility, cost-effectiveness, and minimal safety hazards. In line with the principle of "like dissolves like," solvents with polarity comparable to that of the solute generally yield superior extraction performance. Commonly employed solvents in phytochemical investigations include ethanol (EtOH) and methanol (MeOH), given their broad-spectrum solubility.

Reduction in particle size tends to enhance extraction yield, as smaller particles facilitate greater surface area for solvent interaction and promote solute diffusion. However, extremely fine particles may hinder filtration and retain unwanted substances, necessitating careful balance in particle size selection.

Temperature modulation also impacts solubility and diffusion rates. Elevated temperatures generally accelerate extraction kinetics but must be carefully controlled to prevent solvent evaporation, extract degradation, or inclusion of thermal impurities.

Extraction duration contributes significantly to yield, especially until dynamic equilibrium is established between the solute concentrations within and outside the plant matrix. Prolonged extraction beyond this equilibrium often results in diminishing returns.

An optimal **solvent-to-solid ratio** is also crucial; higher ratios generally improve yield but may increase solvent recovery time and reduce process efficiency if excessive.

Traditionally, maceration, percolation, and reflux methods—which employ large volumes of organic solvents and longer durations—have been used. However, recent advancements have introduced greener extraction techniques such as:

- **Supercritical Fluid Extraction (SFC)**
- **Pressurized Liquid Extraction (PLE)**
- **Microwave-Assisted Extraction (MAE)**

These modern methods offer enhanced benefits such as reduced solvent consumption, improved selectivity, and shorter extraction times. Nonetheless, some legacy techniques like sublimation, cold pressing, and enfleurage are now rarely applied in contemporary phytochemical research and are thus excluded from this study (Zhang et al., 2018).

4. PLANTS PROFILE

Aloe:

Synonyms: Aloe, Musabbar, Kumari.

Biological Source: Aloe is the dried juice of Aloe barbadensis Mille leaves.

Family: Liliaceae



Figure3.1: Aloe

Aloe vera: Botanical Profile, Constituents, and Therapeutic Applications

Botanical Description

Aloe vera is a succulent plant species characterized by its stemless or very short-stemmed structure, typically growing between 60 to 100 centimeters in height. This plant proliferates through the production of offsets. The leaves are thick, fleshy, and range in color from green to grey-green, often adorned with white flecks on their upper and lower surfaces. Leaf margins are serrated and equipped with small, white, spine-like teeth. During the summer season, Aloe vera produces tubular, pendulous yellow flowers arranged along a spike that can reach up to 90 centimeters in height. Like many species within the Aloe genus, Aloe vera engages in a symbiotic relationship with arbuscular mycorrhizal fungi, which enhance the plant's ability to absorb essential mineral nutrients from the soil (Gong et al., 2002).

Geographical Distribution

Aloe vera is indigenous to regions of Eastern and Southern Africa and is widely cultivated across the Cape provinces, Zanzibar, and the Socotra Islands. Its adaptability has also led to its cultivation in the Caribbean, parts of Europe, and several regions of India, particularly along the Northwestern Himalayan belt.

Phytochemical Composition

The pharmacologically active principle in Aloe vera is aloin, a complex mixture of anthraquinone glycosides. Among these, barbaloin is considered the most potent constituent. These compounds are responsible for the plant's notable therapeutic properties.

Microscopic Anatomy

Microscopically, a transverse section (T.S.) of the Aloe vera leaf reveals a sequence beginning with the outer cuticle followed by an epidermal layer, palisade tissue, and a mucilage-rich parenchymatous mesophyll. The mesophyll contains pericyclic layers surrounding vascular bundles, where large, elongated, thin-walled cells known as aloeitic cells are observed. These cells store the plant's highly viscous yellow sap—commonly referred to as aloe gel. Upon cutting the leaf near the base, this sap is exuded. Calcium oxalate crystals can also be found in small quantities within the parenchymal tissues.

Therapeutic Applications

1. **Anti-inflammatory Properties**

Aloe vera demonstrates significant anti-inflammatory activity through various mechanisms. It acts as a thromboxane A2 synthetase inhibitor, thereby reducing thromboxane production, promoting arterial dilation, and enhancing local circulation. It also mitigates inflammation by blocking vasoactive substances, constricting microvasculature, and inhibiting the infiltration of polymorphonuclear leukocytes (Davis & Leither, 1989). Furthermore, the antioxidant constituents in the gel help neutralize oxygen-derived free radicals, contributing to tissue repair and regeneration. Compounds like emodin and barbaloin undergo biochemical transformation into salicylates, further reinforcing the anti-inflammatory effect. Fatty acids present in the gel serve as competitive inhibitors of thromboxane synthesis, offering additional therapeutic benefits.

2. **Antibacterial Activity**

Aloe vera exhibits strong antibacterial properties primarily due to the presence of acemannan—a polysaccharide known to inhibit a wide range of bacterial strains including Streptococcus spp., Enterobacter cloacae, Citrobacter spp., Serratia marcescens, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Staphylococcus aureus. Aloe gel enhances wound healing rates and reduces prostanoid synthesis. Moreover, when aloe gel is used in conjunction with antibiotics like roxithromycin, cefixime, and levofloxacin, it enhances their antibacterial efficacy with reduced adverse effects. This synergistic interaction underscores the potential of Aloe vera in integrative medical approaches.

3. **Laxative Effects**

Among anthraquinone-based laxatives—including cascara, senna, and rhubarb—Aloe vera is considered the most potent. The latex derived from Aloe vera leaves is traditionally used to alleviate constipation. The compound barbaloin acts as a prodrug, remaining chemically stable in the acidic environment of the stomach. The glycosidic bond in barbaloin prevents early absorption, allowing it to reach the large intestine, where bacterial enzymes such as glycosidases cleave the glycoside, releasing the active aglycones: aloe-emodin, rhein- emodin, and chrysophanol. These compounds stimulate intestinal motility. Despite its efficacy, the bioavailability of aloe-emodin is relatively low (<10%), and its half-life is approximately 48–50 hours. Laxative effects typically occur within 6 to

12 hours after oral ingestion of a 0.25 mg dose. Common side effects include abdominal cramps, flatulence, and colicky pain, which may persist for up to a week.

4. Antidiabetic Activity

Clinical studies have demonstrated that Aloe vera gel can significantly reduce blood glucose and serum triglyceride levels in diabetic patients. In a notable investigation conducted by Bunypraphatsara and Yogchaiyudha, patients receiving Aloe vera gel therapy experienced a reduction in blood glucose from 250 mg/dL to 141 mg/dL. When combined with the hypoglycemic agent glibenclamide, similar reductions in glucose and lipid levels were recorded, indicating Aloe vera's potential as a complementary therapy in diabetes management (Syed & Ahmad, 1996).

5. Antihyperlipidemic Effects

Aloe vera gel has also shown promising results in managing hyperlipidemia, particularly in patients unresponsive to dietary modifications. In such cases, oral administration of 10 ml of Aloe vera gel resulted in significant reductions in serum cholesterol and LDL levels after four, eight, and twelve weeks. Research by Manojkumar further supports these findings, highlighting improved lipid profiles and a 45% reduction in the atherogenic index in hypercholesterolemic rats when Aloe vera gel was combined with the probiotic Lactobacillus rhamnosus. This improvement was attributed to enhanced cholesterol metabolism and absorption, ultimately lowering cardiovascular risk. Additionally, Aloe vera has been purported to assist in weight loss by increasing metabolic activity, particularly in hepatic cells. The plant's protein-digesting properties may also promote thermogenesis due to the higher caloric demand required to metabolize proteins, potentially aiding in weight management (Keivan&Moloud, 2007).

Turmeric:

Synonyms: Indian saffron, Curcuma

Biological Source: Turmeric consists of the plant *Curcumalonga Linn*, driedand fresh rhizomes.

Family: Zingiberaceae.



Figure3.2: Turmeric

Description:

Curcuma longa, a member of the Zingiberaceae family, is a perennial herbaceous plant characterized by its tall, leafy stems and capacity to bear up to twelve leaves. These leaves are typically lanceolate to oblong in shape, reaching lengths of approximately 1 meter. The upper leaf surface is dark green, while the underside is pale green. The petiole and sheath are nearly equal in length to the leaf blade. The plant produces sterile flowers that are pale yellow to reddish in color, with floral bracts that range from green to purplish hues.

The rhizome of Curcuma longa, which develops underground, is the primary part utilized for its medicinal and culinary properties. It is segmented with a tough outer skin and measures between 2.5 and 7.0 cm in length and approximately 2.5 cm in diameter. The rhizome emits a pleasant aroma and has a distinctly bitter flavor. This species is predominantly cultivated in tropical and subtropical climates, thriving at temperatures between 20°C and 30°C under sufficient rainfall conditions (Karłowicz-Bodalska et al., 2017).

Geographical Distribution:

India is the largest producer of turmeric, contributing nearly 90% of the global supply. Among Indian states, Tamil Nadu and Andhra Pradesh collectively produce around 70% of the nation's output, with Kerala also being a major cultivating region.

Macroscopic Characteristics:

Color: Yellowish-brown
Odor: Distinct and characteristic
Taste: Slightly bitter

Phytochemical Constituents:

Turmeric is rich in curcuminoids, the primary pigment compounds responsible for its yellow coloration. The principal bioactive compound is curcumin.

Applications and Therapeutic Potential of Turmeric

1. **Anticancer Activity:**

Curcumin demonstrates potent anticancer properties by modulating various biochemical pathways involved in carcinogenesis. It reduces levels of cholesterol, triglycerides, and oxidative damage caused by free radicals. Its antineoplastic activity is primarily attributed to the inhibition of NF-κB and other transcription factors associated with tumor development, angiogenesis, and metastasis. Curcumin also regulates the cell cycle through β-catenin pathways and both p53-dependent and p53-independent mechanisms. It interferes with tumor progression by affecting gene expression and apoptotic signals, establishing its role as a multifaceted anticancer agent.

2. **Antifungal Properties:**

Extracts of turmeric, especially those obtained using ether, chloroform, and ethanol, have shown significant antifungal activity. Turmeric essential oil is particularly effective against pathogenic fungi such as Aspergillus flavus, A. parasiticus, Fusarium moniliforme, and Penicilliumdigitatum (Jayaprakasha et al., 2001).

3. Antiallergic Effects:

Curcumin has been found to suppress allergic reactions by inhibiting the degranulation of mast cells. In experimental models, it significantly reduced the allergic response triggered by compound 48/80 and immunoglobulin E (IgE)-mediated hypersensitivity. These findings confirm its efficacy in mitigating both generalized and antigen-specific allergic responses.

4. Antimicrobial Activity:

Turmeric has demonstrated substantial antimicrobial effects, particularly against drug- resistant bacterial strains. The essential oil of turmeric leaves inhibits the proliferation of fungi and the production of aflatoxins. Nanocurcumin, a more bioavailable formulation, exerts its antibacterial effect by disrupting bacterial cell walls, leading to lysis. Its synergistic effect with epigallocatechin gallate (EGCG) enhances its action against multidrug-resistant Acinetobacter baumannii, suggesting a viable approach to combat severe bacterial infections (Betts & Wareham, 2014).

5. Neuroprotective Properties:

Research indicates that Curcuma oil provides neuroprotection against ischemic damage by reducing oxidative and nitrosative stress. It helps maintain mitochondrial membrane potential, prevents cytochrome c release, and modulates the Bax/Bcl-2 ratio, ultimately inhibiting caspase activation and apoptosis. These neuroprotective actions position Curcuma oil as a promising agent for mitigating ischemic brain injury, with a favorable therapeutic window (Dohare et al., 2008).

Tulsi:

Synonyms: Sacred basil, Holy basil

Biological source: Tulsi is composed of fresh and dried Ocimum sanctum Linn leaves.

Family: Labiatae



Figure3.3: Tulsi

Botanical Description:

Tulsi (Ocimum sanctum), commonly referred to as Holy Basil, is an erect, highly branched, herbaceous plant. It generally attains a mature height ranging between 30 to 75 cm. The foliage consists of aromatic, simple leaves arranged in an opposite phyllotaxy. The leaves are ovate to elliptical with a rounded apex and toothed margins, averaging up to 5 cm in length. The surface of the leaves is pubescent and gland-dotted, contributing to its characteristic fragrance.

Inflorescence appears in the form of elongated racemes with purple-hued flowers arranged in compact whorls, providing ornamental appeal. Fruits are small, nutlet-type structures, sub- globose in shape, and pale brown to reddish-black in color. Seeds are minute, sub-globose, and yellowish, resembling radish seeds. The optimal planting season is post-monsoon, as Tulsi flourishes in humid, moist conditions. It is customarily cultivated for a few months before harvesting.

Geographical Distribution:
Tulsi is native to the Indian subcontinent and is widely cultivated across tropical and subtropical regions. In India, it is frequently grown in household gardens and temple premises, owing to its cultural and medicinal significance.

Macroscopic Characteristics:
Plant Type: Small, herbaceous, branched.
Height: 30–75 cm.
Leaves: Oblong, pubescent on both sides, aromatic, toothed margin.
Flowers: Purplish, arranged in racemes.
Fruits: Sub-globose nutlets, pale brown to reddish-black.
Seeds: Sub-globose, reddish to black in color.

Phytochemical Constituents:
The primary chemical constituents include:

- **Eugenol (approx. 70%)** – contributes to the characteristic aroma and pharmacological effects.
- **Carvacrol (around 3%)** – known for antimicrobial action.
- **Eugenol-methyl-ether (20%)** – supports antioxidant properties.
- **β-Caryophyllene –** a sesquiterpene with anti-inflammatory and antimicrobial roles.

Therapeutic Applications:

1. **Antioxidant Potential:**

Tulsi contains rosmarinic acid, a potent polyphenolic antioxidant that mitigates cellular oxidative stress by neutralizing free radicals, thus protecting against chronic diseases.

2. **Antibacterial Activity:**

Phytochemicals such as carvacrol, terpenes, and β-caryophyllene demonstrate significant antibacterial properties. β-caryophyllene, in particular, is recognized as a GRAS (Generally Recognized as Safe) compound by the FDA.

3. **Anti-inflammatory Effect:**

Compounds like rosmarinic acid, pegenin, and eugenol exhibit notable anti-inflammatory actions. Eugenol, the principal active component, also assists in modulating blood glucose levels by stimulating pancreatic β-cell function and enhancing insulin secretion.

4. Anti-HIV Potential:

Experimental data suggest that chlorophyll derivatives such as Pheophytin-a, isolated from Ocimum sanctum, possess inhibitory activity against HIV-1 protease, thereby showing promise in antiviral therapy.

5. Antiulcer Properties:

Fixed oil derived from O. sanctum has shown substantial efficacy against various ulcer- inducing agents including Indomethacin, Aspirin, and ethanol in animal models. The antiulcer mechanism is attributed to its lipoxygenase inhibition, antisecretory action, and histamine antagonism.

Neem

Synonyms: Neem, Nimba, Nimtree
Biological Sources: Azadirachtaindica Linn
Family: Meliaceae



Figure3.4: Neem Leaves

Description of Neem (*Azadirachtaindica*)

Neem is a medium-sized evergreen tree that typically reaches a height between 15 and 30 meters and forms a broad, rounded canopy up to 10–20 meters in diameter. Although commonly evergreen, the tree may shed its leaves during particularly dry periods. It features a deep taproot and depends on mycorrhizal relationships for optimal growth. The bark is grey, becoming fissured and flaky as the tree ages, and older trees, especially in humid climates, may exude a sticky, strong-smelling sap. The branches are numerous and widely spreading. Leaves are alternate, petiolated, and generally clustered at the ends of the branches. They are unequally pinnate, smooth, and dark glossy green when mature, measuring 20–40 centimeters in length and consisting of 10–20 leaflets. Leaflets are sickle- shaped, 5–10 centimeters long and 1.2–4 centimeters wide, with slightly toothed margins.

Neem flowers are small, white, fragrant, and produced in large clusters that can be up to 30 centimeters long. The fruits are drupes, smooth, and about 1–2 centimeters long. These fruits contain white, milky sap when unripe and mature to yellow or brown. Each fruit has a thin outer layer, mucilaginous fleshy middle part, and a hard central stone. Inside, there is a variable number of ovoid oil-rich seeds measuring 1–2 centimeters.

Geographical Distribution

Neem is indigenous to India and is also found in Pakistan, Sri Lanka, Malaysia, Indonesia, Japan, tropical regions of Australia, and parts of Africa. Within India, it grows in states including Uttar Pradesh, Maharashtra, Tamil Nadu, Rajasthan, and Madhya Pradesh.

Chemical Constituents

The principal active compounds in Neem include nimbin, nimbidin, and nimbinin.

Uses

Neem is renowned for its antibacterial effects and is used extensively to treat various skins Conditions.

Therapeutic Applications of Neem

1. **Antiulcer Effect**

Aqueous extracts from neem leaves and bark have demonstrated strong antiulcer and anti- acid secretory activities. Nimbi din, one of neem's chief constituents, has shown notable efficacy in preventing ulcers caused by acetylsalicylic acid, indomethacin, stress, or serotonin, as well as those induced by histamine or cysteamine in experimental models.

2. **Antibacterial Properties**

Neem contains various antibacterial compounds, most notably azadirachtin. This complex limonoid, present in both seeds and leaves, is highly active against a broad spectrum of bacteria. Research indicates that neem extracts from leaves, seeds, and bark inhibit the growth of both Gram-negative and Gram-positive bacteria, including strains like M. tuberculosis, even those resistant to streptomycin. In vitro studies demonstrate neem's inhibitory action against pathogens such as Vibrio cholerae, Klebsiella pneumoniae, M. tuberculosis, and M. pyogenes. Neem has also proven effective against oral bacteria like Streptococcus mutans and S. faecalis.

3. **Antifungal Activity**

Neem has long been employed to combat fungal infections affecting skin, hair, nails, and mucous membranes. Its extracts—derived from leaves and oilseed kernels—are effective against a range of dermatophytes and yeasts, including *Trichophyton, Epidermophyton, Microsporum, Trichosporon, Geotrichum,* and Candida species. It is thus used to manage athlete’s foot, ringworm, thrush, and similar mycoses.

4. **Immunostimulant Activity**

Studies have shown that aqueous extracts of neem leaf and bark exhibit immunostimulant properties and anti-complement activity. Neem oil, in particular, enhances cell-mediated immune mechanisms, helping strengthen immune responses to antigens and mitogens.

5. **Hypoglycemic Activity**

Neem leaf extracts are promising for managing blood sugar, as they have been shown to decrease blood glucose levels and counteract hyperglycemia induced by adrenaline or glucose. Both neem leaf extract and seed oil have demonstrated hypoglycemic effects in normal and alloxan-induced diabetic rabbits.

Harsingar:

Synonyms: Night-flowering jasmine, Parijat

Biological Source: Nyctanthesarbor- tristis

Family: Oleaceae



Figure3.5:Harsinghar

Botanical Description of Nyctanthes arbor-tristis (Parijat/Harsingar)

Botanical Identity and Morphology:

Nyctanthes arbor-tristis, widely recognized by its vernacular names Harsingar or Parijat, is a resilient deciduous shrub or small tree, often attaining heights up to 30 meters under optimal conditions. The bark is greyish in hue with a tendency to flake, while the branching pattern is angular, spreading, and scabrous in texture. The foliage is simple and arranged oppositely, measuring between 6–12 cm in length and 2–6.5 cm in breadth. The adaxial (upper) leaf surface is rough with glandular-based trichomes, while the abaxial (lower) surface exhibits soft pubescence.

Floral Characteristics:

The plant is known for its pleasantly aromatic flowers, which bloom nocturnally — typically opening at dusk and wilting by dawn. The inflorescence is cymose, typically comprising 2 to 7 blossoms. Each flower possesses 5 to 8 white lobes radiating from a bright orange tubular corolla. Fruiting results in a heart-shaped to subglobose capsule containing two seeds, each capsule approximately 2 cm in diameter. The typical flowering season spans from late September to early winter.

Geographical Distribution:

Nyctanthes arbor-tristis is indigenous to the Indian subcontinent, notably India and Nepal. It is extensively distributed in the subtropical zones of the Himalayan foothills and is also found naturalized across southern parts of India and regions of Southeast Asia including Thailand, Indonesia, and Malaysia.

Macroscopic Overview:

Botanically classified as a small evergreen tree, the species presents with a thick, often twisted trunk and a spreading canopy. The average mature height typically does not exceed 12 meters, making it suitable for cultivation in garden landscapes and along roadsides.

Phytochemical Constituents:

The plant contains a broad spectrum of bioactive compounds. Iridoid glycosides such as arbortristoside A and C are present in both leaves and seeds. Other notable phytochemicals include mannitol, β-amyrin, β-sitosterol, hentriacontane, benzoic acid, astragalin, nicotiflorin, lupeol, nyctanthic acid, oleanolic acid, and friedelin. The seeds are also reported to harbor glucomannan-type polysaccharides.

Pharmacological and Therapeutic Potentials:

1. **Antifungal Properties:**

The methanolic extracts derived from various plant parts—particularly the leaves, stems, and bark—exhibit pronounced antifungal efficacy. These extracts have demonstrated inhibitory activity against clinically relevant fungal strains including Aspergillus niger, A. flavus, and Penicillium spp., as shown by well-defined zones of inhibition in laboratory assays (Rawat et al., 2021).

2. **Antiallergic Effects:**

Distilled leaf extracts have shown promising results in mitigating allergic reactions and respiratory distress. Isolated iridoid glycosides, arbortristoside A and C, have been identified as key antiallergic agents (Shrivastava et al., 2018).

3. **Immunomodulatory Activity:**

Aqueous extracts of the leaves are reported to stimulate both humoral and cell-mediated immunity. Furthermore, ethanolic extracts from roots and seeds exhibited comparable immunostimulatory effects, likely attributable to the presence of arbortristosides (Shrivastava et al., 2018).

4. **Antibacterial Activity:**

Traditional medicinal claims regarding its antimicrobial properties are corroborated by modern studies. Methanolic extracts from the leaves have demonstrated significant antibacterial action against Salmonella typhi, Staphylococcus aureus, and Staphylococcus epidermidis, with reported MIC values ranging between 1–8 mg/mL (Mahida & Mohan, 2007).

5. **Antioxidant Potential:**

The plant extract showcases extensive free radical scavenging activity in various in vitro assays such as DPPH, hydroxyl, superoxide, and hydrogen peroxide radicals. The ethyl acetate fraction, in particular, was effective in inhibiting lipid peroxidation and preventing DNA damage induced by oxidative stress, likely due to its rich flavonoid and phenolic content (Rathee et al., 2007). Additional studies have also reported CNS effects such as sedation and hypothermia, which are presumed to be mediated via membrane stabilization and antioxidant pathways (Saxena et al., 1987).

Green Tea

Synonyms: Tea plant, tea shrub, tea tree
Biological Source: Camellia sinensis
Family: Theaceae



Figure3.6: Green Tea

Botanical Profile

Camellia sinensis, belonging to the family Theaceae, is an evergreen shrub or small tree that, under natural conditions, can attain a height of 10–15 meters. In cultivated settings, however, it is typically pruned and maintained between 0.6 and 1.5 meters to optimize leaf harvesting. The foliage is alternate, lanceolate, and serrated along the margins. While mature leaves are smooth and glabrous, younger leaves display fine hairs, particularly on the abaxial (underside) surface. The leaves generally measure between 5–30 cm in length and approximately 4 cm in width. The plant produces solitary or clustered (two to four) fragrant, white flowers, 2.5–4 cm in diameter, characterized by numerous yellow-anthered stamens.

Post-pollination, it bears a three-parted, brown-red capsule, each section enclosing a single, nut-sized seed (Biswas, 2006).

Geographical and Climatic Adaptation

This species flourishes in tropical to subtropical climates and is widely cultivated across Asia. Optimal growth and leaf quality are achieved in regions receiving a minimum of 127 cm of annual precipitation.

Microscopic Diagnostic Features

Microscopically, the upper epidermis in younger leaves consists of small, angular cells, transitioning to more defined polygonal cells in maturity. The surface remains largely glabrous with occasional simple, unbranched trichomes on the lower surface in juvenile leaves. The lower epidermis displays larger cells interspersed with numerous stomata, primarily elliptical or circular, flanked by kidney-shaped guard cells. These stomata are limited to the abaxial surface. Adjacent

epidermal cells exhibit curvature aligned with the stomatal aperture, and pointed trichomes are more prominent on emerging leaves. Xylem fibers present do not exhibit significant morphological distinctiveness.

Phytochemical Composition

Leaves of Camellia sinensis are rich in polyphenols, particularly catechins such as epigallocatechin gallate (EGCG), epicatechin gallate, and epicatechin. Flavonoids including kaempferol, quercetin, and myricetin also contribute to its potent bioactivity, notably antioxidant and therapeutic functions (Khar N & Mukhtar, 2013).

Health and Functional Attributes

Renowned for its health-supporting potential, Camellia sinensis offers a wide array of benefits stemming from its phytoconstituents. These bioactives exhibit antioxidant, anti- inflammatory, anticarcinogenic, and neuroprotective effects. Regular consumption of green tea, a primary derivative, is associated with enhanced cognitive performance and a reduced incidence of type II diabetes and cardiovascular conditions. Its versatile pharmacological profile renders it integral to nutraceuticals and functional food formulations.

Therapeutic Applications of Camellia sinensis (Green Tea)

1. **Antifungal Potential**

Extracts derived from green tea leaves exhibit pronounced antifungal activity against various Candida strains, including C. albicans, C. glabrata, C. kruseii, and C. parapsilosis. Catechin compounds, particularly EGCG and ECG, have been identified as key antifungal agents.

Methanolic extracts were especially potent, demonstrating inhibition zones exceeding 17 mm for C. albicans under controlled harvest conditions (Aladaq et al., 2009).

2. **Anticancer Properties**

Green tea's chemopreventive efficacy is attributed to its ability to modulate apoptosis and inhibit tumor angiogenesis. EGCG impedes the synthesis of angiogenic factors within tumors, thereby limiting neoplastic progression. Experimental studies have demonstrated its ability to inhibit tumorigenesis, suppress hepatic carcinoma cell lines, reduce lipid peroxidation, and inhibit catechol-O-methyltransferase (COMT) activity.

3. **Anti-inflammatory Activity**

Green tea polyphenols effectively downregulate inflammatory mediators. They inhibit nuclear factor-kappa B (NF-κB) activation and reduce pro-inflammatory cytokines. These

actions contribute to the prevention and management of conditions like gingivitis and periodontal diseases. Comparative assessments show green tea extract efficacy paralleling that of nonsteroidal anti-inflammatory drugs such as indomethacin.

4. **Antidiabetic Efficacy**

Regular intake of green tea is associated with improved glycemic control and reduced risk of type II diabetes. Preclinical studies revealed significant hypoglycemic effects of aqueous extracts. EGCG enhances insulin signaling by promoting tyrosine phosphorylation of insulin receptors and suppressing gluconeogenesis via redox-sensitive mechanisms, thereby mimicking insulin activity

and aiding metabolic regulation (Miura et al., 2005; Waltner-Law et al., 2002).

5. Antioxidant Properties

Green tea serves as a robust source of antioxidants, offering protection against oxidative stress. It contains a broad spectrum of bioactives including catechins, gallic acid, vitamins C and E, carotenoids, and essential trace elements. These compounds work synergistically to neutralize reactive oxygen species (ROS), thus reducing cellular damage, mutagenesis, and chronic disease susceptibility (Young & Woodside, 2001; Cabrera et al., 2006).

5. PLAN OF WORK

I. Literature survey

II. Procurement and authentication of plant materials

III. Extraction of plant material

IV. Phytochemical Analysis

V. TLC Method and Procedure for Extract

VI. Formulation development of Polyherbal gel

VII. Characterization of Polyherbal gel

- **a.** Physical characterization
- **b.** Determination of pH
- **c.** Washibilty study
- **d.** Extrudibility study
- **e.** Spread ability study
- **f.** Viscosity
- **g.** Stability study
- **h.** %Drug Release study

VIII. Screening of extracts for antiacne activity (Antibacterial Activity)

IX. Summary and Conclusion

X. Compilation and Submission of thesis

6 .Materials and Methods

During project work, various chemicals, solvents, instruments and glassware are used,as shown in Table 6.1 and Table 6.2 below.

TableNo.6.1: List of drugs

S. No	Ingredients	Skin Benefits	Figure
1.	Neem leaves (Azardirachta indica)	Antibacterial l, antifungal, Antiseptic.	
2.	Turmeric (Curcuma longa L.)	Antibacterial, antifungal, Also adds glove to the Skin.	
3.	Aloevera (Aloevera L.)	Moisturizing agent, Delivers soothing property to the skin.	
4.	Green tea (Camellia sinensis L.)	Polyphenols present in green tea helps in anti-ageing. Makes your skin looks younger and better.	

5	Harsingar (Nyctanthes arbor tristis)	Anti-Allergic antiviral and antibacterial.	
6.	Tulsi (Ocimum sanctum Linn.)	Antibacterial	

Table6.2: List of Equipment's

S.No.	Equipment's	Source
1.	UV-spectrophotometer	Model1700,Shimadzu,Japan
2.	FTIR spectrophotometer	PerkinElmer Scientific (Singapore) Pte. Ltd.
3.	Melting Point Apparatus	Jyoti Scientific Industries, Gwalior
4.	Electronic balance	Roy Electronics, India
5.	Differential scanning calorimeter	Perkin Elmer Pyris 6 DSC (Massachusetts, USA)
6.	Magnetic stirrer	Jyoti Scientific Industries, Gwalior
7.	Mechanical shaker	Jyoti Scientific Industries, Gwalior
8.	Brookfield viscometer	Jyoti Scientific Industries, Gwalior
9.	pH meter	VSI-IB,VSI Electronics,India
10.	Thermometer	Jyoti Scientific Industries, Gwalior
11.	A potential and particle size analyzer	Nano ZS, Malvern Instruments Ltd (Worcestershire, UK)

METHODS:

Collection and Extraction of Plant Materials

Collection of Raw Materials

The leaves of Azadirachtaindica (Neem), Aloe vera (L.), and Ocimum sanctum Linn. (Tulsi) were sourced from the local market, ensuring access to fresh and uncontaminated botanical samples. In addition, the leaves of Nyctanthes arbor-tristis were collected from the Jhansi (U.P.) road at Kush Nursery, Gwalior. Rhizomes of Curcuma longa Linn. (Turmeric) were procured from a nearby marketplace. Carefully selecting and identifying these plant materials is essential to preserve the integrity and efficacy of the natural products intended for extraction.

Extraction Principles and Methods

Extraction is the crucial first step in isolating natural products from plant raw materials. The process aims to efficiently separate desired bioactive compounds using various techniques, with **solvent extraction** being the most commonly applied in phytochemical research. The overall extraction process includes the following main stages:

1. **Solvent Contact:** The extraction solvent first reaches the solid plant matrix.
2. **Dissolution:** Target compounds dissolve into the chosen solvent.
3. **Transfer:** Solubilized compounds leave the plant matrix and enter the solvent phase.
4. **Collection:** The enriched solvent, now containing extracted compounds, is collected separately from the solid residue.

The efficiency of extraction is significantly impacted by factors that enhance diffusivity and solubility during these stages. Key influencing parameters include:

- **Extraction solvent properties** (polarity, selectivity, cost, safety)
- **Particle size** of the plant material (smaller size improves extraction but too fine may hinder filtration)
- **Solvent-to-solid ratio** (higher ratio enhances yield but excess increases solvent use and concentration time)
- **Extraction temperature** (higher temperature improves both solubility and diffusion but may degrade thermolabile constituents)
- **Extraction duration** (longer time increases yield up to equilibrium; beyond which gains are negligible)

Solvent Selection

For solvent extraction, selectivity, solubility, cost, and safety are primary considerations. According to the principle of "like dissolves like," solvents with polarity similar to that of the target compounds yield better extraction efficiency. Alcohols, specifically ethanol (EtOH) and methanol (MeOH), are regarded as universal solvents suitable for a wide range of phytochemicals, making them popular choices for plant compound extraction.

Role of Particle Size

A smaller particle size allows better penetration of the solvent and more effective diffusion of

solutes, increasing extraction efficiency. However, extremely fine particles may adsorb too much solvent or solute, complicating filtration steps.

Impact of Temperature and Time

Elevated extraction temperatures enhance solubility and diffusion rates, but if the temperature is too high, loss of solvent and thermal degradation of sensitive (thermolabile) compounds may occur. Extraction efficiency generally increases with time but plateaus once equilibrium between the plant material and solvent is achieved.

Solvent-to-Solid Ratio

A higher solvent-to-solid ratio generally correlates with increased extraction yield. However, excessively high ratios may be inefficient and prolong concentration processes during downstream operations.

Extraction Techniques

Extraction techniques can be broadly categorized as follows:

Conventional Methods

- **Maceration:** Plant material is soaked in a solvent at room temperature for an extended period.
- **Percolation:** Slow and continuous flow of solvent passes through the packed plant material.
- **Reflux Extraction:** Solvent is boiled and condensed back into the raw material, allowing repeated extraction. While reliable, these methods often require large volumes of solvent and longer processing times.

Modern/Greener Techniques

- **Supercritical Fluid Extraction (SFC):** Uses supercritical fluids (commonly CO_2) under controlled temperatures and pressures, leading to selective extraction with minimal solvent residue.
- **Pressurized Liquid Extraction (PLE):** Employs solvents at elevated temperatures and pressures for faster, more efficient extraction.
- **Microwave-Assisted Extraction (MAE):** Utilizes microwave energy to rapidly heat solvents and plant matrices, decreasing extraction time and solvent consumption. These modern methods offer advantages such as reduced solvent use, shorter extraction times, and greater selectivity compared to conventional techniques.Considerations Not Addressed in This Study Techniques such as sublimation, expeller pressing, and enfleurage are either rarely used in phytochemical research or unsuitable for the solvents and plant types involved in this protocol. Therefore, they are not discussed further here.

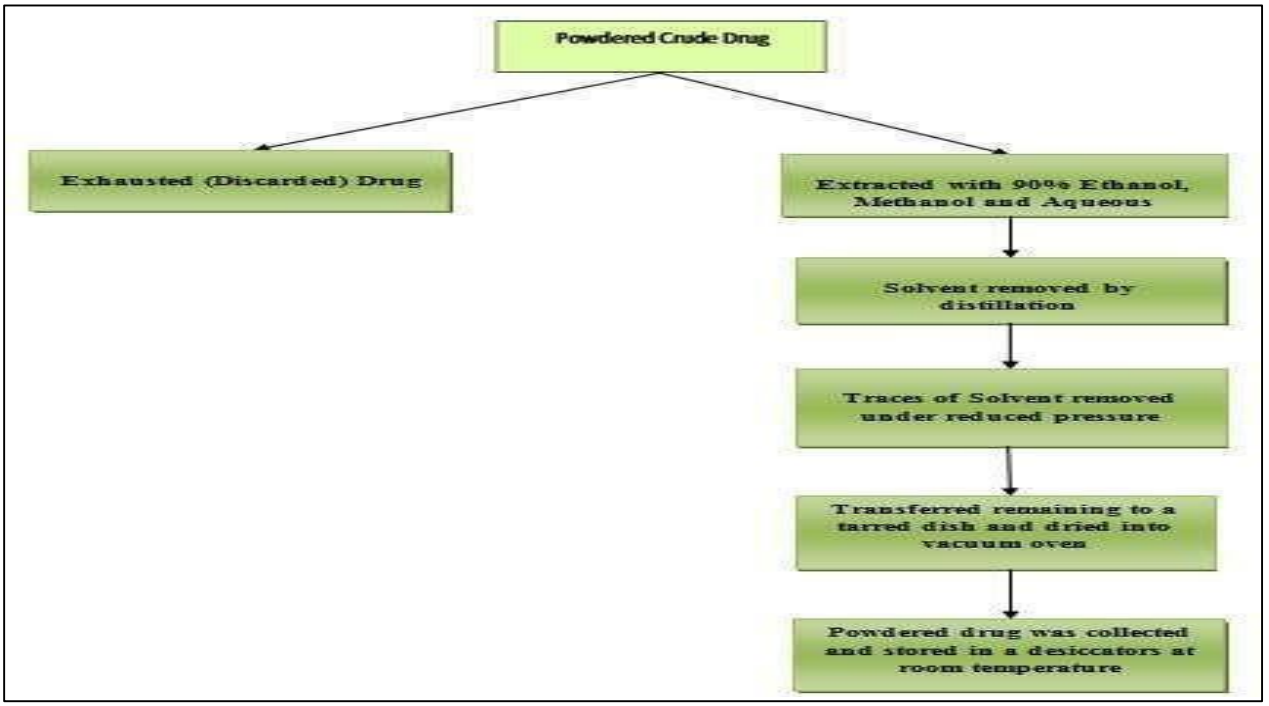


Figure 6.1: Schematic Diagram Illustrating the Extraction Process and Preparation of Powdered Drug

Preparation of Aqueous Plant Extracts

1. **Neem (Azardirachta indica) Leaf Extract**

Fresh neem leaves were collected, thoroughly washed with distilled water, and shade-dried for approximately 10 days. The dried material was ground into a fine powder. A total of 100 grams of the powder was soaked in 350 mL of distilled water for 3 hours, followed by maceration with an additional 150 mL of water using a percolator for duration of 7 days, with intermittent stirring. The extract was then subjected to ethanol-based extraction and gradually concentrated to obtain a dark green residue. The final extract was stored in an airtight container, maintained in a cool, dark environment to preserve its bioactivity (Sawant SE & Tajane MD, 2016).

2. **Turmeric (Curcuma longa Linn.) Rhizome Extract**

Turmeric rhizomes were shade-dried and pulverized into a fine powder. The extraction protocol mirrored that used for neem, employing aqueous maceration followed by ethanol extraction. A deep red extract was obtained, concentrated, and stored in air-tight containers under dark and refrigerated conditions for future use.

3. **Aloe vera (L.) Leaf Extract**

Collected aloe vera leaves were initially washed with tap water and carefully handled to avoid damaging the green rind, which could compromise the internal gel. Using a manual hand-filleting technique, the lower base, leaf apex, and marginal spines were removed. The inner mucilaginous layer was separated, sliced, ground, and lyophilized. The resultant gel powder was subjected to Soxhlet extraction with water at 90 °C for 4 hours. The extract was filtered, concentrated using a rotary evaporator, and stored at 90 °C in dark conditions.

4. Harsingar (Nyctanthes arbor-tristis) Leaf Extract

Collected leaves were air-dried for 48 hours and pulverized into a homogeneous powder. Fifteen grams of the powdered sample were mixed with 250 mL of distilled water in conical flasks, sealed with corks, and agitated using a mechanical shaker for 8 hours. The resultant extract was filtered using vacuum filtration and stored at 4 °C in sterile, airtight containers (Jain AK & Singh KP, 2013).

5. Tea Leaf Extract

Fresh tea leaves were washed thoroughly and oven-dried at 37 °C for six days. Post-drying, the samples were ground using a Waring blender and soaked in distilled water using a 6:1 (solvent: plant) ratio for 48 hours. The aqueous extract was filtered through Whatman No. 1 paper. Methanol used in the extraction was removed using vacuum evaporation at 50 °C until a viscous mass remained, which was then weighed and stored at 4 °C (Tariq AL &Reyaz AL, 2012).

6. Tulsi (Ocimum sanctum Linn.) Leaf Extract

The leaves were washed with Aqua Guard–filtered water, shade-dried, and subsequently oven-dried. After pulverization, 40 grams of leaf powder was soaked in 300 mL of double- distilled water and kept overnight (~20 hours) at room temperature. The mixture was filtered using fine cotton cloth, and the filtrate was subjected to vacuum evaporation. The final residue was carefully collected and preserved at –20 °C for future use (Sen A et al., 2017).

Chemicals Used

Analytical-grade reagents and chemicals used in the study were procured from reputed suppliers such as Sd-Fine Chemicals, Himedia, and Qualigens. The formulation included:

- **Carbopol ® 940**
- **Propylene glycol**
- **Methyl paraben**
- **Propyl paraben**
- **Triethanolamine**
- **Dimethyl sulfoxide (DMSO)**
- **Methanol**
- **Nutrient agar**
- **Clostridial reinforced agar**

The working standard for clindamycin phosphate, used in antimicrobial assays, was obtained from Arbro Laboratories, New Delhi.

Preliminary Phytochemical Screening

1. Alkaloids

- **Mayer's Test:** Cream-colored precipitate formation indicates alkaloids.
- **Dragendorff's Test:** Reddish-brown precipitate observed.
- **Wagner's Test:** Reddish-brown coloration confirms presence.
- **Hager's Test:** Yellow precipitate formation denotes alkaloids (Monsef et al., 2004).

2. Carbohydrates

- **Molisch's Test:** Violet ring indicates presence.
- **Barfoed's Test:** Red precipitate confirms monosaccharides (Devor, 1950).
- **Fehling's Test:** Formation of red cuprous oxide.

3. Proteins

- **Millon's Test:** Red coloration signifies proteins.
- **Ninhydrin Test:** Purple color confirms amino acids.
- **Biuret Test:** Violet hue confirms peptide bonds.
- **Xanthoprotein Test:** Yellow-to-orange shift indicates aromatic proteins (Asthana et al., 2019).

4. Tannins and Phenolics

- **Ferric Chloride Test:** Reddish coloration.
- **Lead Acetate Test:** White precipitate formed.
- **Gelatin Test:** White precipitate confirms tannins (Tamilselvi et al., 2012).

5. Phytosterols and Terpenoids

- **Salkowski's Test:** Yellow to crimson shift.
- **Libermann-Burchard Test**: Color change from pink to purple or red (Harborne, 1973).

6. Glycosides

- **Borntrager's Test:** No change in ammoniacal layer.
- **Modified Borntrager's:** No visible layer change.
- **Keller-Killiani Test:** White precipitate upon treatment (Alamgir, 2018).

7. Flavonoids

- **Flavonoid Test:** Yellow coloration.
- **Shinoda Test:** Pink color confirms flavonoids.
- **Lead Acetate Test:** Yellow precipitate (Tepal, 2016).

8. Saponins

- Persistent foam after shaking in water indicates saponins (Yang et al., 2010).

9. Steroids

- Violet to green/blue color after acetic anhydride and H_2SO_4 indicates steroids (Few, 1965).

10. Terpenoids

- Red-brown coloration at the interface after treatment with chloroform and H_2SO_4 (Singh et al., 2015).

Thin Layer Chromatography (TLC) Analysis

Principle

TLC is an analytical method that separates phytoconstituents based on their differential mobility across a stationary phase (silica gel or alumina) under the influence of a solvent (Bele & Khale, 2011).

Procedure

Sample Preparation

- Fresh leaves were shade-dried and ground into powder (Mandal et al., 2015).
- The powder was soaked in an appropriate solvent (methanol or ethanol) based on the target compound's polarity.
- The mixture was macerated for 24–48 hours and filtered to yield the extract (Lee et al., 2012).

Preparation of TLC Plate

- TLC plates were coated with silica gel and baseline marked ~1 cm from the bottom.
- Plates were dried to remove residual solvent (Cai, 2014).

Spotting

- Extracts were dissolved in suitable solvents and applied using a capillary/micropipette (Luska, 2023).

Development

- A mobile phase was poured into the TLC chamber (0.5 cm depth).
- The spotted TLC plate was placed in the chamber and allowed to develop.
- Upon nearing the top, the solvent front was marked (Perry et al., 1975).

Visualization

- Plates were dried and visualized under UV light or using chemical reagents.
- Rf values and spot characteristics were recorded (Striegel & Hill, 1997).

Preparation of Gel Base

Following optimization, the gel base was prepared using **Carbopol® 940** at concentrations ranging from 1–3%. It was hydrated in **propylene glycol (30%)** and **distilled water**, and left to swell for 24 hours. The mixture was homogenized using a dual-blade mixer at 25 °C (200 rpm) for 10 minutes. Preservatives including **methyl paraben (0.2% w/w), propyl paraben (0.02% w/w),** and **Triethanolamine** were added to enhance gel stability and maintain pH.

Table6.3: Excipients Used for Optimization of Gel Base

Ingredients	**Quantity %w/w**		
Carbopol®940	1	2	3
Propylene glycol	10	20	30
Methyl paraben	1.5	1.5	1.5

Propyl paraben	0.03	0.03	0.03
Triethanolamine	0.5	0.5	0.5
Water	Q.S.	Q.S.	Q.S.

Preparation of Topical Gel Formulations:

For optimization, active plant extracts (1 percent -5 percent w/w) were used to form stable gel formulations. The optimised formulations F1-F6 were prepared separately, each containing 5 percent of the APEs (AENL, AETR, AEAL, AEHL, AETL and AETL). In a mixture of propylene glycol and DMSO, extracts were dissolved (1:2). Subsequently, extract solutions were mixed using spatula with carbopol gel base (control) until homogeneous gels were formed. The gels were then moved to vials of clearglass and centrifuged for up to 10 minutes at 1000 rpm to eliminate any trappedair bubbles. Clindamycin (CLN) and (1 percent w/w) norm (1 percent w/w) were also prepared using the same gel base and acted as positive controls.

Table6.4: Composition of Optimized Herbal Gel Composition

Ingredients/extracts Base F1 F2 F3 F4 F5							F6	PF	CLN
Carbopol®940	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Propylene glycol	20	20	20	20	20	20	20	20	20
Dimethyl sulfoxide	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Methyl paraben	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Propyl paraben	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Triethanolamine	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
AENL		5	-	-	-	-	-	5	
AETR		-	5	-	-	-	-	5	
AEAL		-	-	5	-	-	-	5	
AEHL		-	-	-	5	-	-	5	
AETL						5	-	5	
AETL							5	5	
Clindamycin									1
Deionizer Water	Q.S	Q.S	Q.S.	Q.S.	Q.S	Q.S.	Q.S.	Q.S.	Q.S.

Of course. Here is the requested content rewritten for clarity and flow, while preserving all the original facts, methods, and citations.

Characterization and Evaluation of Gel Formulations

Extract Abbreviations Used in the Study

The following abbreviations are used to denote the different aqueous plant extracts incorporated into the gel formulations:

AENL: Aqueous Extract of Neem Leaves
AETR: Aqueous Extract of Turmeric Rhizomes
AEAL: Aqueous Extract of Aloe Leaves
AEHL: Aqueous Extract of Harsingar Leaves
AETL: Aqueous Extract of Tea Leaves
AETuL: Aqueous Extract of Tulsi Leaves

Physicochemical Characterization of Gels

The prepared gel formulations were evaluated for several key physicochemical properties to ensure their quality and suitability for topical application.

1. **Determination of Homogeneity**

The homogeneity of each formulation was assessed by visual inspection after the gel had set in its container. The samples were carefully examined for their appearance and the presence of any lumps or aggregates to ensure a smooth and uniform consistency (Khan et al., 2013).

2. **Determination of pH**

The pH of the gel formulations was determined using a calibrated digital pH meter. For each measurement, 1 gram of the gel was dissolved in 100 ml of distilled water and allowed to stand for 2 hours. The pH was measured in triplicate for each formulation, and the average value with standard deviation was recorded. The pH was required to be similar to the natural pH of the skin to prevent irritation upon application (Shivhare et al., 2009).

3. **Determination of Viscosity**

The viscosity of the formulated gels was measured using a Brookfield Viscometer (Brookfield Engineering Laboratories, Inc., USA). The analysis was performed with spindle #C 50-1 operating at a speed of 50 rpm at a controlled temperature of 25 ± 0.5°C. The corresponding dial reading was noted, and measurements were conducted in triplicate to obtain an average viscosity value (Pandit et al., 2007).

4. **Determination of Spreadability**

Spreadability is a measure of the gel's ability to spread easily over the skin or affected area upon application. This was evaluated by measuring the time (in seconds) required for two glass slides, with the gel sandwiched between them, to slip apart under a specified load. A shorter time indicates better spreadability. The procedure was repeated three times for each formulation, and the mean time was used to calculate the spreadability using the following formula:

$$S = (M \times L) / T$$

Where:

- **S** = Spread ability (g·cm/sec)
- **M** = Weight tied to the upper slide (20 g)

- **L** = Length of the glass slide (6 cm)
- **T** = Time taken for the slides to separate (in seconds) (Patel & Kamani, 2002).

5. Determination of Extrudability

The extrudability of the gel from its packaging was determined using a closed collapsible tube containing approximately 20 g of the formulation. The crimped end of the tube was firmly pressed while a clamp was applied to prevent any rollback. After removing the cap, the amount of gel extruded was collected and weighed, and the percentage of extruded gel was calculated (Nappinai et al., 2006).

Analysis of Drug Release Kinetics

To understand the mechanism of drug release from the gel formulations, the in vitro drug release data were fitted to different kinetic models: zero-order, first-order, Higuchi, and Korsmeyer-Peppas. The model that provided the best fit, identified by a correlation coefficient (R^2) value close to 1, was chosen to describe the release kinetics of the formulation (Dash et al., 2010).

I. Zero-Order Kinetics

This model describes drug release that is independent of concentration.

- **Plot:** Cumulative amount of drug released vs. time.
- **Equation (1):** $C = K_0 t$

Where K_0 is the zero-order rate constant and t is time. A linear plot suggests zero-order release.

II. First-Order Kinetics

This model describes drug release where the rate is proportional to the concentration of the drug remaining.

- **Plot:** Log cumulative percentage of drug remaining vs. time.
- **Equation (2):** $\text{Log}C = \text{Log}C_0 - (kt / 2.303)$

Where C_0 is the initial drug concentration, k is the first-order constant, and t is time.

III. Higuchi's Model

This model describes drug release as a diffusion process from a matrix, proportional to the square root of time.

- **Plot:** Cumulative percentage of drug released vs. square root of time.
- **Equation (3):** $Q = Kt^{1/2}$

Where K is a constant reflecting the system's design variables and t is time.

IV. Korsmeyer- Pappas Model

This model is used to describe drug release from a polymeric system where the mechanism may be complex.

- **Plot:** Log cumulative percentage of drug released vs. log time.
- **Equation (4):** $M_t/M\infty = Kt^n$ or $\log(M_t/M\infty) = \log K + n\log t$

Where $M_t/M\infty$ is the fraction of drug released at time t, K is a kinetic release constant, and n is the diffusional exponent that characterizes the release mechanism.

Interpretation of the Release Exponent (n):
The value of n indicates the mechanism of drug release:

- **n = 0.45:** Fickian diffusion.
- **0.45 < n < 0.89:** Non- Fickian or anomalous diffusion (a combination of diffusion and polymer swelling).
- **n = 0.89:** Case-II transport (zero-order release).

Interpretation of Diffusion Release Mechanisms:

Table6.5: Value of 'n' with corresponding Drug Release Mechanism

Release Exponent 'n'	Mechanism of drug transport
<0.5	Fickiantran sport
0.5<n<1.0	Non–Fickian Transport
1.0	Case II transport
>1.0	Super case II transport

Stability Assessment of Topical Herbal Gel Formulations

The primary objective of conducting stability studies is to evaluate the impact of various environmental conditions—particularly temperature and humidity—on the physical and chemical integrity of a pharmaceutical product over a defined period. In accordance with ICH (International Council for Harmonisation) guidelines, the stability evaluation of the developed topical herbal gel formulation was carried out over six months in a controlled stability chamber.

The formulations, each containing 5% of aqueous extracts from neem leaves (AENL), turmeric rhizomes (AETR), aloe leaves (AEAL), harsingar leaves (AEHL), tea leaves (AETL), and tulsi leaves (AETL), were placed in a calibrated humidity chamber (floor- standing model; dimensions: 300 × 300 × 300 mm; equipped with three independent compartments for separate control of humidity and temperature; Model: Technico, India). The formulations were subjected to three distinct storage conditions:

- **25°C ± 2°C / 60% RH ± 5% RH**
- **32°C ± 2°C / 60% RH ± 5% RH**
- **40°C ± 2°C / 75% RH ± 5% RH**

At predetermined time intervals—initial (0 month), 1st, 2nd, 3rd, and 6th months—samples were withdrawn and evaluated for critical quality attributes. These included organoleptic properties (colour and odour), homogeneity, pH, viscosity, net content, microbial contamination, and sterility. Observations were documented to determine any significant deviations, thereby establishing the formulation's shelf-life and storage stability (Aiyalu R et al., 2016).

Table6.6: Condition as per ICH Guidelines

Study	Storage condition		Minimum time
	Temperature	Relative humidity%	
Long-term	25ºC±2ºC	60%±5%RH	**12Months**
Intermediate	32ºC±2ºC	60%±5%RH	**6Months**
Accelerated	40ºC±2ºC	75%±5%RH	**3Months**

7. Results and Discussion

Results of Extractive value

With different solvents, extracts were prepared. Table 7.1 includes the percentages of extractive values measured with regard to air-dried drugs.

Table7.1: Extractive value of plants

S.No	Plants	Types of solvents	%w/w
1	Neem	Aqueous	5.342
2	Turmeric	Aqueous	6.198
3	Aloe	Aqueous	7.564
4	Harsingar	Aqueous	5.655
5	Tea	Aqueous	5.987
6	Tulsi	Aqueous	6.011

Table 7.1 illustrates the extractive values of various medicinal plants using aqueous solvents, highlighting the percentage yield of water-soluble phytoconstituents. Among the listed plants, Aloe demonstrated the highest extractive value at 7.564% w/w, indicating a substantial presence of water-soluble bioactive compounds such as polysaccharides, flavonoids, and glycosides. Turmeric (6.198%), Tulsi (6.011%), and Tea (5.987%) followed with moderately high extractive values, suggesting a good degree of solubility for their active constituents in water. In contrast, Neem (5.342%) and Harsinghar (5.655%)showed relatively lower extractive values, which may imply a lesser concentration of water-soluble compounds or a predominance of phytochemicals more efficiently extracted using organic solvents.

Results of Phytochemical Screening:

Phytochemical screening is a qualitative method used to identify the presence of various bioactive compounds in plant extracts. In the ethanolic extracts of Boerhaviadiffusa Linn.leaves, a range of phytochemicals—including alkaloids, carbohydrates, proteins, tannins, phenolic compounds, phytosterols, flavonoids, saponins, glycosides, and terpenoids—were detected. These constituents are recognized for their diverse pharmacological activities and play a significant role in the plant's therapeutic efficacy.

Phytochemical screening result of Neem extract:

Table7.2: Phytochemical screening result of Neem extract

S.No.	Chemical Test	Neem extract
1	Alkaloids	
	Mayer's test	+
	Dragendorff's test	-
	Wagner's test	+
	Hager's test	
2	Carbohydrates	
	Molisch's test	-
	Fehling's test	+
	Barfoed's test	+
3	Proteins and Free Amino acids	
	Ninhydrin test	-
	Biuret test	+
	Xanthoproteic test	+
4	Tannins and Phenolic Compounds	
	Ferric Chloride test	+
	Lead Acetate test	+
	Gelatin test	-
5	Phytosterols	
	Liebermann Burchard test	-
	Salkowski's test	+
6	Flavonoids	
	Shinoda test	+
7	Saponins	+
8	Glycosides	+
9	Terpenoids	
	Liebermann Burchard test	+

	Salkowski's test	-

Table 7.2 presents the outcomes of the preliminary phytochemical screening of Neem extract, highlighting the presence or absence of key classes of secondary metabolites as determined by standard chemical assays. Alkaloids were partially present, as evidenced by positive results with Mayer's and Wagner's reagents, though Dragendorff's test was negative. Carbohydrates also showed partial presence: Fehling's and Barfoed's tests were positive, suggesting the presence of reducing sugars, while Molisch's test was negative, indicating a lack of polysaccharides. Proteins and free amino acids were partially detected, with the Biuret and Xanthoprotein tests yielding positive results, whereas the Ninhydrin test was negative. Tannins and phenolic compounds were confirmed by positive reactions with Ferric chloride and Lead acetate, despite a negative result with the Gelatin test. Detection of phytosterols was inconsistent, with a positive Salkowski test but a negative Liebermann– Burchard test. Flavonoids, saponins, and glycosides all tested positive, confirming their presence in the extract. Lastly, terpenoids were indicated by a positive Liebermann–Burchard reaction but not corroborated by the Salkowski test.

Phytochemical screening result of turmeric extract:

Table7.3: Phytochemical screening result of Turmeric extract

S.No.	ChemicalTest	Turmericextract
1	Alkaloids	
	Mayer's test	-
	Dragendorff's test	+
	Wagner's test	+
	Hager's test	
2	Carbohydrates	
	Molisch's test	+
	Fehling's test	+
	Barfoed's test	-
3	Proteins and Free Amino acids	
	Ninhydrin test	+
	Biuret test	-
	Xantho Protein test	+
4	Tannins and Phenolic Compounds	

	Ferric chloride test	+
	Lead acetate test	+
	Gelatin test	-
5	Phytosterols	
	Liebermann Burchard test	+
	Salkowski's test	-
6	Flavonoid's	
	Shinoda test	+
7	Saponins	-
8	Glycosides	+
9	Terpenoids	
	Liebermann Burchard test	-
	Salkowski's test	-

Phytochemical screening of the Turmeric extract confirmed the presence of a diverse range of secondary metabolites, reinforcing its pharmacological significance. Alkaloids were detected through positive Dragendorff's and Wagner's tests, while Mayer's test was negative, suggesting the presence of specific alkaloid types. Carbohydrates were clearly present, as indicated by positive Molisch's and Fehling's tests; however, the negative Barfoed's test implies the predominance of reducing sugars rather than monosaccharides. Proteins and free amino acids were partially identified, with positive Ninhydrin and Xanthoproteic tests, though the Biuret test was negative. Tannins and phenolic compounds were strongly represented, showing positive reactions with both Ferric chloride and Lead acetate tests. Phytosterols were indicated by a positive Liebermann–Burchard test, though the Salkowski's test failed to confirm their presence. Flavonoids and glycosides were clearly present, as evidenced by positive Shinoda and glycoside tests, respectively. In contrast, saponins were absent, confirmed by a negative saponin test, and terpenoids were not detected, with both Liebermann–Burchard and Salkowski tests yielding negative results. Collectively, the findings highlight a rich phytochemical profile in Turmeric, particularly in flavonoids, phenolics, glycosides, and selected alkaloids, aligning with its well-established traditional medicinal uses.

Phytochemical screening results of aloe extract:

Table7.4: Phytochemical screening result of Aloevera extract

S.No.	Chemical Test	Aloeextract
1	Alkaloids	
	Mayer's test	-
	Dragendroff's test	-
	Wagner's test	+
	Hager's test	
2	Carbohydrates	
	Molisch's test	+
	Fehling's test	-
	Barfoed's test	-
3	Proteins and Free Amino acids	
	Ninhydrin test	+
	Biuret test	+
	Xantho Protein test	-
4	Tannins and Phenolic Compounds	
	Ferric chloride test	+
	Lead acetate test	-
	Gelatin test	-
5	Phytosterols	
	Libermann Burchard test	+
	Salkowski's test	-
6	Flavonoid's	
	Shinoda test	+
7	Saponins	+
8	Glycosides	-
9	Terpenoids	
	Libermann Burchard test	-

	Salkowski's test	+

Phytochemical screening of Aloe vera extract revealed the presence of several key secondary metabolites, supporting its known medicinal and therapeutic potential. Among the alkaloid tests, only Wagner's test yielded a positive result, while Mayer's and Dragendorff's were negative, suggesting the presence of specific alkaloidal compounds in low concentrations. Carbohydrates were partially confirmed by a positive Molisch's test; however, negative results from Fehling's and Barfoed's tests suggest the presence of complex or non-reducing sugars. Proteins and free amino acids were detected through positive Ninhydrin and Biuret tests, though the Xanthoprotein test was negative, indicating a selective presence of proteinaceous compounds. For tannins and phenolic compounds, only the Ferric chloride test was positive, whereas Lead acetate and Gelatin tests were negative, implying the presence of phenolics but not tannins. Phytosterols were indicated by a positive Liebermann–Burchard test, though the Salkowski test did not confirm their presence. Flavonoids were clearly identified via a positive Shinoda test, while saponins were also present. In contrast, glycosides were absent in the extract. Interestingly, terpenoids were detected through a positive Salkowski test, although the Liebermann–Burchard test for this class was negative. Overall, the Aloe vera extract contained notable quantities of flavonoids, saponins, phytosterols, phenolic compounds, proteins, and selective alkaloids, which collectively contribute to its therapeutic efficacy.

Phytochemical screening result of Harsing hare tract:

Table7.5: Phytochemical screening result of Harsing hare tract

S.No.	Chemical Test	Harsing hare tract
1	Alkaloids	
	Mayer's test	+
	Dragendorff's test	+
	Wagner's test	-
	Hager's test	
2	Carbohydrates	
	Molisch's test	-
	Fehling's test	+
	Barfoed's test	+
3	Proteins and Free Amino acids	
	Ninhydrin test	-

	Biuret test	-
	Xantho Protein test	+
4	Tannins and Phenolic Compounds	
	Ferric chloride test	-
	Lead acetate test	+
	Gelatin test	-
5	Phytosterols	
	Libermann Burchard test	+
	Salkowski's test	+
6	Flavonoid's	
	Shinoda test	-
7	Saponins	+
8	Glycosides	-
9	Terpenoids	
	Liebermann Burchard test	-
	Salkowski's test	+

Phytochemical screening of the Harsinghar extract revealed a diverse but selective profile of bioactive constituents. Alkaloidswere confirmed by positive results in Mayer's and Dragendorff's tests, while Wagner's test was negative, suggesting the presence of specific alkaloid subtypes. Carbohydrates were partially present, as indicated by positive Fehling's and Barfoed's tests; however, the negative Molisch's test suggests the dominance of simple reducing sugars rather than complex polysaccharides. Within the protein and amino acid group, only the Xanthoprotein test was positive, indicating the presence of aromatic amino acids, whereas Ninhydrin and Biuret tests were negative. For tannins and phenolic compounds, only the Lead acetate test gave a positive result, implying limited phenolic content. Phytosterolswere clearly detected, with both Libermann–Burchard and Salkowski tests yielding positive outcomes. Interestingly, the Shinoda testwas negative, indicating the absence of flavonoids. Saponinswere confirmed to be present, while glycosides were absent. Terpenoids were suggested by a positive Salkowski test, although the Libermann–Burchard test for this class was negative. Overall, the Harsinghar extract contains a range of phytochemicals including alkaloids, simple carbohydrates, phytosterols, saponins, and certain terpenoids that likely contribute to its traditional medicinal value.

Phytochemical screening result of Tea extract:

Table7.6: Phytochemical screening result of Tea extract

S.No.	Chemical Test	Tea extract
1	Alkaloids	
	Mayer's test	-
	Dragendorff's test	+
	Wagner's test	-
	Hager's test	
2	Carbohydrates	
	Molisch's test	+
	Fehling's test	-
	Barfoed's test	-
3	Proteins and Free Amino acids	
	Ninhydrin test	-
	Biuret test	+
	Xantho Protein test	-
4	Tannins and Phenolic Compounds	
	Ferric chloride test	+
	Lead acetate test	-
	Gelatin test	+
5	Phytosterols	
	Liebermann Burchard test	-
	Salkowski's test	+
6	Flavonoid's	
	Shinoda test	+
7	Saponins	+
8	Glycosides	-
9	Terpenoids	
	Liebermann Burchard test	+
	Salkowski's test	+

Phytochemical screening of the Tea extract revealed the presence of several important secondary metabolites. Among the alkaloid tests, only Dragendorff's reagent yielded a positive result, suggesting the presence of specific alkaloidal compounds, while Mayer's and Wagner's tests were negative. Carbohydrates were partially detected, as indicated by a positive Molisch's test, though negative results from Fehling's and Barfoed's tests point to the likely presence of complex or non-reducing sugars. Within the protein and amino acid group, the Biuret test was positive, indicating the presence of peptides or proteins, whereas both Ninhydrin and Xanthoprotein tests were negative.

Tannins and phenolic compounds were confirmed through positive reactions with Ferric chloride and Gelatin tests, though the Lead acetate test was negative, suggesting a specific subset of phenolic compounds. Phytosterols and terpenoids were indicated by a positive Salkowski test; however, only terpenoids were further confirmed by a positive Libermann– Burchard test, while this test was negative for phytosterols. The presence of flavonoids was supported by a positive Shinoda test, and saponins were also detected. In contrast, glycosides were absent, as all relevant tests returned negative results.

Phytochemical screening result of Tulsi extract:

Table7.7: Phytochemical screening result of Tulsi extract

S.No.	Chemical Test	Tulsi extract
1	Alkaloids	
	Mayer's test	+
	Dragendorff's test	-
	Wagner's test	+
	Hager's test	
2	Carbohydrates	
	Molisch's test	+
	Fehling's test	+
	Barfoed's test	+
3	Proteins and Free Amino acids	
	Ninhydrin test	-
	Biuret test	+
	Xantho Protein test	-

4	Tannins and Phenolic Compounds	
	Ferric chloride test	+
	Lead acetate test	+
	Gelatin test	+
5	Phytosterols	
	Libermann Burchard test	+
	Salkowski test	+
6	Flavanoids	
	Shinoda test	+
7	Saponins	+
8	Glycosides	+
9	Terpenoids	
	Libermann Burchard test	-
	Salkowski test	+

Phytochemical screening of the Tulsi extract revealed a rich and diverse profile of secondary metabolites, underscoring its therapeutic potential. Alkaloids were confirmed by positive results in Mayer's and Wagner's tests, while Dragendorff's test was negative, indicating the selective presence of certain alkaloid types. Carbohydrates were abundantly present, with all three standard tests—Molisch's, Fehling's, and Barfoed's—yielding positive results, suggesting the presence of both reducing sugars and monosaccharides. Among protein and amino acid tests, only the Biuret test was positive, pointing to the presence of proteins but not free amino acids.

Tannins and phenolic compounds were strongly indicated, with Ferric chloride, Lead acetate, and Gelatin tests all returning positive results, confirming their significant presence. Phytosterols were clearly detected through positive outcomes in both the Libermann– Burchard and Salkowski tests. Flavonoids, a major class of bioactives in Tulsi, were identified via a positive Shinoda test. Additionally, both saponins and glycosides were present, further contributing to the extract's medicinal efficacy. Terpenoids were indicated by a positive Salkowski test, although the Libermann–Burchard test did not confirm their presence in this class.

Results of thin layer chromatography

From the Rf value it was confirmed the presence of quercetin as flavanoidscompoundin the extract.

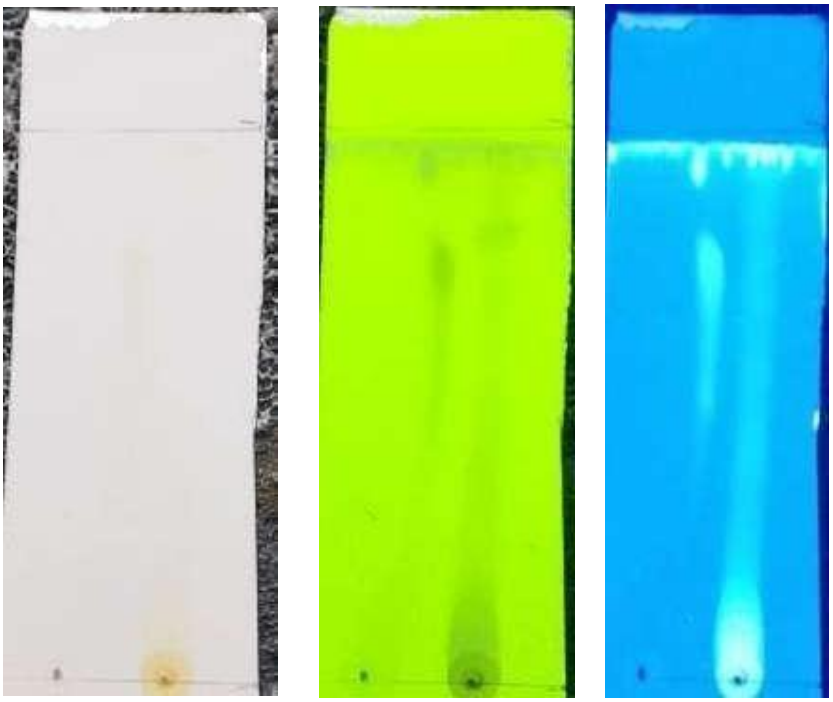
Table 7.8: Identification of phytoconstituents by TLC of Neem extracts (Quercetin)

Extract of Neem extract		
S. No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid(5:4:1)	**Rf value**
1.	**(Quercetin)** Dis. travel by mobile phase= 5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.52 Short-0.52 Normal-0.52
2.	**(Neem extract)** Dis. travel by mobile phase= 5cm No. of spot at long UV = 1 No. of spot at short UV = 3 No. of spot at normal light=3	 Long-0.4,0.76,0.9 Short-0.16,0.54,0.82 Normal-0.94
	Spot Sequence	
	Quercetin	1st
	Neem extract	2nd

Table 7.8 details the identification of phytoconstituents in Neem extract through Thin Layer Chromatography (TLC), using Quercetin as the standard reference compound. The chromatographic analysis was performed using a mobile phase composed of Toluene: Ethyl acetate: Formic acid (5:4:1), with the solvent front migrating 5 cm. The Quercetin standard produced a single spot under long-wave UV, short-wave UV, and visible light, consistently exhibiting an **Rf value of 0.52.**

In contrast, the Neem extract displayed a more complex chromatographic profile. Under **long-wave UV light**, three distinct **spots were** observed at **Rf values of 0.40, 0.76, and 0.90, while under short-wave UV**, three different spots appeared **at 0.16, 0.54, and 0.82**, indicating the presence of multiple UV-active phytoconstituents. Under **visible light**, a single spot was noted at **Rf 0.94**, suggesting at least one compound lacking UV absorbance, possibly a non-aromatic or weakly conjugated molecule.

Notably, the spot at **Rf 0.54** under short UV is very close to the **Rf 0.52** of the Quercetin standard, suggesting the potential presence of Quercetin or a structurally related flavonoid within the Neem extract.



Normal Light Short UV Long UV

Figure: Thin layer chromatography of Neem extract (Quercetin)

Table 7.9: Identification of Phytoconstituents by TLC of Turmeric extracts (Quercetin)

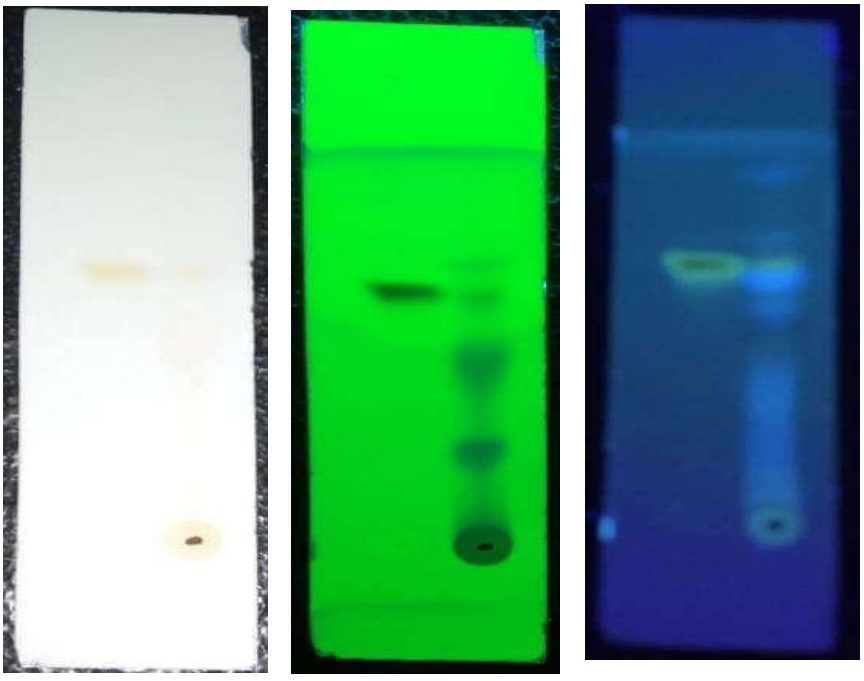
Extract of Turmeric extract		
S. No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid (5:4:1)	***Rf* value**
1.	**(Quercetin)** Dis. travel by mobile phase= 5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.51 Short-0.51 Normal-0.51
2.	**(Turmeric extract)** Dis. travel by mobile phase= 5cm No. of spot at long UV = 5 No. of spot at short UV = 5 No. of spot at normal light=1	 Long-0.16,0.38,0.48,0.51,0.56 Short-0.16,0.38,0.48,0.51,0.56 Normal-0.51

	Spot Sequence	
	Quercetin	1st
	Turmeric extract	2nd

Table 7.9 presents the results of phytoconstituent identification in Turmeric extract using Thin Layer Chromatography (TLC), with **Quercetin** employed as the reference standard. The chromatographic procedure utilized a mobile phase consisting of **Toluene: Ethyl acetate: Formic acid (5:4:1),** with the solvent front migrating **5 cm**. Quercetin produced a single, sharp spot under long-wave UV, short-wave UV, and visible light, with a consistent ***Rf*** **value of 0.51**, confirming its purity and suitability as a reference compound.

In the Turmeric extract, **five distinct spots** were observed under both long- and short-wave UV light at **Rf values of 0.16, 0.38, 0.48, 0.51, and 0.56**, indicating the presence of multiple UV-active phytochemicals. Under **visible light**, only a single spot at Rf 0.51 was detected, aligning exactly with the Rf of Quercetin. This correspondence suggests that the *Turmeric* extract likely contains **Quercetin or a closely related flavonoid**, which appears to be a **major constituent**, given its visibility across all detection methods.

The presence of additional spots at other Rf values highlights a **diverse array of polyphenolic compounds** or structurally related metabolites unique to *Turmeric*, further reinforcing its phytochemical complexity and therapeutic relevance.



Normal Light Short UV Long UV

Figure 7.2: Thin layer chromatography of Turmeric extract (Quercetin)

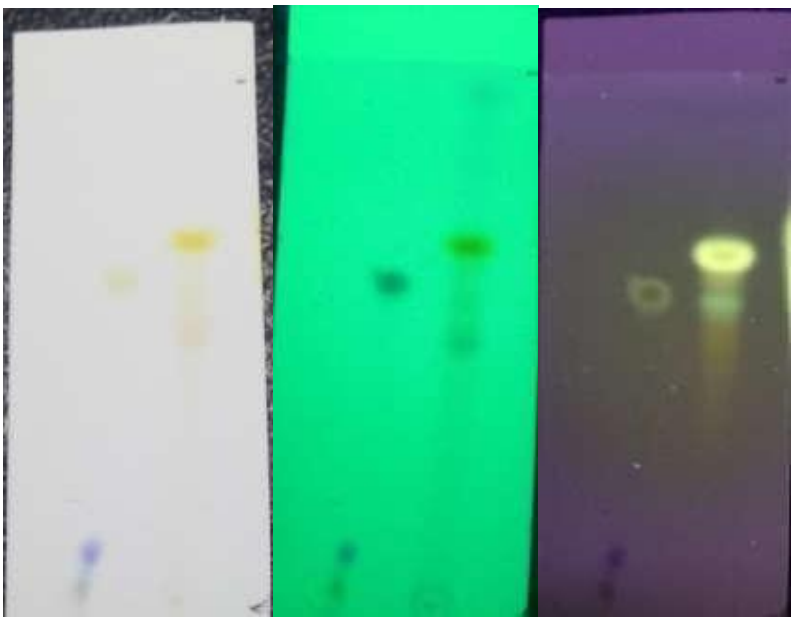
Table 7.10: Identification of Phytoconstituents by TLC of Aloe vera extracts (Quercetin)

Extract of Aloevera		
S. No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid (5:4:1)	*Rf* value
1.	**(Quercetin)** Dis. travel by mobile phase= 5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.70 Short-0.70 Normal-0.70
2.	**(Aloevera extract)** Dis. travel by mobile phase= 5cm No. of spot at long UV = 1 No. of spot at short UV = 3 No. of spot at normal light=3	 Long-0.80, Short-0.70,0.78,0.80 Normal-0.60,0.70,0.80
	Spot Sequence	
	Quercetin	1st
	Aloevera extract	2nd

Table 7.10 outlines the identification of phytoconstituents in Aloe vera extract using Thin Layer Chromatography (TLC), with **Quercetin** serving as the standard reference compound. The TLC analysis was conducted using a mobile phase of **Toluene: Ethyl acetate: Formic acid (5:4:1),** with the solvent front migrating 5 cm. Quercetin exhibited a single, sharp spot under long-wave UV, short-wave UV, and visible light, consistently yielding an ***Rf* value of 0.70**, confirming its purity and stability under all detection conditions.

The Aloe vera extract, in contrast, exhibited a more complex chromatographic profile. Under **long UV,** a single spot appeared at **Rf 0.80.** Under **short UV**, three distinct spots were detected **at Rf values of 0.70, 0.78, and 0.80,** while under **visible light**, spots were observed at 0.60, 0.70, and 0.80. The consistent presence of the **Rf 0.70** spot under both short UV and visible light matches precisely with that of Quercetin, suggesting the presence of **Quercetin or a structurally related flavonoid** in the Aloevera extract.

The additional spots at **higher Rf values (0.78 and 0.80)** indicate the presence of **non-polar flavonoids or phenolic compounds**, potentially unique to Aloe vera. The sequence and consistency of spot development suggest that Quercetin is one of the earlier-developing compounds, followed by a broader array of phytoconstituents. These findings support the conclusion that Aloe vera contains a complex mixture of secondary metabolites, including **Quercetin-like compounds** and other bioactive constituents.



Normal light **Short UV** **Long UV**

Figure 7.3: Thinlay Chromatography of Aloe Vera extracts (Quercetin)

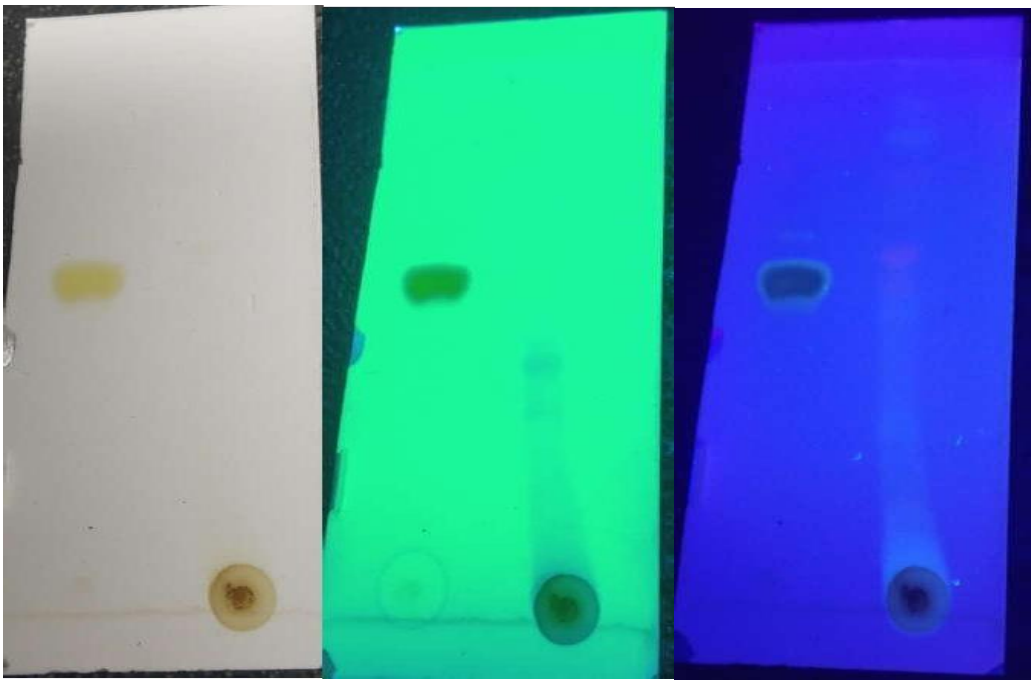
Table 7.11: Identification of phytoconstituents by TLC of Harsingar extract (Quercetin)

Harsingar extract		
S.No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid (5:4:1)	***Rf* value**
1.	**(Quercetin)** Dis. travel by mobile phase= 5.5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.52 Short-0.52 Normal-0.52
2.	**(Harsingar Extract)** Dis. travel by mobile phase= 5.5cm No. of spot at long UV = 4 No. of spot at short UV=4 No. of spot at normal light=1	 Long-0.44,0.78,0.82,0.92 Short-0.24,0.46,0.52,0.62 Normal-0.56
	Spot Sequence	
	Quercetin	1st
	Harsingar Extract	2nd

Table 7.11 presents the Thin Layer Chromatography (TLC) identification of phytoconstituents in Harsinghar (Nyctanthes arbor-tristis) extract, using Quercetin as a standard reference compound. The mobile phase employed was Toluene: Ethyl acetate: Formic acid (5:4:1), and the solvent front migrated 5.5 cm. Quercetin produced a single, well-defined spot under long-wave UV, short-wave UV, and visible light, with a consistent Rf value of 0.52, confirming its purity and reliability as a marker compound.

In contrast, the Harsinghar extract displayed a more complex phytochemical profile. Under long-wave UV light, four distinct spots were observed at Rf values of 0.44, 0.78, 0.82, and 0.92, suggesting the presence of multiple UV-fluorescent compounds. Under short-wave UV, four spots appeared at Rf 0.24, 0.46, 0.52, and 0.62. Notably, the spot at Rf 0.52 aligns precisely with that of Quercetin, indicating the likely presence of Quercetin or a structurally related flavonoid in the extract. Under visible light, a single spot was observed at Rf 0.56, suggesting the presence of at least one compound possessing visible chromophores.

Overall, the TLC analysis confirms that Harsinghar contains a variety of phytoconstituents, including a compound closely resembling Quercetin, along with other UV-active and chromophoric secondary metabolites.



Normal Light **Short UV** **Long UV**

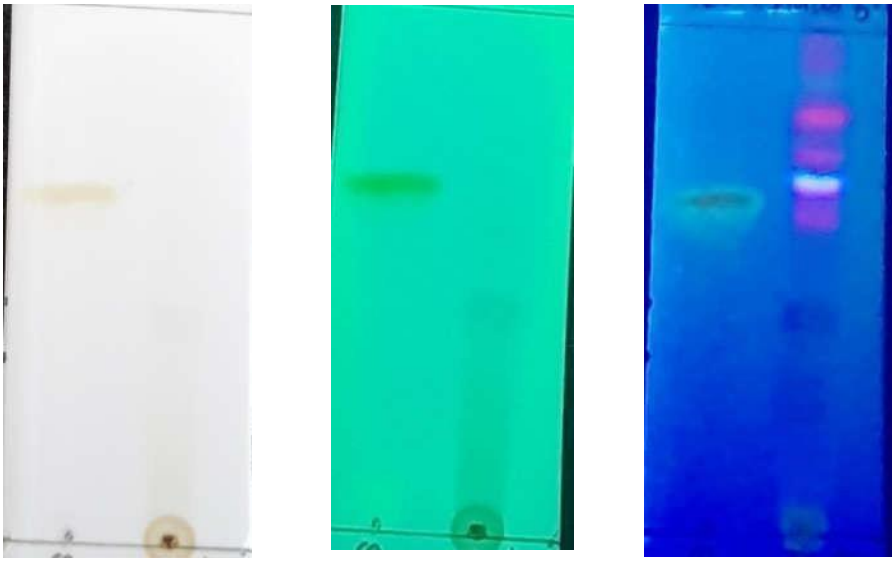
Figure 7.4: Thin layer chromatography of Harsinghar extract (Quercetin)

Table 7.12: Identification of phytoconstituents by TLC of Tea extracts (Quercetin)

Tea extract		
S.No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid (5:4:1)	***Rf* value**
1.	**(Quercetin)** Dis. travel by mobile phase= 5.5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.52 Short-0.52 Normal-0.52
2.	**(Tea Extract)** Dis. travel by mobile phase= 5.5cm No. of spot at long UV = 5 No. of spot at short UV=2 No. of spot at normal light=1	 Long-0.44,0.52,0.58,0.78,0.82 Short-0.24,0.46 Normal-0.56
	Spot Sequence	
	Quercetin	1st
	Tea Extract	2nd

Table 7.12 outlines the Thin Layer Chromatography (TLC) identification of phytoconstituents in the Tea extract, using Quercetin as the standard marker. The analysis was conducted with a mobile phase composed of Toluene: Ethyl acetate: Formic acid (5:4:1), with the solvent front migrating 5.5 cm. Quercetin, used as the reference compound, produced a single distinct spot under long UV, short UV, and visible light at an Rf value of 0.52, confirming its identity, purity, and consistent chromatographic behavior.

In comparison, the Tea extract exhibited a more complex phytochemical profile. Under long- wave UV, five spots were observed at Rf values of 0.44, 0.52, 0.58, 0.78, and 0.82, indicating the presence of a diverse mixture of polyphenols and flavonoids. Notably, the spot at Rf 0.52 aligned exactly with that of Quercetin, confirming its presence in the extract. Under short-wave UV, two additional spots appeared at Rf 0.24 and 0.46, suggesting the presence of other UV-active constituents not detected under long UV. Under visible light, a single spot was observed at Rf 0.56, likely representing a compound with strong chromophoric properties or present in higher concentration.The development pattern reinforces the identification of Quercetin as one of the primary components, followed by a broader spectrum of phytochemicals unique to Tea, consistent with its well-established richness in flavonoids and phenolic antioxidants.



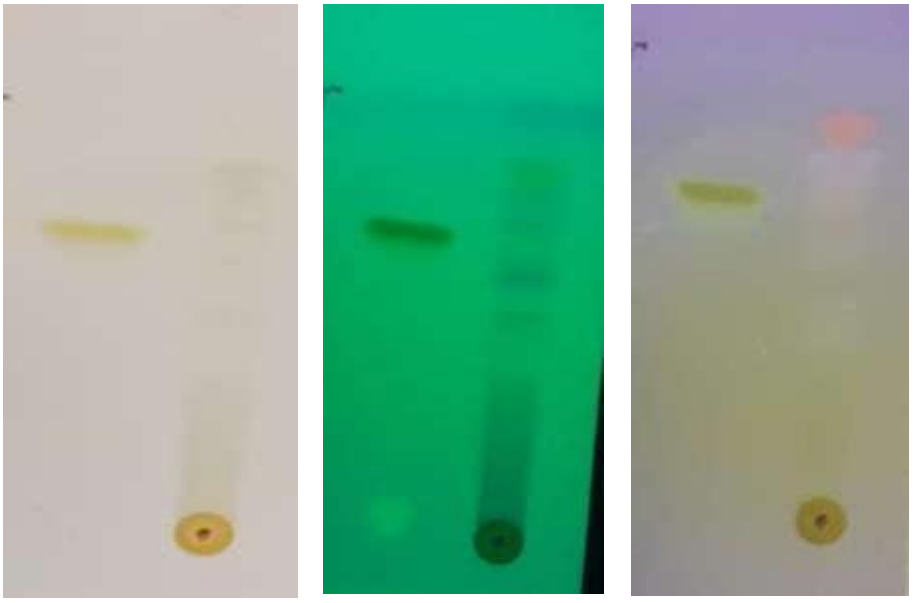
Normal Light **Short UV** **Long UV**

Figure7.5: Thin layer chromatography of Tea extract (Quercetin)

Table 7.13: Identification of phytoconstituents by TLC of Tulsi extracts (Quercetin)

Extract of Tulsi		
S.No.	**Mobile phase** Toluene: Ethyl acetate: Formic acid (5:4:1)	***Rf* value**
1.	**(Quercetin)** Dis. travel by mobile phase= 5cm No. of spot at long UV= 1 No. of spot at short UV=1 No. of spot at normal light=1	 Long-0.60 Short-0.60 Normal-0.60
2.	**(Tulsi extract)** Dis. travel by mobile phase= 5cm No. of spot at long UV = 2 No. of spot at short UV = 5 No. of spot at normal light=0	 Long-0.60,0.86 Short-0.48,0.56,0.60,0.66, 0.86 Normal-0
	Spot Sequence	
	Quercetin	1st
	Tulsi Extract	2nd

Table 7.13 presents the Thin Layer Chromatography (TLC) analysis of phytoconstituents in the Tulsi extract, using Quercetin as the reference standard. The TLC was carried out with a mobile phase composed of Toluene: Ethyl acetate: Formic acid (5:4:1), and the solvent front migrated 5 cm. Quercetin, serving as the standard, exhibited a single, well-defined spot under long UV, short UV, and visible light, with a consistent Rf value of 0.60, confirming its purity and stable chromatographic behavior.In the Tulsi extract, a more complex profile was observed. Under long-wave UV, two spots appeared at Rf values of 0.60 and 0.86. Under short-wave UV, five distinct spots were detected at Rf 0.48, 0.56, 0.60, 0.66, and 0.86, indicating the presence of multiple UV-active phytochemicals. Notably, no spots were observed under visible light, suggesting that the detected compounds may lack strong chromophoric groups or are present at concentrations below the detection threshold in the visible spectrum. The presence of a spot at Rf 0.60under both long- and short-wave UV, matching precisely with the Quercetin standard, strongly suggests that Tulsi contains Quercetin or a structurally related flavonoid. The appearance of additional spots further highlights the rich polyphenolic and flavonoid diversity within the extract. The order of spot development also indicates that Quercetin elutes early, followed by a more complex phytochemical fingerprint characteristic of Tulsi.



Normal light Short UV Long UV

Figure 7.6: Thin layer chromatography of Tulsi extract (Quercetin)

Formulation of Polyherbal Gel:

In the present study, seven herbal gel formulations were developed for the topical delivery of active plant extracts. Topical application was selected due to its direct targeting of lesions, offering enhanced localized efficacy and reducing the likelihood of systemic side effects commonly associated with herbal drugs. The selection of an appropriate topical base was crucial to ensure optimal flow properties, spread ability, and release behavior of the active ingredients. To achieve

this, formulation components were selected based on pharmaceutical acceptability and compliance with the Generally Recognized as Safe (GRAS) classification. The optimized formulation included Carbopol® 940 as the gelling agent, propylene glycol as a co-solvent, distilled water as the solvent, Triethanolamine for pH adjustment, and a suitable preservative to ensure stability. Preliminary trials revealed that Carbopol® 940 at concentrations between 1% and 3% w/w produced opaque, stable gels. However, higher
concentrations (5% and 10% w/w) resulted in excessively viscous gels with poor spread ability. Therefore, a concentration of 3% w/w Carbopol® 940 was found to be optimal for incorporating plant extracts into the gel matrix.

The final topical formulations (F1–F6 and PF), prepared using Carbopol® 940, exhibited acceptable consistency, appropriate thickness, and uniform application on the skin. Triethanolamine, as suggested by Allen (1999), was employed to neutralize the Carbopol and achieve the desired pH, while distilled water served as the formulation vehicle.

Characterization of Herbal Gel:

Carbopol® 940 is a cross-linked polyacrylate polymer that forms gels by entrapping water within microcells in the presence of an aqueous environment. It is a highly efficient rheology modifier, known for imparting high viscosity and excellent suspension capacity. Hydrophilic compounds can be retained in solution within these aqueous microstructures, while non- hydrophilic compounds are maintained in stable suspension due to the polymer's robust suspension properties. This results in the formation of a stable, easy-to-apply gel formulation capable of effectively delivering active compounds upon topical application. Furthermore, Carbopol-based gels can be combined with other excipients to enhance clinical performance (Date et al., 2006).

Formulations F1–F6, along with the Polyherbal formulation (PF), were evaluated for various parameters, including pH, viscosity, spread ability, homogeneity, and in vitro antimicrobial activity.

Ph Analysis: The pH of each gel formulation was measured using a digital pH meter at room temperature. All formulations exhibited pH values within the physiological range of healthy human skin (5.4–5.9), indicating good compatibility with skin and minimal risk of irritation in pH-sensitive individuals. The consistency in pH across all batches also reflects a reliable and reproducible manufacturing process.

Viscosity Measurement: Viscosity was determined using a Brookfield Viscometer (Brookfield Engg. Labs Inc., Stoughton, MA, USA). Readings were recorded 60 seconds after the initiation of spindle rotation to ensure display stability. An average viscosity value was calculated from a maximum of three readings. The gel formulations exhibited intrinsic
viscosities ranging from 6000 to 6900 centipoise (cP), demonstrating desirable rheological characteristics for topical application.

Spread ability Test: To evaluate the ease of spreading on the skin, a custom test method was developed, and results were expressed in g·cm/sec (see Table 7.14 and Table 7.15). The values indicated that all formulations were readily spreadable, suggesting user-friendly application properties.

Extrudability: More than 90% of the contents of gel formulations F1 to F6 were extricable, indicating excellent extrudability. The PF formulation showed 80% extrudability, which is considered good based on the standard grading scale (>90%: excellent, >80%: good, >70%: fair).

Table7.14: pH, Viscosity and spread ability of optimized herbal gel formulations

Formulation Code	pH ± SD (n=3)	Viscosity (cp)±SD (n=3)	Spread ability ±SD (n=3)(g.cm/sec)
F1	5.76±0.09	6704±50	7.8±0.08
F2	5.72±0.06	6896±40	7.9±0.06
F3	5.79±0.03	6087±75	8.7±0.13
F4	5.85±0.07	6756±60	7.5±0.07
F5	5.65±0.05	6455±75	8.4±0.09
F6	5.59±0.05	6445±75	8.3±0.09
PF	5.49±0.02	6525±65	8.2±0.11

Table 7.15: Physical appearance and extrudability of optimized herbal gel formulations

Formulation Code	Physical appearance	Extrudability
F1	eenish, smooth and translucent	Excellent
F2	Dark green, smooth, homogenous, translucent	Good
F3	Dark greenish, homogenous,smooth, translucent	Good
F4	Dark green, smooth, homogenous, translucent	Excellent

F5	Dark greenish, homogenous,smooth, translucent	Excellent
F6	eenish, smooth and translucent	Good
PF	Dark greenish, smooth, homogenous, translucent	Excellent

Drug Kinetic Release:

The drug release data from all formulation batches were analyzed using various kinetic models, including zero-order, first-order, and the Higuchi square root of time model, to determine the release mechanism. Linear regression analysis was applied to evaluate the best-fitting model for each batch, with the results summarized in Table 7.16. Among the models tested, the Higuchi model consistently demonstrated higher correlation coefficients (r^2 values), indicating that the drug release followed a diffusion-controlled mechanism and best fit the Higuchi kinetics compared to zero-order and first-order models.

Table7.16: Co-efficient of correlation for poly herbal formulation

Zero Order		First Order		Higuchi Model		Korsmeyer- peppas	
R2	K0	R2	K1	R2	KH	R2	K
0.456	0.001	0.971	-0.001	0.933	0.022	0.935	0.602

Stability Testing:

Stability testing of the PF formulation, developed using Carbopol 934, was performed in accordance with ICH guidelines to evaluate its consistency, protection, and efficacy over its intended shelf life. This formulation was selected due to its superior quality characteristics. Throughout the stability study conducted at intervals of 0, 1, 2, 3, and 6 months, no significant changes were observed in critical parameters, including colour, odour, homogeneity, pH, viscosity, and net content of the topical herbal gel. These findings confirm that the PF formulation remained physically and chemically stable over the study period. The stability of the topical gel is well supported by the data presented in Table 7.17, Table 7.18, and Table 7.19.

Table7.17: Stability Studies of Topical Herbal Gel Formulation of PF

S.No.	Storagecondition						
	Months(25°C±2°C/60%RH±5%RH)						
		0	1	2	3	6	12
1	Color		Nochangeincolor				
2	Odour		Nochangeinodour				
3	Homogeneity		Smooth				
4	pH	6.4	6.44	6.42	66.34	6.43	6.49

5	Viscosity (poise)	0.387	0.385	0.385	0.370	0.385	0.375
6	tcontent(%)	99	99	99	97	99	98.5

Table7.18: Stability Studies of Topical Herbal Gel Formulation of PF

Storagecondition						
	Months(32°C±2°C/60%RH±5%RH)					
		0	1	2	3	6
1	Color	Nochangeincolor				
2	Odour	Nochangeinodour				
3	Homogeneity	Smooth				
4	pH	6.44	6.42	6.34	6.43	6.49
5	Viscosity(poise)	0.385	0.385	0.370	0.385	0.375
6	Netcontent(%)	99	99	97	99	98.5

Table7.19: Stability studies of topical herbal gel formulation of PF

Storagecondition					
	Months(40°C±2°C/75%RH±5%RH)				
		0	1	2	3
1	Color	Nochangeincolor			
2	Odour	Nochangeinodour			
3	Homogeneity	Smooth			
4	pH	6.44	6.42	6.34	6.43
5	Viscosity(poise)	0.385	0.385	0.370	0.385
6	Netcontent(%)	99	99	97	99

8. Summary and Conclusion

Human skin, the body's outer layer, is the strongest organ in the body. It also represents the first line of defence; it is a human being's introductory identification to the universe. The desire to look good is, therefore, a human weakness and is as old as the roots of human beings themselves. Cosmetics are substances that are specifically formulated to improve beauty and increase a person's attractiveness.

Skin has been depicted as the body's largest organ as it compresses or secures the entire body. The vast majority of the external body is protected by skin, which varies in thickness and shape. The exterior skin layer is known as the epidermis. Epidermis cells continuously multiply and repair layers. This is important because the skin is the primary blockade that protects the body from harmful elements. The covered layer is called the dermis. The Derma layer nourishes the skin and provides solid support. Versatile tissue from Fibro gives the skin its structure. Two areas consist of Dermas. Slim papillary dermis are in the upper zone, and reticular dermis are in the lower zone. Hypoderms are the deepest sheet. Hypoderms, mainly fat tissue, vary the most. Both skin layers are connected by sebaceous glands, hair follicles, sweat glands and nerve filaments. Epidermis is considered vascular, but dermis is vascular.

Cosmetic embarrassments, however, continue to be a hurdle to the protection of appearance, occurring worldwide and comprising about 34 percent of all occupational diseases.

They impact people from neonates to the elderly of all ages and serve many causes for medical consultation, including rashes, viral infections, fungal infections, bacterial infections, pigmentation, and acne. Acne has served as an all-time favourite topic of concern among these pathogens, as it affects about 85 percent of adolescents and can extend to adulthood. It has been calculated that the neurological, social and emotional disability arising from acne is equal and in some cases greater than that of diabetes, arthritis, epilepsy and asthma.

Acne vulgaris can cause scarring, leading to self-esteem issues over life. Acne is estimated to affect 650 million individuals worldwide and is the world's eighth most prevalent disease. Most individuals assume that acne vulgaris appears to vanish with time and decreases or decreases with age. There is no way, however, to predict how long it will take to begin to decrease or fully disappear. It has been found that traditional medicinal tools, especially plants, play a significant role in the management of skin disorders. They have been used in the treatment of skin ailments in many countries around the world, contributing substantially to the population's primary health care. India is blessed with the traditional medicinal system's rich heritage and rich biodiversity of the botanicals needed for the treatments. Natural therapy is inexpensive and said to be healthy. The current research is interested in researching botanicals for new antimicrobial agents for the treatment of acne.

It can be inferred, on the basis of the current analysis, that botanicals retain significant antimicrobial activity and serve as a potential source of herbal formulation production in the treatment of acne vulgaris. A large variety of herbal plants with an antibacterial spectrum against Propionibacterium acnes (anaerobic) and Staphylococcus epidermidis (aerobic) bacteria have been listed after all the screening procedures.

Conclusion

The purpose of the present work was to establish and classify polyherbal formulations for the treatment of acne vulgaris. The extracts of neem, tulsi, harsingar, aloe, tea and turmeric leaves and rhizomes were collected from Jhansi District, (U.P.), India, during the month of December 2023.

The topical solution is very effective since the medicine is applied directly to the lesions and side effects are less likely to be caused by the herbs. In order to prepare topical formulations with optimal flow, spreadability and release properties, selection of the topical basis was therefore very critical. For the preparation of the gel formulation, various components were selected. The topical gels F1 to F6, PF prepared with carbopol® 940, showed an appropriate thickness and uniformly dispersed to the skin when applied. Triethanolamine was used as a pH changing agent to neutralise carbomer® 940 gel and distilled water was used as a formulation vehicle.

All the information was fitted into different kinetic models such as zero order, first order and higuchi model to find out the drug release from the data collected. For all the batches and their effects, linear regression analysis was performed.

After 0,1,2,3 and 6 months of stability testing, no improvement in colour, odour, homogeneity, pH, viscosity and net content of the topical herbal gel formulation was observed for this formulation. The study results clearly showed that the formulated topical gel PF was found to be stable.

5.342 percent w/w extractive value of aqueous extract of neem leaves. 6.011 percent w/w extractive value of aqueous extract of tulsi leaves. 6.198 percent w/w extractive value of aqueous extract of Turmeric leaves. Aqueous Harsingar extract with an extractive value of 5.655 percent w/w. Aqueous tea extract with an extractive value of 5.987% w/w. Aqueous aloe extract with an extractive value of 7.564% w/w. The effect of the operation of anti acne using various extracts was defined as follows. First of both, all extracts were made with various plant extracts and the anti-acne activity extracts tested on different models were used. For further analysis, those extracts which demonstrated potent activity were used. The extract of neem leaves shows an inhibition zone of 14.31, 13.4 and 11.8 mm respectively, and clindamycin. Aqueous extract of turmeric rhizomes 13.53, 14.17- and 12.8-mm inhibition region, respectively, and clindamycin. Aqueous extract of Aloe leaves 13.6, 12.15- and 13.1 mm inhibition region, respectively, and clindamycin. Harsingar's Aqueous Extract leaves 12.7, 11.43 and 11.83 mm of inhibition zone and clindamycin respectively. 13.50, 14.67- and 12.83-mm inhibition zone of aqueous extract of tea leaves and clindamycin, respectively. Aqueous extract of 15.13, 13.47- and 15.87mm inhibition zone of tulsi leaves and clindamycin, respectively. Polyherbel formulation 16.33, 14.4- and 14.9-mm zone of inhibition and clindamycin respectively after antibacterial assay against Propionibacterium acne, S. epidermidsand S. aureus after 24 hr. The MIC was defined as the lowest concentration of the compound to inhibit the growth of microorganisms.

1. Aditi Vats, Pranav Sharma., formulation and evaluation of topical anti acne formulation of coriander extract. Int. J. Pharm. Sci. Rev. Res., 2012; 16(2), 97-103.
2. Aisha Saleem, Irum Naureen, Muhammad Naeem, Hafiza Safoora Murad, Samra Maqsood, Gulnaz Tasleem. Aloe Vera Gel Effect on Skin and Pharmacological Properties. Sch Int J Anat Physiol. 2022; 5(1): 1-8.
3. Aiyalu R, Govindarjan A, Ramasamy A 2016 Formulation and evaluation of topical herbal gel for the treatment of arthritis in animal model. Brazilian Journal of Pharmaceutical Science vol. 52, n. 3, 493-507.
4. Aladaq H, Ercisli S, Gormez A, Yesil D.Z, Yesil M. Antifungal activity of green tea leaves (Camellia sinensis). Res Art 2009; 5: 437-440
5. Alege G. O. and Ojomah B. O., Cytotoxic effects of Aloe vera leaf extract on Allium sativum root tips. European Journal of Experimental Biology, 2014; 4(4):9-14.
6. Ammosov, S., and Litvienko, V.I., 2013, Triterpenoids of plants of Glycyrrhiza L and Meristotropis Fisch. Et Mey Genuses, *Pharmaceutical Chemistry Journal,* Vol. 37, pp. 83-94.
7. Ansong JA, Asante E, Johnson R, Boakye-Gyasi ME, Kuntworbe N, Owusu FW, Ofori-Kwakye K. Formulation and Evaluation of Herbal-Based Antiacne Gel Preparations. BioMed Research International. 2023; 2023(1):7838299.
8. Arti Jain, Abhishek Mehta, Sourabh Jain, Gaurav Saxena. Antimicrobial activity of tulsi (ocimum sanctum linn): a systematic review. Int. J. Res. Ayurveda Pharm. 2022; 13 (4), 172-175.
9. Asnaashari S, Kazemnezhad M, Masoud F, Javadzadeh Y. An overview on the anti-acne properties of herbal essential oils. Journal of Herbal Medicine. 2023; 38:100642.
10. Asri SR M, Safitri R. Antibacterial Activity Test of Anti-Acne Gel Preparations Containing Ethanol Extracts of Bidara Arab Leaf (Ziziphus spina-christi (L.) Desf) Againts Propionibacterium acnes. PCJN: Pharmaceutical and Clinical Journal of Nusantara. 2023; 2(01):19-29.
11. Atul N Chandu, Santhosh kumar. C, Chiranjib Bhattacharjee, Subal debnath, K. kamala kannan. Studies on immunomodulatory activity of Aloe vera (Linn). International journal of applied biology and pharmaceutical technology. 2011; Vol. 2, Issue 1, 19-22.

12. Azam Rezvanirad, Mahnaz Mardani, Hedayatollah Shirzad, Seyyed Mohammad Ahmadzadeh, Sedigheh Asgary, Azar Naimi, Ghafar Mahmoudi. Curcuma longa: A review of therapeutic effects in traditional and modern medical references. Journal of chemical and pharmaceutical sciences. 2016; Vol. 9, Issue 4, 3438-3448.
13. Behl, PN., Srivastava, G., 2002, *Herbs Useful in Dermatological Therapy*, 2nd edition. New Delhi, India: CBS Publishers. Benjamin/Cummings Publishing Co., Available online from The National Health Museum, Access Excellence Activities Exchange.
14. Betts J. W., Wareham D. W. In vitro activity of curcumin in combination with epigallocatechin gallate (EGCG) versus multidrug-resistant Acinetobacter baumannii. BMC Microbiology. 2014;14(1):p. 172.
15. Biswas KP (2006). Description of tea plant. In Encyclopaedia of Medicinal Plants. New Dehli: Dominant Publishers and Distributors, pp. 964-966.
16. Biswas, K., Chattopadhyay, I., Banerjee, R.K., Bandyopadhyay, U., 2002. Biological activities and medicinal properties of Neem (*Azadirachta indica*). Current Science 82(11), 1336–1345.
17. Burkhart, C.N., and Burkhart, C.G., 2003, Microbiologic principle of biofilms as a major factor in pathogenesis of acne, *International Journal of Dermatology*, Vol. 42, pp. 925-27.
18. C.T. Ramachandra and P. Srinivasa Rao. Processing of Aloe Vera Leaf Gel: A Review. American Journal of Agricultural and Biological Sciences, 2008; 3(2):502-510.
19. Cabrera C, Artacho R, Gime´nez R (2006) Beneficial effects of green tea—a review. J Am Coll Nutr 25:79–99
20. Carson, C.F., Mee, B.J., and Riley, T.V., 2002, Mechanism of action of Melaleuca alternifolia (teatree) oil on Staphylococcus aureus determined by time–kill, lysis, leakage, andsalt tolerance assays and electron microscopy. Antimicrobial Agents Chemotherapy, Vol. 46, pp. 1914–20.
21. Cellini L, Di Bartolomeo S, Di Campli E, Genovese S, Locatelli M, Di Giulio M. In vitro activity of Aloe vera inner gel against Helicobacter pylori strains. Letters in Applied Microbiology. 2014; 59(1):43-88.
22. Ch, M.T., 2010, Pathogenesis of Acne Vulgaris: Simplified, *Journal of Pakistan Association of Dermatologists,* Vol. 20, pp. 93-97.

23. Chaudhary, S., 2010, Antiacne activity of some Indian herbal drugs, *International Journal of Pharma Professional's Research, Vol, 1, issue1, pp.* 78-80.
24. Chomnawang M. T., Surassmo S., Nukoolkarn V. S., Gritsanapan W., (2005). "Antimicrobial effects of Thai medicinal plants against acne-inducing bacteria," Journal of Ethnopharmacology, vol. 101, no. 1–3, pp. 330–333.
25. Chopra, I.C., Gupta, K.C., Nair, B.N., 1952. Biological activities and medicinal properties of neem (Azadirachta indica). Indian Journal of Medicinal Research 40, 511–515.
26. Darshan Dharajiya, Nalin Pagi, Hitesh Jasani and Payal Patel. Antimicrobial Activity and Phytochemical Screening of Aloe vera (Aloe barbadensis Miller). Int. J. Curr. Microbiol. App. Sci., 2017; 6(3): 2152-2162.
27. Dash TR and Verma P (2013): Matrix Tablets: An Approach towards Oral Extended Release Drug Delivery. International Journal of Pharma Research & Review, 2(2): 12-24
28. Daud, F. S., Wankhede, S., Joshi, M., Pande, G., 2013, Development of herbal antiacne gel and its evaluation against acne causing bacteria propionibacterium acne and staphylococcus epidermidis, *Inernational Journal Reasearch Ayurveda Pharmacy*, Vol. 4, Issue 5,pp. 781-786.
29. Davis R H, Leither J M, Wound Healing: Oral and topical activity of aloe vera. J Am Padiatri Med ASS 1989; 79(11):559-62.
30. Davood Hekmatpou, Fatemeh Mehrabi, Kobra Rahzani, Atefeh Aminiyan. The effect of aloe vera clinical trials on prevention and healing of skin wound: a systematic review. Iranian journal of medical sciences. 2019; 44(1):1-9.
31. Dawson AL, Dellavalle RP. Acne Vulgaris, *BMJ* 2013; 346: f2634p
32. Devarsi Choudhury, Dolly Roy. Evaluation of anti-inflammatory effect of aqueous extract of aloe vera in albino rats. International Journal of Basic & Clinical Pharmacology, 2016; 5(6), 2488–2495.
33. Dohare P, Garg P, Sharma U, Jagannathan NR, Ray M (2008) Neuroprotective efficacy and therapeutic window of curcuma oil: in rat embolic stroke model. BMC Complementary and Alternative Medicine 8: 55
34. Dr Akshatha Gadiyar, Dr Anil V Ankola, Dr Ladusingh Rajpurohit. Evaluation of the Antimicrobial Activity of Ocimum Sanctum L. (Tulsi) Extract against Streptococcus Mutans and Lactobacillus Acidophilus – An in Vitro Study.

International Journal of Health Sciences & Research, 2017; Vol. 7, Issue, 4, 224- 228.

35. Du G, Zhao HY, Song YL, Zhang QW, Wang YT. Rapid simultaneous determination of isoflavones in Radix puerariae using high-performance liquid chromatographytriple quadrupole mass spectrometry with novel shell-type column. J Sep Sci. 2011;34(19):2576–2585.
36. Elseena Jose, Shilpa Joseph, Mariya Joy. Aloe vera and its biological activities. World J Curr Med Pharm Res. 2021; 3(2): 21-26.
37. Embark H, Abdalla A. A study on the effect of Aloe vera extract on the motor and exploratory activities in normal healthy rats. Assiut Veterinary Medical Journal. 2019; 65(163):47-57.
38. Ezugwu Ndubuisi Samuel, Ozoemena Chiadikaobi Lawrence, Ugbor Ekene Valentine. Neuroprotective effect of aqueous extract of aloe vera on the male adult wistar rats with nicotine induced oxidative stress and hippocampal injury. J. Bio. Innov, 2023; 12(6), 1037-1057.
39. FAO, 2015. Grassland Index. A searchable catalogue of grass and forage legumes. FAO, Rome, Italy
40. Fareeha Iqbal, Ambreen Ahmed. Antibacterial activity of aloe barbadensis mill. Pol. J. Environ. Stud., 2021; Vol. 30, No. 4, 3637-3643.
41. Fulton, James. Acne Vulgaris. eMedicine from WebMD. [Online] December 17, 2010.
42. Ghazanfar, SA., 1994, *Handbook of Arabian Medicinal Plants.* Boca Raton, FL: CRC Press.
43. Gong M, Wang F, Chen Y (2002). "[Study on application of arbuscular-mycorrhizas in growing seedings of Aloe Vera]". Zhong Yao CAI (in Chinese). 25 (1): 1–3. PMID 12583231
44. Graber, Emmy M. and Thiboutot, Diane. Over-the- counter acne treatments. [book auth.] Zoe Diana Draelos. Cosmetic Dermatology Products & Procedures. Oxford: Blackwell Publishing Ltd, 2010, 60. ISBN 978-1- 4051-8635-3.
45. Graham HN. Green tea composition, consumption, and polyphenol chemistry. Preventive medicine. 1992; 21(3):334-50.
46. Harold, N., Graham,P.D., 1992, Green tea composition, consumption and polyphenol chemistry, *Preventive Medicine Journal*, Vol. 21, pp. 334-350.

47. Hosea ZY, Kator L, Rhoda EH. Phytochemical properties and antimicrobial activities of aqueous extract of Curcuma longa (Turmeric) rhizome extract. Asian Journal of Research in Crop Science. 2018; 2(1):1-8.
48. Ilangovan M, Guna V, Hu C, Nagananda GS, Reddy N. Curcuma longa L. plant residue as a source for natural cellulose fibers with antimicrobial activity. Industrial crops and products. 2018; 112:556-560.
49. Indian Pharmacopoeia. New Delhi: 1996, Controller of Publications, Government of India, Vol. 2, Issue 4.
50. Iweala EJ, Uche ME, Dike ED, Etumnu LR, Dokunmu TM, Oluwapelumi AE, Okoro BC, Dania OE, Adebayo AH, Ugbogu EA. Curcuma longa (Turmeric): Ethnomedicinal uses, phytochemistry, pharmacological activities and toxicity profiles A review. Pharmacological Research-Modern Chinese Medicine. 2023; 6:100222.
51. J Hamman, Composition and applications of aloe vera leaf gel, 2008; 13(8):1599-1616.
52. J. Rao, MD, FRCPC. Combination Therapy for Acne Vulgaris. Division of Dermatology and Cutaneous Sciences, University of Alberta, Edmonton, Canada).
53. J. S. Rathee, S. A. Hassarajani and S. Chattopadhyay. Antioxidant activity of Nyctanthes arbor-tristis leaf extract. Food Chem. 103(4): 1350-57 (2007).
54. Jain AK and Singh KP 2013: Evaluation OfantibacterialStudiesinHarsingaar. Int. Res. J. Pharm. 4 (7): 151-153.
55. Javad Arbab, Mohammad Reza Farahpour, Amir Hossein Roohollahi-Masoumi. The effect of co-administration of aloe vera gel and cinnamon zeynalicum hydroethanolic extract on wound healing process in diabetic mice. IJVS, 2018; 13(2):40-48.
56. Jayaprakasha GK, Negi PS, Anandharamakrishnan C, Sakariah KK. Chemical composition of turmeric oil – a byproduct from turmeric oleorsin industry and its inhibitory activity against different fungi. Z. Naturforsch., C, 2001; 56:40-44.
57. Joyruth , P., Sukirtha, and P. Kalaimathy. Investigation of Antimicrobial Activity of Aloe Vera and it's Application. Journal of Advances in Microbiology, 2024; 24 (2):122-128.

58. Jyotiprabha Mishra, Geeta Chauhan, Ravikant Agrawal, Ashutosh V Khawale, Bidyut Prava Mishra and Jameel Ahmad. International journal of advanced biochemistry research, 2024; 8(9): 322-328.

59. K. Karlowicz-Bodalska, S. Han, J. Freier, M. Smolenski, A. Bodalska, Curcuma longa as medicinal herb in the treatment of diabetic complications, Acta Pol. Pharm.–Drug Res. 74 (2017) 605–610

60. Kalid, S.A., Duddect, H., Gonzalez-Sierra, M.J., 1989. Antifungal properties of neem. Journal of Natural Products 52, 922–927.

61. Kanitakis, J., 2002, Anatomy histology and immune histochemistry of normal human skin, *European Journal of Dermatology,* ***Vol.*** *12*, Issue 4, pp. 390–401.

62. Kapoor S., Saraf S., (2011). "Topical herbal therapies an alternative and complementary choice to combat acne," Research Journal of Medicinal Plant, vol. 5, no. 6, pp. 650–669.

63. Kedarnath, Kamble Kaveri M, Vishwanath B Chimkod and C S Patil. Antimicrobial activity of aloe vera leaf extract. International journal of applied biology and pharmaceutical technology. 2013; 4(4): 286-290.

64. Keivan Z., Moloud A., Antiviral activity of aloe vera against herpes simplex virus type2: An in vitro study. African J of Biotech 2007; 6(15):1770-1773.

65. Khan AW, Kotta S, Ansari SH, Sharma RK, Kumar A, Ali J. 2013; Formulation develop-ment, optimization and evaluation of Aloe Vera gel for wound healing. Pharma-cognosy Mag. 9(1):S6-S10.

66. Khare, C P., 2004, Encyclopedia of Indian Medicinal Plants: Rational Western Therapy, Ayurvedic and other Traditional Usage, Botany, Springer-Verlag Berlin, Heidelburg, NewYork.

67. Kumar, S., 2004, *Formulation and Evaluation of Herbal drugs for Antiacne activity.* A dissertation submitted to Rajiv Gandhi University of Health Sciences, Bangalore, Karnataka.

68. Kushwaha, A., Bhowmick, M., and Rathi, J., 2017, Formulation development and evaluation of polyherbal hydrogel for effective treatment of acne, *Research Journal Topical and Cosmetic Science,* Vol. 8, Issue 1, pp. 1-11.

69. Layton, A.M. Disorders of the Sebaceous Glands. [ed.] D.A. Burns, et al. Rook's Textbook of Dermatology. 8th. Oxford: Blackwell Publishing Ltd., 2010, Vol. 2, 42. ISBN: 978-1-4051-6169-5.

70. Li P, Xu G, Li SP, Wang YT, Fan TP, Zhao QS, Zhang QW. Optimizing ultra performance liquid chromatographic analysis of 10 diterpenoid compounds in Salvia miltiorrhiza using central composite design. J Agric Food Chem. 2008;56(4):1164– 1171.

71. Lone, A. H., Ahmed, T., Anwar, M., Sofi, Gh., and Naiyar, A.H., 2011, Clinical evaluation of efficacy and safety of a polyherbal formulation in acne vulgaris, *Egyptian DermatologyOnline Journal*, Vol 7, Issue 2:2, pp. 1-9.

72. Lwin KM, Mon HM, Myint KH. Evaluation of the antimalarial activity of Curcuma longa Linn., singly and in combination with Eupatorium odoratum Linn. Journal of Ayurvedic And Herbal Medicine. 2017; 3(1):11-14.

73. Mahida Y, Mohan JSS. Screening of plants for their potential antibacterial activity against Staphylococcus and Salmonella sp. Natural Product Radiance 2007; 6: 301-305

74. Manjunath K, Prakash GB, Subash KR, Tadvi NA, Manikanta M, Rao KU. Effect of Aloe vera leaf extract on blood glucose levels in alloxan induced diabetic rats. Natl J Physiol Pharm Pharmacol, 2016; 6(5):471-474.

75. Marks, A., 1997, Herbal extracts in cosmetics, Agro-Food-Industry Hi-Tech., Vol. 8, pp. 28-31.

76. Markum, E., and Baillie, J., 2013, Combination of essential oil of Melaleuca alternifolia andiodine in the treatment of molluscum contagiosum in children, *Journal of Drugs Dermatology,* Vol.11, pp. 349–354.

77. Masdar ND, Uyup NH, Zainol ZE, Roslani MA, Anuar SN, Zulkafle MA. The chemical properties and anti-acne activity determination of Swietenia macrophylla seed extracts. Malays. J. Anal. Sci. 2022; 26:229-240.

78. Melnik, Bodo C. and Schmitz, Gerd. Experimental Dermatology 18(10): Role of insulin, insulin-like growth factor-1, hyperglycaemic food and milk consumption in the pathogenesis of acne vulgaris. Wiley Online Library. [Online] August 25, 2009.

79. Mishra I, Dubey BK, Basedia D. Phytochemical and pharmacological evaluation of anti-acne activity of herbal extract of Cassia angustifolia. World Journal of Biology Pharmacy and Health Sciences. 2023; 13(1):203-14.

80. Miura T, Koike T, Ishida T (2005) Antidiabetic activity of green tea (Thea sinensis L.) in genetically Type 2 diabetic mice. J Health Sci 51:708–710

81. Mohammed Fadlalla Mohamed, Salma Elghali Mustafa and Omer Abdalla Ahmed Hamdi. Determination of Phytochemical and Antioxidant Activities of Aloe vera Gel Extracts. Acta Scientific Medical Sciences, 2020;4(10):1-6.
82. Mullaicharam, A.R., and Elhadi, F.A., 2012, Evaluation of anti-acne property of polyherbal formulation, *Journal of Biomedical and Pharmaceutical Reasearch*, Vol. 1, Issue 3, pp. 28-35.
83. Nachimuthu Maithilikarpagaselvi, Magadi Gopalakrishna Sridhar, Ramalingam Sripradha. Evaluation of free radical scavenging activities and phytochemical screening of curcuma longa extracts. J Young Pharm, 2020; 12(2):113-117.
84. Nafiu Muhammad Wada, Ahmad Adamu Ambi, Ahmad Aliyu Ibrahim, Saadatu Kirfi Bello, Abdullahi Umar, Dalukus Timothy James. Antimicrobial Activity of Extracts of Turmeric (Curcuma longa) and Garlic (Aliium sativum) Against Selected Bacterial Clinical Isolates. Mediterr J Infect Microb Antimicrob, 2021; 10(6): 1-7.
85. Naghibi, Farzaneh, et al. Iranian Journal of Pharmaceutical Research 2: Labiatae Family in folk Medicine in Iran: from Ethnobotany to Pharmacology. Shaheed Beheshti University of Medical Sciences and Health Services. [Online] 2005.
86. Nappinnai, M.; Pakalapati S.; Arimilli R. Roficoxib gels–preparation and evaluation. Indian Drugs., v.43, p.513-15, 2006.
87. Narsih, Agato. Evaluation of bioactive compounds of aloe vera extract using sub- critical water method. BTAIJ, 2016; 12(3), 113-120.
88. Nelson, K.M., Dahlin, J.L., Bisson, J., Graham, J., Pauli, G.F., and Pauli, G.F., 2017, The essential medicinal chemistry of curcumin, *Journal of Medicinal Chemistry*, Vol. 60, pp. 1620-37.
89. Nupur Bhatnagar, Mudit Sharma, Farah Naz Faridi, Ruby Grover. Antifungal Activity of Aloe Vera Extracts Against Phytopathogenic Fungus Aspergillus Spp. International journal of health sciences and research, 2022; Vol. 12, Issue 12, 86-91.
90. Nurrulhidayah AF, Rafi M, Lukitaningsih E, Widodo H, Rohman A, Windarsih A. Review on in vitro antioxidant activities of Curcuma species commonly used as herbal components in Indonesia. Food Res. 2020; 4(2):286-293.
91. Onuoha Udumma Nsofor, Alaebo Prince Ogochukwu, Appeh Osita Gabriel, Enya Emmanuel and Chukwuma Maduako Linus. Evaluation of antibacterial

activity of aloe vera extract on some bacterial pathogens. International journal of phytology research, 2023; 3(1):26-29.

92. P. Joyruth, Sukirtha and P. Kalaimathy. Investigation of antimicrobial activity of aloe vera and it's application., J. Adv. Microbiol., 2024; Vol. 24, No. 2, 122-128.
93. Pandit, J.K., Bharathi, D., Srinatha, A., Ridhurkar, D.N., Singh, S., 2007. Long acting ophthalmic formulation of indomethacin: Evaluation of alginate gel systems. Indian Journal of Pharmaceutical sciences. 69: 37-40.
94. Panigrahi L, Jhon T, Shariff A and Shobanirani RS: Formulation and Evaluation of Lincomycin HCl Gels. Indian Journal of Pharmaceutical Sciences. 1997; 59(6): 330-32.
95. Patel, R.P., Kamani, R., 2002. Formulation optimization and evaluation of mometazone furoate cream. Journal of Pharmacy Research. 2: 1565-1569.
96. Patel, V. K., Bhatt, H., 1988, Folkflore therapeutic indigenous plants in periodontal disorders in India (Review, experimental and clinical approach), *International Journal of Clinical Pharmacology Therapy and Toxicology,* Vol. 26, Issue 4, pp. 176-184.
97. Peck, G.L., Olsen, T.G., Yoder, F.W., Strauss, J.S., Downing, D.T., and Pandya, M., 1979, Prolonged remissions of cystic and conglobate acne with 13-cis-retinoic acid, *The New England Journal of Medicine,* Vol. 300, Issue 7, pp. 329–33.
98. Phrompanya P, Buncharoen W, Tragoolpua Y, Saenphet K. Antioxidant, anti-inflammatory, and antibacterial activities against acne-causing bacteria of Miliusa velutina (A. DC.) Hook. f. & Thomson extracts. Journal of Pharmacy & Pharmacognosy Research. 2024; 12(2):243-54.
99. Pillai, N.R., Santhakumari, G., 1981. Anti arthritic and antiinflammatory actions of Nimbidin. Plant Medica 43, 59–63.
100. Pochi, P.E., 1990, The pathogenesis and treatment of acne, *Annual Review of Medicine Journal,* Vol. 41, pp. 187-198.
101. Pochi, P.E., and Strauss, J.S., 1988, Sebaceous gland activity in black skin. *Dermatology Clinic Journal*, Vol. 6, Issue 3, pp. 349-51.
102. Pragathesh, Singh K., Latha, D., Monisha, M., Esther, M.M., Jayasree, A.S., Muthulaxmi, V., Vijayalakshmi, S., and Jevanand, R., 2017, Topical herbal

formulation for the treatment of acne vulgaris, *International Journal of Biomedical Research*, Vol. 8, Issue 7, pp. 425-427.

103. Purseglove JW, Brown EG, Green CL, Robbins SR. Spices. Vol. 1. London, New York: Longman; 1981.
104. Quelemes, P.V., Perfeito, M.L.G., Guimaraes, M.A., Dos Santos, R.C., Lima, D.F., Nascimento, C., Leite, J.R.S.A., 2015. Effect of neem (Azadirachta indica A. Juss) leaf extract on resistant Staphylococcus aureus biofilm formation and Schistosoma mansoni worms. Journal of Ethnopharmacology 175, 287–294.
105. R.C. Saxena, B. Gupta, K.K. Saxena, V.K. Srivastava and D.N. Prasad. Analgesic, antipyretic and ulcerogenic activity of Nyctanthes arbortristis leaf extracts. J. Ethnopharmacol. 19: 193-200 (1987).
106. Raichurkar Amruta M., Tolsarwad Ganesh S. and Patil Vishnu N. A review article on medicinal plant (aloe vera). World journal of pharmaceutical research, 2022; Vol. 11, Issue 3, 1182-1190.
107. Rao, D.V.K., 1986, *In-vitro* antibacterial activity of Neem oil, *Indian Journal of Medical Research*, Vol. 84, pp. 314.
108. Ravindran PN, Nirmal Babu K, Sivaraman K. Turmeric. The golden spice of life. In: Turmeric. The Genus Curcuma. Boca Raton, FL, USA: CRC Press; 2007. p. 1-14.
109. Ravishankar, P., Koushik, O.S., Himaja, V., Ramesh, J., and Pragna, P., 2015, Acne causes and amazing remedial measures for acne, *Indo American Journal of Pharmaceutical Research,* Vol. 5, Issue 7, pp. 2512-2522.
110. Rawat H Verma Y, Saini N. 2021. A traditional herbal plant with , miraculous potential end medicine. International Journal of Botany Studies, 6(3):427-440.
111. Ray, A., Banerjee, B.D., Sen, P., 1996. Modulation of humoral and cell-mediated immune responses by *Azadirachta*. Phytotherapy Research 34, 698–701.
112. Ray, C., Trivedi, P., and Sharma, V., 2013, Acne and its treatment lines, *International Journal of Reasearch in Pharmaceutical and Biosciences,* Vol. 3, Issue 1, pp. 1-16.
113. Renisheya Joy Jeba Malar T, Johnson M, Nancy Beaulah S, Laju R S, Anupriya G, Renola Joy Jeba Ethal T., Anti-bacterial and antifungal activity of aloe vera gel extract. IJBAR, 2012; 03(03): 184-187.

114. Reuter, Juliane, Merfort, Irmgard and Schempp, Christoph M. Am J Clin Dermatol. 11(4): Botanicals in Dermatology: An Evidence-Based Review.Medscape 2010.

115. Riyanto and Wariyah, Ch. The antioxidative-activity stability of aloe vera (Aloe vera var. chinensis) instant during storage. Food Research, 2021; 5 (4): 288 – 293.

116. Roshni Prajapati and Pallavi Rai. Studies of Antifungal Activities of Curcuma Longa (L.). Research Communications, 2023; Vol. 1, Issue 1, 105-111.

117. Rutuja V. Dalavi, Manali V. Gharat, Aniket R. Chikane, Amit A. Dound, Prof. Kajal A. Walunj., A Research Article on Formulation and Evaluation of Antiacne Herbal Face Wash. IJARSCT, 2022; Volume 2, Issue 5, 269-276.

118. S. Dada Khalandar, T. Naga Adithya, S. Jilani Basha, M. Koshma. A current review on curcuma longa linn. plant. IJPCBS, 2018; 8(1), 68-73.

119. S. Neha, G. D. Ranvir and C. R. Jangade. Analgesic and antipyretic activities of Curcuma longa rhizome extracts in Wister Rats. Veterinary World, 2009; 2(8):304-306.

120. Saeedi, M., Morteza, Semnani K., and Ghoreishi, M.R., 2003, The treatment of atopic dermatitis with licorice gel, *Journal of Dermatological Treatment*, Vol. 14, pp. 153-57.

121. Saleh A. Almatroodi, Mohammed A. Alsahli, Ahmad Almatroudi, Arshad Husain Rahmani. Ocimum sanctum: Role in Diseases Management Through Modulating Various Biological Activity. Pharmacogn J. 2020; 12(5): 1198-1205.

122. Saritha V, Anilakumar K R and Farhath Khanum. Antioxidant and antibacterial activity of Aloe vera gel extracts. International Journal of Pharmaceutical & Biological Archives, 2010; 1(4):376-384.

123. Sawant SE and Tajane MD 2016: Formulation and evaluation of herbal ointment containing Neem and Turmeric extract. Journal of Scientific and Innovative Research (4): 149-151.

124. Sen A et al., 2017 Aqueous leaf extract of Tulsi (*Ocimum sanctum*) protects against high fat diet-induced injury to rat liver through antioxidant mechanisms: a dose- and time-dependent study. Journal of Pharmacy Research 11(4): 334-351.

125. Sen, P., Medinata, P.K., Ray, A., 1992. Immunostimulant Activities of *Azadirachta indica*. Indian Journal of Experimental Biology 12, 1170–1175.

126. Shivhare UD, Jain KB, Mathur VB, Bhusari KP, Roy AA. 2009;Formulation, development and evaluation of Diclofenac Sodium gel using water soluble polyacrylamide polymer. Dig J Nanomaterials and Bios. 4(2):285-290.

127. Shrivastava R, Bharadwaj AK. 2018. Nyctanthes arbortristis an important Medicinal Plant of Madhya Pradesh State UK Journal of Pharmaceutical and Biosciences, 6(6):10-15.

128. Silva RM, Martins GR, Nucci LM, Granero FO, Figueiredo CC, Santiago PS, Silva LP. Antiglycation, antioxidant, antiacne, and photoprotective activities of crude extracts and triterpene saponin fraction of Sapindus saponaria L. fruits: An in vitro study. Asian Pacific Journal of Tropical Biomedicine. 2022; 12(9):391-9.

129. Simoons, Frederick J. (1998). Plants of life, plants of death. Univ of Wisconsin Press. 7-40.

130. Soleymani S, Farzaei MH, Zargaran A, Niknam S, Rahimi R. Promising plant-derived secondary metabolites for treatment of acne vulgaris: a mechanistic review. Arch Dermatol Res. 2020; 312(1):5-23.

131. Srinivasan, V., 2002, Melatonin oxidative stress and neurodegenerative diseases, *Indian Journal of Experimental Biology,* Vol. 40 pp. 668- 679.

132. Suva, M.A., Patel, A.M., Sharma, N., Bhattacharya, C., and Mangi, R.K., 2014, A brief review on acne vulgaris : pathogenesis, diagnosis and treatment, *Science Technology and Medical Journals,* Vol. 4, Issue 3, pp. 1-12.

133. Swapnil Shinde, Shrinivas Mohite. Exploring Antipsoriatic Potential of Aloe vera Gel. IJDDT, 2024; Vol. 14, Issue 2, 675-680.

134. Swarnali Roy, Sankhadip Bose, Dhrubajyoti Sarkar, Sanjit Mandal, Sipra Sarkar, Sudip kumar Mandal. Formulation and evaluation of anti-acne gel containing murraya koeinigii extract. Int J Curr Pharm Res, 2020; Vol. 12, Issue 4, 108-113.

135. Syed T A, Ahmad S A Management of psoriasis with *aloe vera* extract in a hydrophilic cream: a placebo controlled double blind study. Trop Med Int Health 1996;1(4):505-9.

136. Tariq AL and Reyaz AL. Extraction of cannabinoids from Cannabis sativa L plant and its potential antimicrobial activity. Universal Journal of Medicine and Dentistry.2012; 1(4):051-055.

137. Tastan, Z., Alp Avci, G., Uysal Kilic, T., and Avci, E., In vitro evaluation of the biological activity potential of aloe vera gel: antioxidant activity and cytotoxic effects in hepg2 and l929. Journal of Microbiology, Biotechnology and Food Sciences, 2024; 13(5), e10668. https://doi.org/10.55251/jmbfs.10668

138. Thakur R, Puri HS, Husain A. Major Medicinal Plants of India. Lucknow: Central Institute of Medicinal and Aromatic Plants; 1989.

139. Thappa, D., Adityan, B., and Kumari, R., 2009, Scoring Systems in Acne Vulgaris, *Indian Journal of Dermatology Venereology and leprology, Vol.* 75, Issue 3, pp. 323–326.

140. Thappa, D.M., Dogra, J. J Dermatol. 21(10): Nodulocystic acne: oral gugulipid versus tetracycline. [Online] October 1994.

141. Thi Sinh Vo, Tran Thi Bich Chau Vo, Tran Thi Thu Ngoc Vo, and Thi Ngoc Huyen Lai. Turmeric (Curcuma longa L.): Chemical Components and Their Effective Clinical Applications. JOTCSA. 2021; 8(3): 883-898.

142. Verma, M.K., Najar, I.A., Tikoo, M.K., Singh, G., Gupta, D.K., and Anand, R., 2013, Development of a validated UPLC-qTOF-MS method for the determination of curcuminoids and their pharmacokinetic study in mice, Daru 2013;21:11.

143. Waltner-Law ME, Wang XL, Law BK, Hall RK, Nawano M, Granner DK (2002) Epigallocatechin gallate, a constituent of green tea, represses hepatic glucose production. J Biol Chem 277:34933– 34940

144. Weber, G., Adamczyk, A., Freytag, S. Fortschr Med. 107(26): Treatment of acne with a yeast preparation. PubMed: U.S. National Library of Medicine and the National Institutes of Health. [Online] September 10, 1989.

145. Yadav S, Gupta M, Formulation and Evaluation of Anti-Acne Herbal Face Wash Gel, Journal of Drug Delivery and Therapeutics. 2019; 9(4):523-525.

146. Yarnell, Eric and Abascal, Kathy. Alternative & Complementary Therapies: Herbal Medicine for Acne Vulgaris. Touro Institute. [Online] December 2006.

147. Yi Y, Zhang QW, Li SL, Wang Y, Ye WC, Zhao J, Wang YT. Simultaneous quantification of major flavonoids in "Bawanghua", the edible flower of

148. Grace R. Cosmeceuticals: Functional food for the skin. Nat Foo Merchandiser. 2002;23:92-99.

149. Ray C, Trivedi P, Sharma V. Acne and its treatment lines. International Journal of Research in Pharmaceutical and Biosciences,2013;3(1):1-16.

150. Thiboutot D. Regulation of human sebaceous glands. Journal of Investigative Dermatology. 2004; 123(1):1-12. https://doi. org/10.1111/j.1523-1747.2004.t01-2-.x

151. Hassan KAM, Eltayb N. Eucalyptus oil as a treatment for acne. Pharmanest: International Journal of Advances in Pharmaceutical Sciences. 2013;4(4):557-566.

152. Amrita G, Greeshma N, Deepa M, Poornima E. A review on antiacne potential of medicinal plant extracts against Propionibacterium acnes. International Journal of Pharma Bioscience. 2012;3(3):987- 997.

153. Mohan PK, Sreelakshmi G, Muraleedharan CV, Joseph R. Water soluble complexes of curcumin with cyclodextrins: Characterization by FT-Raman spectroscopy. Vibrational Spectroscopy. 2012;62:77- 84. https://doi.org/10.1016/j.vibspec.2012.05.002

154. Meena M, Figueiredo NR, Trivedi K. Aloe vera–An update for Dentistry. Journal of dentofacial sciences. 2013;2(4):1-4.

155. Borate SR, Mundada AS. Simultaneous Estimation of Curcumin and Vitamin E in Bulk and Cosmeceutical Formulation by UV Spectrophotometry. International Journal of Pharmaceutical Quality

156. Assurance. 2023;14(3):637-641. DOI: 10.25258/ijpqa.14.3.309. Surjushe A, Vasani R, Saple D. Aloe vera: a short review. Indian journal of dermatology. 2008;53(4):163-166.

157. Singh AR, Kalirajan K. Antimicrobial activity of turmeric natural dyeagainst different bacterial strains. Journal of Applied Pharmaceutical Science. 2012:210-212. https://dx.doi.org/10.7324/

158. JAPS.2012.2624

159. Joshi GA, Kumar RA, Tupsakhare DI. Emulgel: As a novel drug delivery system using indomethacin. An International Journal of Advances in Pharmaceutical Sciences. 2014;5:2221-2228.

160. Madan J, Singh R. Formulation and Evaluation of Aloevera Topical Gels. International Journal of Pharmaceutical Sciences. 2010;2(2):551-555.

161. Ramachandra CT, Rao PS. Processing of Aloe vera leaf gel: a review. American Journal of Agricultural and Biological Sciences. 2008;3(2):502-510.

162. Mustafa AM. Facile Synthesis and Antioxidant Activity of Pyrimidine Derivatives via Thienyl Chalcones Under Phase Transfer Catalysis Method. International Journal of Drug Delivery Technology. 2022;12(2):558-563. DOI: 10.25258/ijddt.12.2.16

163. Gurjar NB, Barot BS, Shelat PK. Development and evaluation of cinnamon and aloe-vera containing herbal antiacne gel. International Journal of Pharmacy and Industrial Research. 2012;2(4):446-451.

164. Hassan F, Al-Saffar AZ, Al-Shanon AF. Antioxidant Enzymes Level Detection in Cisplatin Treated Iraqi Lung Cancer Patients and In-vitro Estimating the Cytotoxic and Reactive Oxygen Species Generation in A549 Cell Line. International Journal of Pharmaceutical Quality Assurance. 2020;11(1):32-37. DOI: 10.25258/ijpqa.11.1.5

165. A-Ani ZSM, Abdulmawjood SA, Al-Hussain AOA, Al-Bajari SA. Synthesis and Biological Activity of few Pyrimidines Derivatives against Hepatic Injury Stimulated by Carbon Tetrachloride in

166. Bhuiyan MA, Hoque MZ, Hossain SJ. Free radical scavenging activities of Zizyphus mauritiana. World journal of agricultural sciences. 2009;5(3):318-322.

167. Reller LB, Weinstein M, Jorgensen JH, Ferraro MJ. Antimicrobial susceptibility testing: a review of general principles and contemporary practices. Clinical infectious diseases. 2009;49(11):1749-1755. https:// doi.org/10.1086/647952

168. Sharma K, Agrawal SS, Gupta M. Development and Validation of UV spectrophotometric method for the estimation of curcumin in bulk drug and pharmaceutical dosage forms. International Journal of Drug Development & Research. 2012;4(2):375-380.

169. Bhramaramba R, Babu IS, Deepthi CD. Formulation and evaluation of herbal gel containing Terminalia chebula Retz., Leaves Extract. Scholars Academic of Journal Pharmacy. 2015;4(3):172-126.

170. "Murrayakoenigii".Germplasm Resources Information Network(GRIN).Agricultural Research Service(ARS),United States Department of Agriculture(USDA).

171. Dalziel, J.M. (1956) 'The useful Plants of West Tropical Africa' Crown Agens, London.pp.612.3.Henry, Trimen (1893).Butler M, Buss AD, A new model for

utilizing chemical diversity from natural sources, Drug development research, 62, 2004, PP 362–370

172. Chatterjee A, Pakrashi SC, The Treatise on Indian Medicinal Plants, National Institute of Science Communication CSIR, (5),1997. New Delhi. PP-78-96

173. Cox P, Balick M, The ethnobotanical approach to drug discovery. Scientific American, 19, 1994, PP 82-87.

174. Cox PA et al, Ethno pharmacology and the search for new drugs, In Bioactive Compounds from Plants, Ciba Foundation Symposium, John Wiley & Sons, 15, 1999. PP 40-55.

175. Handa SS, Herbal remedies in indigenous system of medicines. Pharma Times 23(4), 1991, PP 13-16

176. Handa SS, Medicinal and aromatic plants global industry overview, "Quality Control, Scientific Validation and Business Prospects of Medicinal and Aromatic Plants", Port of Spain, Trinidad & Tobago, 28 (7), 2007, PP 1-21

177. Kirtikar KR, Basu BD, Indian medicinal plants 2nd edition, Lalit Mohan Basu, Allahabad, 1999. PP 1273 -1275

178. Mathur A, Who owns Traditional Knowledge, Working Paper No. 96, Indian Council for Research on International Economic Relations, 2003. PP 1-33

179. Said HK, A medicine through the ages, Hamadard academy, Karachi, 1980, PP 70-75

180. Said HK, 2005.Traditional medicine in the service of health, Hamadard foundation press, Karachi, 1988, PP 27-36

181. Shrikumar S, Ravi TK, Approaches towards development and promotion of herbal drugs, Pharmacognosy Reviews, 1(1), 2007, PP 180-184

182. Singh A, Ethics in herbal medicine, Ethnobotanical leaflets, 11, 2007, PP 206-211 133

183. Singh AP, Current status and future direction of herbal medicine, Trends in Pharmacological sciences, 23(8), 2005, PP 347-348

184. World Health Organization (WHO), WHO Traditional Medicine Strategy, 2006, Geneva,

185. World Health Organization (WHO), WHO Traditional Medicine Strategy, 2002, Geneva,

186. Glynn LE, 1981. The pathology of scar tissue formation, In: Glynn, L.E., Handbook of Inflammation, vol. 3. Tissue Repair and Regeneration, Elsevier North Holland Biomedical Press, Amsterdam, 200, PP 178-187

187. Koyama T, Ogura K, Tagahara T, Konoshima M, Phytochemistry, 31, 1932, PP 2907-2915

188. Vane J, Booting R, Inflammation and the mechanism of action of anti-inflammatory drugs, Journal of American Societies for Experimental Biology 1, 1987, PP 89–96

189. Varma N, Painuly P, Sharma JS, Indian Journal of Chemistry, 24, 1985, PP 791-784

190. Tripathi VD, Agarwal SK, Rastogi RP, Indian Journal of Chemistry, 9 (17), 1993, PP 97- 99 Tripathi YB, Pandey S, Shukla Y, Indian Journal of Experimental. Biology, 31, 1993, PP 533-539 .

191. Butler M, Buss AD, A new model for utilizing chemical diversity from natural sources, Drug development research, 62, 2004, PP 362–370

192. Chatterjee A, Pakrashi SC, The Treatise on Indian Medicinal Plants, National Institute of Science Communication CSIR,
(5),1997. New Delhi. PP-78-96

193. Cox P, Balick M, The ethnobotanical approach to drug discovery. Scientific American, 19, 1994, PP 82-87

194. Cox PA *et al*, Ethno pharmacology and the search for new drugs, In Bioactive Compounds from Plants, Ciba Foundation Symposium, John Wiley & Sons, 15, 1999. PP 40-55

195. Handa SS, Herbal remedies in indigenous system of medicines. Pharma Times 23(4), 1991, PP 13-16

196. Handa SS, Medicinal and aromatic plants global industry overview, "Quality Control, Scientific Validation and Business Prospects of Medicinal and Aromatic Plants", Port of Spain, Trinidad & Tobago, 28 (7), 2007, PP 1-21

197. Kirtikar KR, Basu BD, Indian medicinal plants 2nd edition, Lalit Mohan Basu, Allahabad, 1999. PP 1273 -1275

198. Mathur A, Who owns Traditional Knowledge, Working Paper No. 96,

Indian Council for Research on International Economic Relations, 2003. PP 1-33

199. Said HK, A medicine through the ages, Hamadard academy, Karachi, 1980, PP 70-75

200. Said HK, 2005.Traditional medicine in the service of health, Hamadard foundation press, Karachi, 1988, PP 27-36

201. Shrikumar S, Ravi TK, Approaches towards development and promotion of herbal drugs, Pharmacognosy Reviews, 1(1), 2007, PP 180-184

202. Singh A, Ethics in herbal medicine, Ethnobotanical leaflets, 11, 2007, PP 206-211

203. Singh AP, Current status and future direction of herbal medicine, Trends in Pharmacological sciences, 23(8), 2005, PP 347-348

204. World Health Organization (WHO), WHO Traditional Medicine Strategy, 2006, Geneva,

205. World Health Organization (WHO), WHO Traditional Medicine Strategy, 2002, Geneva,

206. Glynn LE, 1981. The pathology of scar tissue formation, In: Glynn, L.E., Handbook of Inflammation, vol. 3. Tissue Repair and Regeneration, Elsevier North Holland Biomedical Press, Amsterdam, 200, PP 178-187

207. Koyama T, Ogura K, Tagahara T, Konoshima M, Phytochemistry, 31, 1932, PP 2907-2915

208. Vane J, Booting R, Inflammation and the mechanism of action of anti-inflammatory drugs, Journal of American Societies for Experimental Biology 1, 1987, PP 89–96

209. Varma N, Painuly P, Sharma JS, Indian Journal of Chemistry, 24, 1985, PP 791-784

210. Tripathi VD, Agarwal SK, Rastogi RP, Indian Journal of Chemistry, 9 (17), 1993, PP 97- 99

211. Tripathi YB, Pandey S, Shukla Y, Indian Journal of Experimental. Biology, 31, 1993, PP 533-539

212. Calder PC, n-3 polyunsaturated fatty acids, inflammation, and inflammatory diseases, American Journal of Clin Nutraceuticals, 83, (6), 2006,PP 1505- 1519

213. Chettibi S, Ferguson MW, Wound repair an overview, In Gallin, J.I., Snyderman, R.Inflammation Basic Principles and Clinical Correlates. Lippincot, Williams and Wilkins, Philadelphia, 19 (7), 1997, PP 865-881

214. Choi SW, Son BW, Son YS, Park YI, Lee SK, Chung MH, The wound healing effect of a glycoprotein fraction isolated from *Aloe vera*, British Journal of Dermatology, 145, 2001, PP 535-545

215. Curtis CL, Harwood JL, Dent CM, Caterson B, Biological basis for the benefit of nutraceutical supplementation in arthritis, Drug discovery today, 9, 2004 PP 165–172

216. Curtis CL, Hughes CE, Flannery CR, Little CB, n-3fatty acids specifically modulate catabolic factors involved in articular cartilage degradation, Journal of Biochemistry, 275, 2000, PP 721-724

217. Curtis CL, Rees SG, Little CB, Flannery CR, Hughes CE, Wilson C, Pathologic indicators of degradation and inflammation in human osteoarthritis cartilage are abrogated by exposure to n-3 fatty acids, Arthritis Rheum, 46, 2002, PP 1544-1553

218. Daniel M, Methods in Plant Chemistry and Economic Botany, Kalyani Publishers, New Delhi, 1991, PP 207-236

219. David L, Lentz A, Alice M, Clark B, Charles D, Hufford B, Barbara M, Antimicrobial properties of Honduran medicinal plants, Journal of Ethnopharmacology, 63,1998, PP 253–263

220. Dengre RG, Patel KN, Chauhan MB, Acne vulgaris, Ancient Science of Life 13, 11(3), 1999, PP 65-179

221. Gnanamani A, Shanmuga PK, Radhakrishnan N, Babu M, Antibacterial activity of two plant extracts on eight burn pathogens, Journal of Ethnopharmacology, 86, 2003, PP 59-61

222. Gupta M, Mazumder U, Ramanathan SK, Thangavel SK, Studies on

anti-inflammatory, analgesic and anti-pyretic properties of methanol extract of *Caesalpinia bonducella* leaves in experimental animal models, Iranian Journal of Pharmacology, and Therapeutics 2, 2003, PP 30-34

223. Hazra B, Basu S, Ghosh A, Evaluation of the Antibacterial Activity of *Ventilago madraspatana* Gaertn. *Rubia cordifolia* Linn. and *Lantana camara* Linn., Isolation of Emodin and Physcion as Active Antibacterial Agents, Phytotherapy research, 19,2005, PP 888-894

224. Hernandez V, Recio MDC, Manez S, Prieto JM, Giner RM, Rios JL, A mechanistic approach to the in vivo anti-inflammatory activity of sesquiterpenoid compounds isolated from *Inula viscose*, Planta Medica 67, 2001, PP 726-731

225. Hj Baie S, Sheikh KA, The wound healing properties of *Channa striatus*-cetrimide cream-wound contraction and glycosaminoglycan measurement, Journal of Ethnopharmacology, 73, 2000, PP 15-30

226. Jagetia GC, Rajanikant GK, Role of curcumin, a naturally occurring phenolic compound of turmeric in accelerating the repair of excision wound, in mice whole body exposed to various doses of gamma-radiation, Journal of Surgical Research, 120, 2004, PP 127-138

227. Johansen DA, Plant Microtechnique, McGraw Hill Book, New York,1940, PP 523-538

228. Joharapurkar AA, Zambad SP, Wanjari MM, Umathe SN, *In vivo* evaluation of antioxidant activity of alcoholic extract of *Rubia cordifolia* Linn. and its influence on ethanol-induced immunosuppression, Indian Journal of Pharmacology, 35, 2003, PP 232-236

229. Kamboj VP, Herbal medicines, current sciences, 78 (1), 2000, PP 35-39

230. Khanna S, Venojarvi M, Roy S, Sharma N, *et al,* Dermal wound healing properties of redox-active grape seed proanthocyanidins, Free

Radical Biology and Medicine, 15, 2002, PP 1089-1096

231. Kumara HM, Krishna A, Shankarmurthy K, Rahimana AB, Wound healing activity of gel of embelin isolated from the ethanol extract of leaves of *Embelia ribes* Burm, Journal of Ethnopharmacology, 109, 2007, PP 529-534

232. Leite SN, Palhano G, Almeida S, Biavattii MW, Wound healing activity and systemic effects of *Vernonia scorpioides* gel in guinea pig, Fitoterapia, 73, 2002, PP 496-500

233. Letts MG, Villegas LF, Marcalo A, Vaisberg AJ, Hammond GB, In vivo wound healing activity of olanolic acid derived from the acid hydrolysis of *Andredera diffusa*, Journal of Natural Products, 69, 2006, PP 978-979

234. Maquart FX, Chastang F, Simeon A, Birembaut P, Gillery P, Wegrowski Y, Triterpenes from Centella asiatica stimulate extracellular matrix accumulation in rat experimental wounds, European Journal of Dermatology, 9, 1999, PP 289-296

235. Mujumdar AM, Kale M, Misar AV, DaveV, Joshi M, Anti-inflammatory activity of *Dalbergia lanceolaria* barks ethanol extract in mice and rats, Journal of Ethnopharmacology, 112, 2007, PP 300-304

236. Muniappan M, Sundararaj T, Anti-inflammatory and antiulcer activities of *Bambusa arundinacea,* Journal of Ethnopharmacology, 88, 2003, PP 161-167

237. Govindarajan RA, Pushpangadan P, Kumara B, Vijayakumar M., Ethnopharmacological approaches to wound healing-Exploring medicinal plants of India Journal of Ethnopharmacology, 114, 2007, PP 103–113

238. Al-Khalil SA, Survey of plants used in Jordanian traditional medicine, International Journal of Pharmacognosy, 33,1995, PP 317-323

239. Anonymous, Indian Herbal Pharmacopoeia, Revised New Edition, Published by India Drug Manufactures Association Mumbai (IDMA),

2002, PP 223- 228

240. Anonymous, Indian Pharmacopoeia, Ministry of Health and Family Welfare, Government of India, 2(A-74), 1996, PP 567-568

241. Anonymous, The Ayurvedic Pharmacopeia of India, first edition, Government of India, Dept of Ayurveda, Yoga, Naturopathy, Unani, Siddha and Homeopathy, The Controller of Publication, Delhi, 4(1), 2004, PP 159-160

242. Anonymous, Wealth of India, First supplementary Series, Vol-3, (D-I), Raw materials, Published by Niscom, 2002, PP 130-133

243. Anonymous, The Ayurvedic Formulary of India, Part-I (I-edition), New Delhi, 1978, PP- 98-145

244. Denilson F, Oliveira A, Aline C, Pereira A, Henrique CP, Figueiredo B, Antibacterial activity of plant extracts from Brazilian southeast region, Fitoterapia, 78, 2007, PP 142–145

245. Fu SC, Hui CW, Li LC, *et al,* Total flavones of *Hippophae rhamnoides* promote early restoration of ultimate stress of healing patellar tendon in a rat model, Medical Engineering Physics, 27,2005, PP 313-321

246. Gamble JS, Flora of the Presidency of Madras, Botanical Survey of India, Calcutta, India, 1, 1935, PP 301-304

247. Gerald SL, Diane MC, David RK *et al*, 1994, Definitions and guidelines for assessment of wounds and evaluation of healing, Wound Repair and Regeneration, 2, PP 165– 170

248. Ghosh D, Thejomoorthy P, Anti-inflammatory and analgesic activities of oleanolic acid from *Randia dumetorum*, Indian journal of Pharmacology, 15 (4), 1981, PP 331-342

249. Harsh Mohan, Textbook of Pathology, Jaypee Brothers Medical Publishers (p) Ltd., 5th Edition, New Delhi, 2005, PP 133- 138

250. Hazra B, Basu S, Ghosh A, Evaluation of the Antibacterial Activity of *Ventilago madraspatana* Gaertn. *Rubia cordifolia* Linn. and *Lantana camara* Linn. Isolation of Emodin and Physcion as Active Antibacterial Agents, Phytotherapy research, 19, 2005, PP 888-894

251. Henry AN, Nair NC, Flora of Indian medicinal plants, Botanical survey of India, 1, 1983, PP 184- 1987

252. Inouye H, Takeda Y, Nishimura H, Kanomi A, The hyperlipidemic effect of pomegranate in mice, Phytochemistry, 27, 1988, PP 2591-2596

253. Itokawa H, Qiao Y, Takeya K, Phytochemical details of Pomegranate, Phytochemistry, 1991, 30, PP 637

254. Izhaki I, Emodine a secondary metabolite with multiple ecological functions in higher plants, New Phytol 155, 2002, PP 205- 217

255. Khory K, Katrak A, Materia Medica of India and their Therapeutics, Komal Prakashan, 2006, PP 324-328

256. Kokate CK, Purohit AP, Gokhale SB, Textbook of Pharmacognosy, Nirali Prakashan, 14th edition, 2000, PP 72-103

257. Kusano A, Seyama Y, Nagai M, Shibano M, Kusano G, Effects of fukinolic acid and cimicifugic acids from *Cimicifuga species* on collagenolytic activity, Biological Pharmaceutical Bulletin, 24, 2001, PP 1198-1201

258. Larsen GL, Henson PM, 1983, Mediators of inflammation, Annual Review of Immunology, 1, PP 335-339

259. Laszlo M, Gyurjan I, Danos B, *et al*, Planta Medica, 56, 1992, PP 613-619

260. Leyman H, Demirezer L, Kuruu A, Banog ZF, Anti-inflammatory effect of the aqueous extract from *Rumex patientia* L. roots, Journal of Ethnopharmacology, 65, 1999, PP 141-148

261. Sabitha Rani A, Saritha K, Nagamani V, Sulakshana G. In vitro Evaluation of Antifungal Activity of the Seed Extract of Embelia Ribes. Indian J Pharm Sci.2011. 73(2): 247–249.

262. Phan TT, Wang L, See P, *et al,* Phenolic compounds of *Chromolaena odorata* protect cultured skin cells from oxidative damage: implication for cutaneous, Biological and Pharmaceutical Bulletin, 24, 2001, PP 1373-1379

263. Solereder H, Systematic anatomy of the Dicotyledons, Transl. L.A.Boodle and F.E.Fritich, Oxford Clarendon press.1998, 202-243

264. Srinivasan KK, Shirwaikar A, Joseph A, Prabu SL, Indian Drugs, 43 (2), 2006, PP 141-145

265. Yamamoto M, Masui T, Suglyama K, Yokota M, Nakagomi K, Nakazawa H, Anti-inflammatory Active Constituents of *Aloe arborescens* Miller, Agricultural Biological Chemistry, 55, 1991, PP 1627-1629

266. Adwankar MK, Chitnis MP, Khandalekar DD, Bhadsavle CG, Indian Journal Experimental Biology, 1980, 18, PP 102-111

267. Akindele AJ, Adeyemi OO, Anti-inflammatory activity of the aqueous leaf extract of *Byrsocarpus coccineus*, Fitoterapia, 78, 2007, PP 25- 28

268. Aditya GN, Chattopadhyay RN, Mandal S, *et al,* Possible mechanism of anti-inflammatory activity of calcium channel blockers, Indian Journal of Pharmacology, 29, 1997, PP 325-
326

269. Adailkan PG, Gauthaman K, History of herbal medicines with an insight on the pharmacological properties of Tribulus terrestris. The Aging Male 4, 2001, PP 163–169

270. Hitotsuyanagi Y, Aihara T, Takeya K, A novel dimeric antitumor bicyclic hexapeptides from Rubia cordifolia L., Tetrahedron Letters, 41, 200, PP 6127-6130

271. Lo TN, Saul WF, Lau SS, Carrageenan stimulated release of arachidonic acid and of lactate dehydrogenase from rat pleural cells, Biochemical Pharmacology, 36, 1987, PP 2405- 2409

272. Manojlovic NT, Solujic S, Sukdolak SS, Milosev M, Antifungal activity of Rubia tinctorum, *Rhamnus frangula* and *Caloplaca cerina*, Fitoterapia, 76, 2005, PP 244-246

273. Menon S, Herbal medicines in Ayurveda, Siddha and Unani, Heritage Healing 1(2), 1999, PP 19-22

274. Metcalfe CR, Chalk I, Anatomy of the Dicotyledonous, Claredon press,

Oxford, 1979, 2007, PP 276-299

275. Rajni S, Jain, A, Panwar S, Gupta D, Khare SK, Antimicrobial activity of some natural dyes, Dyes and Pigments, 66, 2005, PP 99-102

276. Saleem R, Sadaf F, Ahmed M, Ahmad I, Healing potential of cream containing extract of *Sphaeranthus indicus* on dermal wounds in Guinea pigs, Journal of Ethnopharmacology 107 , 2006, PP 161-163.

277. Singh R, Chauhan SM, Geetanjali, Anthraquinones and other biologically active compounds from the genus Rubia, Journal of Chemistry and Biodiversity,1, 2005, PP 1241-1264

278. Stevenson PC, Simmonds MS, Sampson J, *et al, W*ound healing activity of acylated iridoid glycosides from *Scrophularia nodosa*. Phytotherapy Research, 16, 2002, PP 33-35

279. Talapatra SK, Sarkar AC, Talapatra B, Phytochemistry, 20, 1981, PP 1923-1929

280. Tas C, Yalcin, O, Baykara T, Drug Development. Indian journal of pharmaceutical sciences, Pharm, 30, 2004, PP 637-647

281. Trombetta D, Puglia C, Perri D, *et al,* Effect of polysaccharides from *Opunta ficus-indica* cladodes on the healing of dermal wounds in the rat, Phytomedicine, 13, 2006, PP 289-294

282. Winter CA, Risley EA, Nuss CW, Carrageenan-induced edema in hind paws of rats-an assay for anti-inflammatory drugs, Proceedings of Society Experimental Biology Medicine, 111, 1962, PP 544-547.

283. Winter CA, Risley EA, Nuss GW, Carrageenin-induced edema in hind paws of the rats as an assay for anti-inflammatory drugs, Proceedings of Society for Experimental Biology and Medicine, 111, 1962, PP 544-550.

284. Mishra AN, Jain NK, Transdermal Drug Delivery, controlled and novel drug delivery, New Delhi CBS Publishers, 1997, PP 100-128

285. Barry BW, Dermatological Formulations, Marcel Dekker., Inc., New York, Basel, 18,1983, PP 96-115

286. Bhattacharya N, Doshi AB, Sahasrabudhe AS, Hair Dye Composition Prepared from Rubiaceae Extracts, R J of Pharmacy, 87, 1998, PP 26-49

287. The Ayurvedic Pharmacopoeia of India, Ministry of Health and Welfare, Government of India, New Delhi, Part I, Volume I, 1989, PP-32-36

288. Indian Pharmacopoeia, Controller of Publications, New Delhi, 1996 edition, Volume-I, Appendix- A-54

289. Khandelwal KR, A text book of practical Pharmacognosy, Nirali Prakashan, 27th edition, Pune, 2005, PP 151-163

290. Mukherjee PK, Quality Control of Herbal Drugs, First edition, Business Horizons Pharmaceuticals Publishers, New Delhi, 4th edition, 2002, PP 16-22,143,144,189-196

291. Sass JE, Elements of botanical micro techniques, McGraw Hill Book, New York,20, 1940, PP 222-238

292. O'Brien TP, Feder N, Mc Cull ME, Polychromatic staining of plant cell walls by toludine blue, protoplasma, 59, 1964, PP 364-373

293. Mukherjee PK, GMP for Indian systems of medicine, regulatory and quality issues on phytomedicines, Business horizons, New Delhi, 2005, PP 99-112

294. Harborne JB, Chromatographic Methods, Reinhold New York, 1967, PP 677-680

295. Pal DK, Mandal M, Senthilkumar GP, Padhiari A, Antibacterial activity of *Cuscuta reflexa* stem and *Corchorus olitorius* seed, Fitoterapia, 77,2006, PP 589-591

296. Martin AA, The use of antioxidants in healing, Dermatological Surgery, 22, 1996 PP 156–160

297. Martin P, Wound healing aiming for perfect skin degeneration, Science, 276, 1997, PP 75–81

298. Phillips GD, Whitehe RA, Kinghton DR, Initiation and pattern of angiogenesis in wound healing in the rat, American Journal of

Anatomy, 192, 1991, PP 257-262

299. Pierce GF, Mustoe TA, Pharmacologic enhancement of wound healing, Annual Review of Medicine, 46, 1995, 467–481

300. Purna SK, Babu M, Collagen based dressings,/a review, Burns, 26, 2000, PP 54-62

301. Rajani M, Kumar VP, Chauhan NS, Padh H, Search for antibacterial and antifungal agents from selected Indian medicinal plants, Journal of Ethnopharmacology, 107, 2006 PP 182-188

302. Ramakrishnappa K, Impact of cultivation and gathering of medicinal plants on biodiversity a case study from India,

biodiversity and the ecosystem approach in agriculture, Forestry and Fisheries, 21, 2003, PP 1745-1749

303. Rashed AN, Afifi FU, Disi AM, Simple evaluation of the wound healing activity of a crude extract of Portulaca oleracea L. growing in Jordan, Journal of Ethnopharmacology, 88, 2003, PP 131-136

304. Raskin I, Ribnicky DM, Komarnytsky S, *rt al,* Plants and human health in the twenty-first century, Trends in biotechnology, 20(2), 2003, PP 522-531

305. Ozgen U, Ikbal M, Hacimuftuoglu A, *et al,* . Fibroblast growth stimulation by extracts and compounds of Onosma argentatum roots, Journal of Ethnopharmacology, 104, 2003, PP 100-103

306. Ozturk N, Korkmaz S, Ozturk Y, Baser KH, Effects of gentiopicroside, sweroside and swertiamarine, secoiridoids from gentian (Gentiana lutea ssp. symphyandra), on cultured chicken embryonic fibroblasts, Planta Medica, 72, 206, PP 289-294

307. Paiva LA, de-Alencar-Cunha KM, Santos FA, *et al,* Investigation on the wound healing activity of oleoresin from Copaifera langsdorffi in rats, Phytotherapy Research, 16, 2003, PP 737-739

308. Pal S, Shukla Y, Herbal medicine current status and future, Asian pacific journal of cancer prevention, 4, 2004, PP 281-288

309. Antarkar SS, Chinwalla T, Bhatt N, Anti-inflammatory activity of

Rubia cordifolia Linn. In rats, Indian Journal of Pharmacology, 15 (3), 1983, PP 185-188

310. Araujo CC, Leon LL, Biological activities of Curcuma longa L., Mem Inst Osawaldo Cruz, 96, 2001, PP 723–728

311. Baboir BM, Oxygen dependent microbial killing by phagocytes (first of two parts), New England Journal of Medicine, 29, 1978, PP 629–668

312. Babu M, Shanmuga PK, Gnanamani A, Radhakrishnan N, Healing potential of Datura alba on burn wounds in albino rats, Journal of Ethnopharmacology, 83, 2002, PP 193-199

313. Leyden J and et al. Comparison of the efficacy and safety of a combination topical gel formulation of benzoyl peroxide and clindamycin with benzoyl peroxide, clindamycin and vehicle gel in the treatments of acne vulgaris. American Journal of Clin. Dermatol, 2 (1), 2001, 3–9

314. Biswas TK, Mukherjee B, Plant medicines of Indian origin for wound healing activity, Lower Extremity Wounds, 2, 2003, PP 25–39

315. Brakenhielm E, Cao R, Cao Y, Suppression of angiogenesis, tumor growth, and wound healing by reseveratrol, a natural compound in red wine and grapes, FASEB Journal, 15, 2001, PP 1798-1800

316. Buffoni F, Bancheli G, Cambi S, *et al,* Skinwound healing: some biochemical parameters in Guinea pig, Journal of Pharmaceutics and Pharmacology, 45, 1993, PP 784–790

317. Burgalassi S, Raimondi L, Pirisino R, *et al,* Effect of xyloglucan (tamarind seed polysaccharide) on conjunctival cell adhesion to laminin and on corneal epithelium wound healing, European Journal of Ophthalmology, 10, 2003, PP 71–76

318. Cowan MM, Plant products as antimicrobial agents, Clin Microbiology Review, 12, 1999, PP 564-582

319. Chaudhari M, Mengi S, Evaluation of phytoconstituents of Terminalia arjuna for wound healing activity in rats, Phytotherapy Research, 20, 2006, PP 799-805

320. Satoskar RS, Bhandarkar SD, Ainapure SS, Pharmacology and Pharmacotherapeutics, Popular Prakashan, 16th Edition, 2001, PP 153- 154

321. Stahl E, The historical development of the method, In Thin layer chromatography, Springler- Verlag, Berlin, 2nd edition, 2002, PP 24-36

322. Simone F, Aquino R, Feo V, New compounds and anti-inflammatory activity of *Uncaria tomentosa.* Journal of Natural products, 54, 2004, PP 453–459

323. Shukla A, Rasik AM, Jain GK, *et al,* In vitro and in vivo wound healing activity of asiaticoside isolated from *Centella asiatica*, Journal of Ethnopharmacology, 65, 2003, PP 1-11

324. Seibert K, Masferrer JL, Role of inducible cyclooxygenase (COX-2) in inflammation, Receptor 4, 1994, PP 17–23

325. Thiem B, Grosslinka O, Antimicrobial activity of *Rubus chamaemorus* leaves, Fitoterapia, 75, 2003, PP 93–95

326. Tripathi KD, Essentials of Medical Pharmacology, 5th Edition Jaypee Brothers Medical Publishers (p) Ltd., New Delhi, 2003, PP 1-9

327. Tripathi YB, Sharma M, Comparison of antioxidant action of the alcoholic extract of Rubia *cordifolia* with Rubiadin, Indian Journal of Biochemistry and Biophysics, 12, 1998, PP313

328. Tripathi YB, Sharma M, Shukla S, Tripathi P, Indian Journal of Experimental Biology, 10(2), 1995, PP 10-33

329. Tripathi YB, Shukla SD, Phytochemical research of crude drugs, Phytotherapy research, 12, 1996, PP 454-469

330. Trivedi PC, Herbal Medicine, Traditional practices, Aavishkar Publishers, Distributors, Jaipur, India, 5 (61), PP 128-139

331. Acevedo C, Mino J, Moscatelli V, *et al,* Antinociceptive and anti-inflammatory activities of *Artemisia copa* extracts. Pharmacological Research. 50, 2004,PP 59- 63

332. Muniappan M, Immunopharmacological and antibacterial studies on *Bambusa arundinacea*, Ph.D. Thesis, Madras University,

Chennai, India, 1998, PP 56-89

333. Villegas LF, Marcalo A, Martin J, *et al,* epi-Alpha-bisabolol [correction of bisbolol] is the woundhealing principle of *Peperomia galioides*: investigation of the in vivo wound-healing activity of related terpenoids, Natural Products, 64, 2001, PP 1357-1359

334. Vinegar R, Schreiber W, Hugo R, Biphasic development of carrageenin induced edema in rats, Journal of Pharmacology and Experimental Therapeutics, 166, 1969, PP 96-103

335. Wagner H, Bladt S, Plant drug analysis, A TLC Atlas, Springer publication, 2nd edition,1996 , PP 68, 70, 300

336. Wagner H, Wolff P, New natural products and plant drugs with pharmacological, biological and therapeutic activity, Springer-Verlag, Berlin, 1977, PP 147-191

337. Wakdikar S, Global health care challenge, Indian experiences and new prescriptions, Biotechnology issues for developing countries, 7(3), 2004, PP 214-220

338. Watts K, Current and emerging approaches for natural product biosynthesis in microbial cells. Advance Synthetic Catal. 347, 2005, PP 927–940

339. William CE, Trease and Evans Pharmacognosy, WB Saunders company, London, 1996, PP 178-191

340. Willis JC, Airy-shaw HK, A dictionary of the flowering plants and ferns, Cambridge University Press, London, 12, 1973, PP 14-26

341. Young JM, De Young LM, In Spector, J., Back, N. (Eds.), Pharmacological Methods in the Control of Inflammation.

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Review article

A Comprehensive Review on Formulation and Evaluation of Herbal Anti-acne Gel

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Abstract

Acne vulgaris is a Common human skin disease that affects both adults and teenagers is acne. It is a prevalent inflammatory skin condition affecting the pilosebaceous unit. Although it can also affect the back, trunk, and upper arms, it usually shows up on the face. Acne affects 83% of teenage females and 99.5% of teenage boys due to hormonal changes, and it can last all teenage years. Propionibacterium acne and Staphylococcus epidermidis are the microorganisms that cause acne. The public is paying increasing attention to herbal formulations due to their superior qualities and less adverse effects. Furthermore, it supplies the skin with the hydration and nutrients it needs. The herbal Gel is essentially an emulsion of water and oil that has less adverse effects. This study reviews recently published research on the creation of herbal anti- acne Gels.

Keywords: Anti-acne, herbal formulation, microorganisms, inflammatory skin

1. Introduction

1.1 Acne

Acne is a skin condition that has detrimental social and psychological impacts on those who have it. Both adults and many youngsters struggle with it. The most contributing elements Increased sebum production, keratinocyte shedding, bacterial growth, and inflammation all contribute to the development of acne. By triggering specific inflammatory mediators, the anaerobic pathogen Propionibacterium acnes (P. acnes) contributes significantly to the pathophysiology of acne [1]. Individual differences in acne severity can be substantial, and hereditary factors are a major contributing factor. The microbial population, follicular hyperkeratosis, androgen-driven seborrhea, as well as a number of immunological and inflammatory processes, are important causes of acne. Each person's unique acne phenotype is shaped by the interactions between these factors [2]. When the keratinocytes lining the sebaceous follicle shed abnormally, a microplug or microcomedo forms, which is the first step in the development of an acne lesion. Increased amounts of androgens in the blood during puberty cause the pilosebaceous unit to produce more sebum. The commensal bacteria Propionibacterium acnes can colonize the area thanks to these modifications. As P. acnes grows in number, They produce chemotactic factors and

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inflammatory chemicals that initiate and maintain the local inflammatory response, which may also result in an increase in keratinocyte proliferation [3].

1.2 Factors responsible for acne [4]:

- Propionibacterium acnes (P. acne)
- Altered follicular keratinization
- Genetics
- Over Washing the Face with Cleansers
- Inflammation
- Androgen-induced enhanced sebum hyper-production
- Medications.
- Due to the Cosmetics Used
- Stress
- Hormonal Changes and Menstruation
- Squeezing the Pimples
- Diet

2. Herbal cosmetics

The phrase "herbal cosmetics" describes goods with a greater natural component count that are only intended to provide certain cosmetic advantages. The herbal medicine market is expanding swiftly as they don't have any negative side effects. Herbs and plants are the sole ingredients in herbal cosmetics [5]. There are natural and synthetic formulations for a range of skin disorders, including sunscreen, anti-acne, anti-wrinkle, and skin protection. Herbal medicines offer several benefits, such as anti-inflammatory, antiseptic, antibacterial, and antioxidant properties, which prevent side effects as compared to synthetic formulations [6].

2.1 Advantages of herbal cosmetics over traditional cosmetics [7]

1. They have no adverse side effects and don't cause allergic responses.
2. They blend in with skin and hair with ease.
3. Compared to other cosmetics in modest amounts, they are far more effective.
4. Plant extract reduces the cosmetics' bulk qualities and provides the right pharmacological effects.
5. Easily accessible and present in a wide range of plants.
6. Their herbal ingredients are more stable, pure, and effective.
7. Simple to produce.
8. Herbal cosmetics are easy to handle and store for an extended amount of time.

3. Gel

Gels are classified as semisolid emulsions that are designed for external application and can be either water in oil (w/o) or oil in water (o/w) in kind. Gels are used for cleaning,

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beautifying, and enhancing looks in addition to their medical and cosmetic uses. The goal of these topical formulations is to locally administer the drug, either into the underlying layer of the skin or into the mucous membrane. To enhance the site-specific delivery of medicine for skin diseases, these products must be applied topically [8]. The Gel's goals are to prevent acne and tan lines, cure any disease, and calm the skin's reaction to different environmental factors. Foundation, vanishing, cleaning, massage, hand, and body Gels are among the many types of Gels. It is easy to apply Gels to any portion of the body. For people of all ages, using Gel is convenient [9].

3.1 Formulation of herbal Gel

Several papers over the previous several years have been examined by us. Our research clearly shows that the herbal anti-acne Gel consists of two components: excipients and chief elements.

3.2 Chief constituents

These are the primary pharmacologically active ingredients that provide the Gel its anti-acne properties. These are the natural medications that are obtained from natural resources. During our investigation, we discovered a lot of medications, which are listed below:

Eucalyptus globules: The eucalyptus leaf is a component of the anti-acne Gel composition. Propionibacterium acnes (P. acnes) is among the many bacteria that the essential oil of eucalyptus exhibits antibacterial action against. 10 We concluded from our investigation that it can be utilized at levels as low as 2% [10] and as high as 4% [11].

Iris ensata: An anti-acne lotion made of polyherbal ingredients contains iris extract. It was made by combining the iris roots with 60:80 petroleum ether in the Soxhlet's Equipment. It is utilized at a 1.5% concentration. [11]

Azadirachta indica: This medication is commonly referred to as neem. Because of its antimicrobial qualities, it is widely utilized in India. Since ancient times, it has been utilized for its many advantages. Additionally, it exhibits antibacterial properties against acne-causing microorganisms. Its extract is utilized to make the polyherbal anti-acne Gel. In the Soxhlet's apparatus, it was made by combining neem leaves with petroleum ether in a 60:80 ratio. As little as 0.5% [13] and as high as 5% [12] can be achieved using it.

Cyperus rotundus: It is frequently referred to as nut grass. Africa, southern and central Europe, and southern Asia are the natural habitats of Cyperus rotundus. It is an excellent component for cosmetics because of its antifungal, antibacterial, and antimicrobial qualities [14]. In the Soxhlet's apparatus, its extract is also made by using its roots in a 60:80 petroleum ether ratio. As little as 1.5% [11] or as high as 2% [14] can be employed.

Nyctanthes arbortristis: Harsinghar is its native name. The Indian traditional medical system makes use of it. It works well as an antibacterial. Its extract, which may be created by combining

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its steam with petroleum ether in a 60:80 ratio, is used in its formulation. It is utilized at a 1.5% concentration [11].

Astragalus sarcocolla: Anjira is the local name for it. It is a traditional herbal remedy as well. Its anti-oxidant properties will help to promote skin health. It was extracted using a 50:50 ratio of alcohol to distilled water. It is utilized at a 1.5% concentration [11].

Aloe barbadensis: In India, it's generally referred to as aloe vera. Aloe Vera gel is used as a moisturizer, to heal burn wounds, and to lessen acne and pimples [13]. Aloe Vera is utilized for its calming and skin-glow properties. possesses anti-inflammatory and antioxidant properties as well [15]. The sterile knife was used to cut away the colorless parenchymatous tissue, which is aloe vera gel. The fibers and contaminants are then eliminated by filtering it through muslin fabric. The clear aloe vera gel filtrate or filter product can then be utilized in the process [13]. Its use ranges from as low as 0.63% [16] to 3% [11].

Matricaria chamomilla: Baboona is the name of the medication. Its essential oil is utilized in the creation of polyherbal anti-acne lotion. Its preparation involves the usage of monkey flowers. The conc. of 0.5% uses it [11].

Vetiveria zizanoides: When making a polyherbal anti-acne Gel, it is utilized. Khas is its local name. Its essential oils are extracted and employed in the formulation. It can be applied to a 0.3% concentration [11].

Commiphora myrrha: it is also called Mur-makki. A multi-herbal anti-acne Gel is made with its essential oil. Its antimicrobial, astringent, and anti-inflammatory properties make it useful. The conc. of 0.2% uses it [11].

Boswellia serrata: Gugal/Luban is its native name. Because of its anti-inflammatory qualities, it is a component in the polyherbal anti-acne Gel. Its essential oils are employed in the preparations. In the conc, it is used. ranging from 0.2% [11] to 4% [18].

Jasminum officinalis: Another name for it is Chameli. It emits a really nice scent. It is utilized in the creation of polyherbal anti-aging products as an antioxidant and anti-wrinkle agent. Gel for acne. Very little of its essential oils are utilized. It is utilized at a concentration of 0.3% [11].

Olea europaea: In India, it's referred to as both Olive and Zaitoon. It has anti-oxidant and moisturizing qualities. A multi-herbal anti-acne Gel is made with its fixed oil. The conc. of 5% uses it [11]. It functions as a supportive agent as well.

Salix alba: It is known as The White Willow. It is a species of willow native to Europe and western and central Asia. In this poly herbal Gel preparation the bark of white willow is used. It helps in the exfoliation of skin and promotes new cell growth. It is used in the conc. Of 0.63% [16].

Saccharum officinarum: We call it sugar cane. It contains a lot of sugar. In the composition of the polyherbal Gel, it also serves as an exfoliating agent. As an excipient, it also serves a supportive function. The conc. of 0.63% contains sugar cane juice [16].

Cucumis sativus: It is commonly known as Cucumber. It provides cooling, healing and soothing to irritated skin, whether caused by sun, or the effects of cutaneous eruption, due to high anti

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oxidant nature. For the formulation it is prepared by using the fruit of cucumber in the Soxhlet apparatus and extracted with petroleum ether (60 to 80°C) to defat the drug. It is used in the conc. of 1.5% [14].

Daucus carota: We call it wild carrot. It has high levels of both vitamin A and vitamin C. Additionally, vitamin A is an excellent antioxidant that slows down the aging process. The body uses vitamin C to make collagen, a protein that is necessary for our skin to be elastic. Additionally, it keeps the skin from getting wrinkles. Because of its anti-oxidant and anti-aging properties, it is utilized in the formulation of herbal anti-acne Gels. It is utilized at a concentration of 0.5% [19].

Ocimum sanctum: It is frequently referred to as holy basil, or tulsi. Because of its antibacterial properties and ability to reduce black spots, tulsi is frequently used in skin preparations and primarily in herbal cosmetics and medicine. Tulsi cleanses the body of impurities and detoxifies the blood. Antioxidants found in tulsi prevent aging by counteracting the negative effects of free radicals. Because of its antibacterial properties against acne germs, it is incorporated into the composition. Because of its flexibility, it offers several skin-benefitting properties. It is utilized at a concentration of 0.5% [19].

Casuarina equisetifolia: Pakistan, India, Sri Lanka, and tropical Africa all cultivate this attractive shrub. Antibacterial, antifungal, anti-inflammatory, anti-cancer, antioxidant, and analgesic properties are all present in this plant. As an astringent, C. equisetifolia bark is utilized. Five percent utilize it [20].

Cinnamomum verum: In common parlance, it is also known as cinnamon. It is referred to as darchini in unani preparation. It is utilized for its main antiseptic activity. It is used to make herbal anti-acne Gel. It is utilized in the 1% conc. [21].

Rubia cordifolia: Manjishtha is a kind of flowering plant that belongs to the Rubiaceae family, which also includes coffee. According to the Unani herbal classification, it is known as Husune Yusuf. Its antibacterial and anti-inflammatory properties make it useful. It is used in the preparation in conc. as low as 0.3%15 to as high as 1% [21].

Catharanthus roseus: Vinca is the name of it. The vinca flower is used in the herbal anti-acne Gel formulation. Acne can be effectively treated using its astringent, disinfectant, and antibacterial qualities. It is utilized in the 0.9% conc. [22].

Foeniculum vulgare: Fennel is its common name. It possesses strong antibacterial, antioxidant, and anti-inflammatory properties. The southern Mediterranean area is where it first appeared. It was grown by the Romans for its fragrant seeds. It is a component in herbal anti-acne Gel formulations. In the context of 1%, it is utilized [23].

Camellia sinensis: In the flowering plant family Theaceae, Camellia sinensis is a species of evergreen shrub or small tree whose leaves, leaf buds, and stems can be used to make tea, also known as Green Tea. Its moisturizing, skin-protecting, and ant melanogenesis qualities make it a perfect candidate to be used in the formulation of herbal anti-acne Gel in conjunction with other medications; it is used in the concentration of 10% [24].

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4 Excipients

An excipient is a material that is added to a drug in addition to the active component. Excipients are used in a variety of objectives, such as boosting the therapeutic qualities of the active component in the finished dosage form, bulking up solid formulations with strong active ingredients in tiny doses, or providing long-term stability. They can improve solubility, decrease viscosity, or aid in medication absorption. The qualities of the chosen necessary excipient are taken into consideration while choosing the excipients. after examining how the recently released research publications were written. We found that an excipient's primary contribution to the final formulation determines whether it should be included in the formula or not.

A. Thickening agents:

A material that may raise a liquid's viscosity without significantly altering its other characteristics is known as a thickening agent or thickener. For example: Steric acid, Carbopol 940, PEG1500, Cetyl alcohol etc

We discovered that steric acid is utilized more frequently than any other agent based on these data. Therefore, we can confidently state that, in comparison to other medications, it is an excellent thickening agent. Additionally, it's a excellent binder. It ranges from as low as 3% [12] to as high as 16.2% [16] in conc.

B. Anti-Inflammatory Agents:

These are chemicals that lessen the body's inflammation, which includes pain, swelling, and redness. Anti-inflammatory drugs prevent some chemicals that lead to inflammation in the body. Additionally, these excipients strengthen the primary constituents' anti-inflammatory properties. For example: Spermaceti, Almond oil, White beeswax, Salicylic acid, Castor oil etc.

C. Moisturizing Agent:

A. To hydrate the skin and stop moisture loss, moisturizing ingredients are added to cosmetics. They offer the skin a smooth look and aid in preserving its natural moisture content. These consist of emollients, occlusives, and humectants. For example: Glycerylmonosterate, White petroleum, PEG1500, Silicone oil, Glycerin, White bees wax, Petroleum jelly, Mineral oil, Propylene glycol etc.

We may conclude from our analysis of these data that glycerin would make a good moisturizer in our recipe of herbal anti-acne Gel. Glycerin exhibits the highest hydrating properties with fewer adverse effects and other medication interactions. It is suitable for usage at concentrations as low as 1.9% [16] and as high as 12% [21].

D. Antioxidants:

Compounds known as antioxidants prevent oxidation. a chemical process capable of generating free radicals. These free radicals' existence will result in the herbal or spoiling components, which will ultimately impact the product's shelf life. By interacting with oxygen before the active chemicals in the medication, the antioxidants will shield the active compounds. For example: Citric acid, Sodium metabisulfite, Zinc oxide etc.

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We can confidently state that zinc oxide is a good option for antioxidants based on our analysis of these data. Mint will display several attributes in the interim, including astringent and will give the Gel its freshness. Zinc oxide serves as an antioxidant in a variety of formulations. It may range from as low as 0.76% [16] to as high as 1.5% [11] in the conc.

E. Buffering agent:

A solution that can withstand a pH shift when acidic or basic substances are added is called a buffer. It can counteract trace levels of additional basic or acid, keeping the solution's pH comparatively constant. These substances are employed to keep the mixture stable under different circumstances. For example: Sodium citrate, Potassium hydroxide, Triethanolamine, Borax, EDTA.

F. Preservative:

These are the substances or medications that will aid in preventing our preparation from spoiling. Microbial growth will cause these compounds to break down. For example: Methyl paraben, Propyl paraben, Borax, Disodium EDTA, EDTA etc.

We can confidently conclude from our analysis of these facts that both Propyl and methyl paraben are excellent preservatives. This is simple to add to the majority of formulas. There are several articles that utilize methyl paraben. It is applicable to Conc. ranging from 0.01% [14] to 0.6% [25].

G. Skin protectant:

Skin protectant is a thin layer or barrier that can be applied to skin that has been damaged or is susceptible to harm. The shield offers a protective layer that both shields the injured skin and speeds up the healing process. For example: Mineral oil, Zinc oxide, Lanolin, Bismuth subnitrate, Ammonium acryloyldimethyltaurate etc.

Based on our analysis of these data, we may conclude that Lanolin and zinc oxide will both promote healing and offer a protective layer. Lanolin is used in as low as 2% [11] to as high as 4.3% [22] in the conc.

H. Emulsifier:

Emulsifiers are surface-active substances, which means they create connections by floating inside the aqueous-oily phase interfaces. crucial prerequisite for emulsifiers. These substances will enable the creation of an emulsion. For example: Cetostearyl alcohol, Cetyl alcohol, Borax, Sodium lauryl sulfate, Tween60, Polysorbate, Polyethylene glycol etc.

We can confidently state that borax and cetyl alcohol are both effective emulsifying agents based on our analysis of these facts. Borax can be utilized at concentrations ranging from 0.1% [15] to 0.8% [18]. However, the percentage of cetyl alcohol that can be employed ranges from 0.95% [16] to 5.8% [21].

I. Antimicrobial Agent:

Preservatives with antimicrobial properties serve two purposes: (i) to stop the growth of bacteria that might cause the product, and (ii) to stop the development of harmful bacteria that might endanger the user's health when used repeatedly over long periods of time—often by several

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people. This covers both antifungal and antibacterial properties. For example: White bees wax, Sulfur, Castor oil etc.

We can confidently state that white beeswax has strong antibacterial action based on our analysis of these data. In particular, it has strong antibacterial properties that might extend the duration of the preparation. It appears in several articles. Its confidence level might range from 1.6% [15] to 16.67% [18].

J. Fragrance Agents: These are the substances that will give the mixture a pleasing scent. Despite the minimal quantity of scent included in cosmetics, it is a necessary component of makeup. For example: Rose water, Min etc.

Based on our analysis of these data, we conclude that mint and rose water work well together to provide the formulation aroma. Rose water also gives anti-ageing property to the skin. Since they give aroma, they are often employed in drips based on demand.

5. Evaluation tests for Gel

5.1 PH of Gel

The pH meter is calibrated using a standard buffer solution. Weighing and dissolving approximately 0.5 g of the Gel in 50.0 ml of purified water is required, along with its They measure the pH. To avoid irritating the skin, the Gel's pH should be between 5.6 and 5.8.

5.2 Viscosity

Using spindle number seven, the Brookfield Viscometer can measure the formulation's viscosity at 100 rpm.

5.3 Phase Separation

The prepared Gel is stored away from light in a covered container between 25 and 1000C. Phase separation is then monitored for 30 days at 24-hour intervals. days. The phase separation is seen to shift.

5.4 Acid value

After dissolving 10 grams of material in 50 milliliters of an equal amount of alcohol and solvent ether, the flask is attached to a reflux condenser and heated gradually until the sample is fully dissolved. One milliliter of phenolphthalein is then added, and the mixture is titrated with 0.1N NaOH until After 30 seconds of shaking, a subtle pink hue emerges.

Acid value = n*5.61/w

n = the number of ml of NaOH required.

w = the weight of substance.

5.5 Saponification value

After 30 minutes of refluxing about 2 grams of the material with 25 milliliters of 0.5 N alcoholic KOH, add 1 milliliter of phenolphthalein and titrated right away using 0.5 N HCL.

Saponification value = (b-a)*28.05/w

The volume in ml of titrant = a

The volume in ml of titrate = b

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The weight of substance in gm = w

5.6 Irritancy test

The purpose of these tests is to assess the material and chemical quality and establish whether or not they are harmful to the skin. To check for irritation, the Gel is first applied to the hand and kept on for a while. On the dorsal surface of the left hand, mark a 1 sq. cm area. Time is recorded as the Gel is administered to the designated region. Erythema, edema, and irritation are monitored for up to 24 hours at regular intervals and reported.

5.7 Accelerated stability testing

Two of the most stable produced formulations undergo accelerated stability testing at room temperature, followed by a seven-day study at 40°C ± 1°C for 20 days. The formulations are maintained at room temperature and at a higher temperature, and stability parameters are measured on the 0th, 5th, 10th, 15th, and 20th days.

Conclusion

We came to the conclusion that the herbal anti-acne Gel is a very efficient composition with little negative effects after carefully reviewing the papers in our study. Our Research looked at the amounts of different natural herbs used in anti-acne Gel formulations, as well as how they were evaluated. Our study's objective is to present comprehensive details on the various herbs and excipients used in the herbal anti-acne Gel. The stability, safety, and effectiveness of a herbal anti-acne Gel may be ascertained by evaluating the assessment parameters.

Following our investigation, we developed a broad anti-acne Gel composition. We have attempted to construct a range of each and every element, therefore this is only suggested in nature. that a person may start their job by creating a formula at random and then use optimization techniques to get the best suited formulation. We believe that a method for creating an ideal formulation may be designed by analyzing a large number of formulations of any dosage form and calculating the average percentage of constituents.

Reference

1. Dreno B. Topical Antibacterial Therapy for Acne Vulgaris. Drugs,2004:64(21):2389–97.
2. Lehmann p. Acne Dermatologie,2009:60(5):402–8.
3. Webster GF. The pathophysiology of acne. Cutis,2005:76(2):4–7.
4. Tuchayi SM, Makrantonaki E, Ganceviciene R, Dessinioti C, Feldman SR, Zouboulis CC. Acne vulgaris. Nature Reviews Disease Primers,2015:1(1):1 20.
5. Jagannadha H. Therapeutic Applications of Almonds (Prunus amygdalus L): A Review. Journal of Clinical and Diagnostic Research,2012:6(1):130–5.
6. Smit N, Vicanova J, Pavel S. The Hunt for Natural Skin Whitening Agents. International Journal of Molecular Sciences,2009:10(12):5326–49.
7. M Vimladevi. Text book of Cosmetics; Edition, CBS Publishers & Distributor, 2005, 29, 67, 88, 101, 253.

ISSN: 0975-3583,0976-2833 VOL 14, ISSUE 12, 2023

8. Sonalkar MY, Nitave SA. Formulation and evaluation of polyherbal cosmetic Gel. World journal of pharmacy and pharmaceutical sciences,2016:5(2):772 9.

9. Mohiuddin AK. Skin Care Gels: Formulation and Use. Dermatology Clinics & Research,2019:5(1):238 71.

10. Athikomkulchai S, Watthanachaiyingcharoen R, Tunvichien S, Vayumhasuwan P, Karnsomkiet P, Sae Jong P, et al. The development of anti-acne products from eucalyptus globulus and psidium guajava oil. J Health Res,2008:22(3):109–13.

11. Parveen S, Zafar S, Masroor Ali Qureshi, Bano H. Clinical trial of Unani herbomineral Gel to evaluate its topical effects on Acne vulgaris. Indian Journal of Traditional Knowledge,2009:8(3):431–6.

12. Chandrasekar R, Sivagami B. Formulation and Evaluation of a Poly Herbal Skin Care Gel containing Neem and Tulsi. Research Journal of Topical and Cosmetic Sciences,2018:9(1):25.

13. Navindgikar NN, Kamalapurkar KA, Chavan PS. Formulation and evaluation of multipurpose herbal Gel. International Journal of Current Pharmaceutical Research,2020:12(3):25–30.

14. Rajvanshi A, Sharma S, Khokra S, Sahu R, Jangde R. Formulatio and evaluatio of cyperus rotu dus a d cucumis sativus based herbal Pharmacologyonline,2011:2:1238–1244.

15. Choudhari NN, Dudhe AR, Tatte SP, Zile TS, Nandeshwar YK, Dhawale TP, et al. Formulation and evaluation of anti-acne face Gel. World Journal of Advanced Research and Reviews,2023:19(1):1181–8.

16. Abbasi M, Kausar A, Ur-Rehman A, Saleem H, Jahangir S, Sabahat Z, et al. Preparation of new formulations of anti-acne Gels and their efficacy. African Journal of Pharmacology,2010:4(6):298–303.

17. Mullaicharam Bhupathyraaj, Lakshmi Sreenath, Hanan Obaid Al-Habsi, Halligudi NM. Development of Poly Herbal Gel Formulations Containing Wild Growing Omani Medicinal Plants, 2021, 57–65.

18. Satpute Kl, Kalyankar Tm. Development and evaluation of herbal Gel for the treatment of acne. Journal of pharmacognosy phytochemistry,2019:8(3):2618–24.

19. 19. Sharma A, Bharat Prasar. Formulation and Evaluation of herbal cosmetic Gel to produce multipurpose effect on skin. Research Journal of Topical and Cosmetic Sciences,2013:4(1):1–4.

20. Shafiq Y, Naqvi BS, Rizwani GH, Usman M, Shah BA, Hina B. Anti-acne activity of Casuarina equisetifolia bark extract: A randomized clinical trial. Bangladesh Journal of Pharmacology,2014:9(3):337–41.

21. Chaudhary SS, Zaman R, Shamsi S. Formulation and Evaluation of Unani Anti-acne Gel. Journal of AYUSH: Ayurveda, Yoga, Unani, Siddha and Homeopathy,2016:5(3):17–22.

ISSN: 0975-3583,0976-2833 VOL 14, ISSUE 12, 2023

22. Aman M, Preeti M, Sapna M, Anil K. Formulation and evaluation of herbal anti acne Gel. World Journal of Pharmaceutical Research,2017:6(16):589–98.

23. Kumbhar SP, Kolekar MD, Chavan RH, Deshmukh AV, Patil SV. Formulation and evaluation of herbal Gel by using fennel in the treatment of acne. International journal of creative research thoughts (JCRT),2022:10(9):c195–206.

24. Samia Alsawi, Saleh W, Donia Algadaafie, Ali S, Kamal A. Formulation and Evaluation of Gel of Green Tea Extract and Salicylic Acid for Acne Treatment. AlQalam journal of medical and applied sciences, 2024, 235–41.

25. Gonçalves GMS, Gobbo J. Antimicrobial effect of Anacardium Occidentale extract and cosmetic formulation development. Brazilian Archives of Biology and Technology,2012:55(6):843–50.

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FORMULATION AND EVALUATION OF HERBAL ANTI-ACNE GEL

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Abstract
Pimples, also known as acne vulgaris, are caused by a variety of circumstances and primarily impact the pilosebaceous follicle. It mostly denotes inflammation and open and closed comedones, which can result in a number of ailments such nodules, papules, and pustules. Propionibacterium acnes, Staphylococcus aureus, and Staphylococcus epidermidis are the primary microorganisms that cause the disorder. Papules, comedones, cysts, pustules, and abscesses are just a few of the skin lesions that are indicative of acne vulgaris, a chronic inflammatory disorder that affects the pilosebaceous unit. Extracted from the rhizomes of Curcuma longa (Family: Zingiberaceae), curcumin is known for its strong anti-inflammatory, wound-healing, and antioxidant qualities. The purpose of this study was to create a herbal antiacne gel formulation using phytosomes containing bioactive curcumin. Numerous physicochemical characteristics of the prepared gel, such as pH, spreadability, viscosity, and drug content, were assessed. Furthermore, Propionibacterium acnes was used to assess the improved gel formulation's antiacne properties in vitro. The results demonstrated that the created antiacne gel containing curcumin phytosomes was on par with an antiacne treatment that was sold commercially. According to ICH requirements, stability investigations showed that the prepared product stayed stable for three months under accelerated stability circumstances.

Keywords: Anti-acne, herbal formulation, microorganisms, inflammatory skin

1. Introduction
The pilosebaceous unit is impacted by acne vulgaris, a chronic inflammatory illness that is most common during adolescence, a period of profound psychological transformation. Although it can appear at any age, this multifactorial condition, which affects an estimated 85% of the population, is most prevalent between the ages of 12 and 24. Better knowledge of the pathophysiology of acne has resulted in more sensible and successful treatment strategies. Scars, inflamed lesions, and noninflamed lesions are the three types of acne vulgaris lesions. Common acne lesions include comedones, inflammatory papules, and pustules; more severe cases may include cysts and nodules, which might cause scarring and psychological discomfort.[1-2]
During puberty, elevated levels of androgens activate the sebaceous glands, which are linked to hair follicles, resulting in acne. Increased production of sebum, a natural substance that protects and hydrates the skin, causes changes in skin cell maturation that increase the likelihood of obstruction in hair follicles. A elevated region results from the inhibited hair follicle's growth. Inflammation can result from things that irritate the skin and bacteria that live there naturally penetrating deeper layers of the skin if the follicular wall breaches.[3]
Although synthetic medications are frequently used to treat acne, they can have serious negative effects, and long-term usage can make acne-causing bacteria more resistant. Numerous human ailments may be treated by minerals and natural products created from plants and animals, and

herbal therapy is becoming more and more well-liked as a result of the negative effects and toxicity of manufactured medications.[4]

Curcuminoids, a combination of curcumin (diferuloylmethane), demethoxycurcumin, and bis-demethoxycurcumin, are found in turmeric, which is obtained from the rhizomes of Curcuma longa (family: Zingiberaceae). About 90% of turmeric's curcuminoid content is made up of curcumin, the main active ingredient. Curcumin may be used as a treatment for acne since studies have shown that it possesses substantial anti-inflammatory, wound-healing, and antioxidant qualities. When used topically in therapeutic levels or ingested as part of a diet, turmeric is regarded as safe. Clinical studies have shown that curcumin offers therapeutic potential for conditions like pancreatitis, inflammatory bowel disease, arthritis, chronic anterior uveitis, and several types of cancer. [5,6]

Benzoyl peroxide, azelaic acid, and topical retinoids (tretinoin and adapalene) are frequently used to treat mild acne. Topical antibiotics like clindamycin and erythromycin, oral antibiotics like erythromycin and tetracycline, isotretinoin, and hormonal treatments like estrogen and estrogen-containing oral contraceptives are all choices for treating moderate acne. Isotretinoin is frequently used to treat severe acne. Nevertheless, adverse effects from synthetic medications might include minor irritation, dryness, contact dermatitis, nausea, diarrhea, itchy skin, painful eyes, and bacterial resistance, especially from antibiotics. [7]

Due to its many advantages, including fewer side effects, better patient tolerance, cheaper costs, and a long history of use, plant-based natural medicines are becoming more and more popular than synthetic medications. In various situations, phytosomes have been found to improve the solubility, permeability rate, and bioavailability of active compounds. Additionally, they can be utilized without creating any negative effects and prevent or delay physical and chemical deterioration. The goal of the current study was to create and evaluate a herbal topical gel that treats acne as effectively as commercial formulations by using curcumin phytosomes.[8]

2. Material and Methods

2.1 Pre-formulation Study

The first stage in the logical creation of dosage forms for a pharmacological substance is preformulation testing. A preformulation scientist describes the physical, chemical, and medicinal characteristics of a new pharmacological ingredient, both by itself and in conjunction with other excipients, during the preformulation phase of the research and development process.[9] Preformulation studies are created to comprehend the physicochemical characteristics of novel drug entities. This knowledge can then be used to support formulation design, justify the need for molecular modification, or simply verify that there are no major obstacles to the development of the compounds.[10]

Infra Red Spectral Analysis:

Infrared spectroscopy was used to figure out what the medicines were. In a KBr press, 3–5 mg of each drug was pressed together with 100–150 mg of potassium bromide to make a ball about 1 mm in diameter. The It was put in the IR chamber of a Shimadzu FTIR and scanned between wave numbers 4000-600 cm-1.[11] The FTIR spectrum of regular nicorandil is shown in Figure , and the FTIR spectrum of the drug sample is shown in Figure.

Differential Scanning Calorimetry Analysis

Differential scanning calorimetry was used to find the freezing point of the dicyclomine. After being carefully weighed, 2 mg samples were put in aluminium pans and sealed.[12] With Perkin Elmer Thermal Analysis, all of the materials were heated at a rate of 5°C per minute between 45°C and 200°C. Figure shows the thermogram.[13]

Solubility Analysis:
A solubility analysis was done to find the best solvent system for dissolving the medicine properly and to see how well it would dissolve in the planned dissolution media. Nicorandil was soluble in water, ethanol, and chloroform at a rate of 1 in 20. It was not soluble at all in ether.

Melting Point Determination:
The melting point of the obtained drug sample was determined since it serves as an effective indicator of purity, given that a minor variation in the melting point range may indicate the presence of trace residues. [14] A digital melting point apparatus is employed to determine the melting point.

Partition Coefficient Measurement:
The partition coefficient (P) can be determined by comparing the equilibrium concentrations (ci) of a solute in a biphasic system composed of two immiscible fluids. In the presence of n-octanol and water: $\mathbf{P_{o/w} = c_{octanol}/c_{water}}$

Loss on Drying:
A vacant Petri dish was meticulously cleaned, dried, and weighed. The petri dish contained approximately 1 gramme of medication and was weighed again. The precise weight was recorded. The petri dish containing the medication was maintained at 105°C for four hours. [15] The sample was reweighed, and the subsequent procedures were employed to determine the drying loss.

Compatibility Study by FTIR Spectroscopy:
Infrared spectrum research revealed that Nicorandil effectively interacted with the sugars and film-forming polymers utilised in film production.[16] We conducted an infrared spectrum analysis of polymers, Nicorandil, and the Nicorandil-polymer combination to examine alterations in the drug's chemical composition post-mixing. The objective was to align the sample drug's spectra with the reference spectrum [18]. 3-5 mg of each medication and 100–150 mg of potassium bromide were compacted in a KBr press (Model M-15, Techno Search Instruments) to form a sphere approximately 1 mm in diameter. Figures illustrate that the pellet was placed in the IR chamber, and a Shimadzu FTIR was employed to scan it within the range of 4000 to 500 cm-1.

2.2 Formulation and Development of Fast Dissolving Oral Film: Composition of the Placebo Film:
The well-known polymers HPMC-5, HPMC 15cps, HPMC 50cps, PVA (poly vinyl alcohol), PVP, and Eudragid RL-100 have outstanding film-forming qualities. As a result, these polymers were chosen to create films both alone and in combination. To compare the efficiency of each polymer with one another, films were examined. In every film, the polymeric content was maintained at 2%.

Optimisation of the Polymer for Placebo Film Formulation:
The polymer's film-forming capacity, the mechanical properties of the films, disintegration duration, and physical aesthetics—delineated in the table—are the paramount aspects that require optimisation in the development of fast-dissolving oral films. 8.10 and 8.11 Fabrication of a placebo fast-dissolving film incorporating diverse quantities of PVA, HPMC-15, and polymer mixtures: Placebo films with HPMC-15 at concentrations of 1% to 3%, PVA films at concentrations of 1% to 3%, and combinations of HPMC-15: PVA or HPMC-50:

Fabrication of Drug-Loaded Films:
Fast-dissolving films incorporating the medication nicorandil were fabricated with the solvent casting method. Upon dissolving the requisite amount of polymer in 5 millilitres of water and

maintaining continual agitation for one hour, the appropriate quantities of plasticiser and sweetener were dissolved in 95% ethanol and thereafter incorporated into the polymeric solution. The medication was thereafter dissolved in two millilitres of water in an ideal quantity and sonicated to guarantee sufficient dispersion. A magnetic stirrer was employed to amalgamate the drug solution with the polymeric solution for 30 minutes, after which the mixture was allowed to remain undisturbed until the entrapped air bubbles dissipated. The aqueous solution was deposited in a 68 cm^2 plastic Petri dish and subjected to drying at an elevated temperature (microwave oven) and a controlled ambient temperature (25° to 30°C, 45% relative humidity). At controlled room temperature, the film required around 48 hours to dry [19]. Upon meticulous removal from the petri plate, the desiccated film was cut to the requisite dimensions for testing. The films were stored in airtight plastic bags until required again.

2.3 Assessment of Developed Fast Dissolving Films:

Physicochemical Assessment:

Cinema The thickness of the films, after four folds, was measured via a screw gauge. Five videos were randomly selected, and their average was calculated; the results are presented in Table [20].

Weight Variation:

The investigation was conducted on 10 films derived from each formulation batch. The average weight of the film and the deviation from the average were computed and documented as presented in Table.

Hydration Study (Water Uptake/Swelling Study): Following weighing, the film sample was placed on a pre-weighed stainless steel wire mesh. The wire mesh was subsequently submerged in a petri dish containing 20 millilitres of distilled water. [21-22] The film's weight was incrementally increased until it attained a stable weight, as shown in Table. The hydration ratio of the film was established using the subsequent formula:

Hydration ratio $= W_t - W_0 / W_0$

Where Wt =weight of film at time t and W0=weight of film at zero time.

Moisture Loss and Percent Moisture Absorption:

By putting the produced film in desiccators with anhydrous calcium chloride, the percentage of moisture loss was calculated. The video was taken and reweighed after three days [23]. Table displays the results of the calculation of the percentage moisture loss using the formula mentioned below.

Moisture loss $= W_0 - W_t / W_0 \times 100$

Where W0=initial weight Wt =final weight.

The physical stability of the films under very humid circumstances was examined using the % moisture absorption test. After precisely weighing and cutting out three 1 cm diameter films, the films were put in a desiccator with a saturated sodium chloride solution, which maintained a 75% humidity level inside the device. The films were taken off after three days, weighed, and the percentage of moisture absorption was determined. The following formula is used to determine the average percentage of moisture absorption.

Percentage moisture absorption = (Final weight – Initial weight)/Initial weight×100

Measurement of Mechanical Properties:

The characteristics of the mechanical property—tensile strength, elastic modulus, percentage strain, and load at yield—give an indicator of the film's strength and elasticity. [24-25] Table displays the polymer's characteristics.

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Table 1: Mechanical Properties of Film

Type of polymer	Tensile Strength	Elastic Modulus	%Strain
Soft and Weak	Low	Low	Low
Hard and Brittle	Moderate	High	Low
Soft and Tough	Moderate	Low	High
Hard and Tough	High	High	High

The film's mechanical properties elucidate its capacity to withstand force or stress during handling, production, packaging, and transportation. Desirable features of film include moderate tensile strength, low elastic modulus, high percentage strain, and elevated yield load. The polymer is expected to yield a soft but resilient film, as indicated in the aforementioned table.

Percent Elongation: A pulley system was employed to extend the produced film. Weights were incrementally placed to the pan to enhance the pulling force until the film fractured. The elongation was determined on graph paper by documenting the pointer's trajectory prior to the film's rupture [26-27]. According to table, the formula-(mm-2) was employed to calculate the percentage elongation. Percent elongation = L1/L0X100
Where L1=increase in the length, L0=Initial length.

Tensile Strength:
A 2 x 2 cm2 film strip that didn't have any holes or other flaws was held in place by two clamps that were 3 cm apart. A piece of cardboard was stuck to the clamp's surface with double-sided tape so that the film wouldn't get cut by the clamp's holes. In order to measure, weights were put on the pan until the film broke. This was done to pull the strips at the bottom clamp. The force that was recorded when the films broke is shown in Table.
Tensile strength (kg/mm^2) =Force at Break/ Initial cross sectional area of the film (mm^2)

Folding Endurance:
This parameter was determined by repeatedly folding one film at the same place till it broke. The number of times the film could be folded at the same place without breaking/cracking gave the value of folding endurance as shown in table.

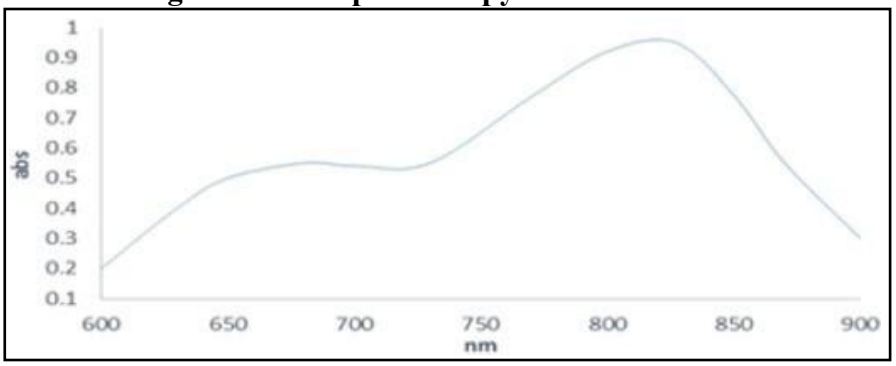
Drug Content: A test for drug content and content uniformity was performed to ensure consistent drug distribution. Five 2 cm × 2 cm film segments were extracted from the centre of the film (n = 3) and from each of the four corners. One hundred millilitres of distilled water were added to each film unit. Ten millilitre samples were extracted, diluted with twenty-five millilitres of a 1% w/v methyl orange solution, and subsequently extracted using three aliquots of seven and a half millilitres of chloroform. The sample volume was subsequently augmented to 50 ml using sodium acetate solution. The solutions were filtered and analysed using a Shimadzu UV-Visible Spectrophotometer from Japan at a wavelength of 465 nm.

3. RESULTS AND DISCUSSION

Identification of the Drug:
Estimation of Nicorandil by spectrometric method with simulated saliva buffer pH 6.8 media was done by the procedure and compared with reference results. Maximum absorbance was observed at 845 nm shown in Figure 1.

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Figure 1: U.V Spectroscopy of the Nicorandil



FTIR Spectroscopy

The acquired sample's IR spectrum was completed in accordance and met Nicorandil's reference IR spectrum. The drug sample's infrared spectra display comparable distinctive peaks. The standard drug Nicorandil's IR spectra analysis is displayed in Figure, while the sample drug's IR spectra are displayed in Figure Table provides the explanation.

Figure 2: IR spectra analysis of standard Nicorandil and IR spectra analysis of Nicorandil (Sample)

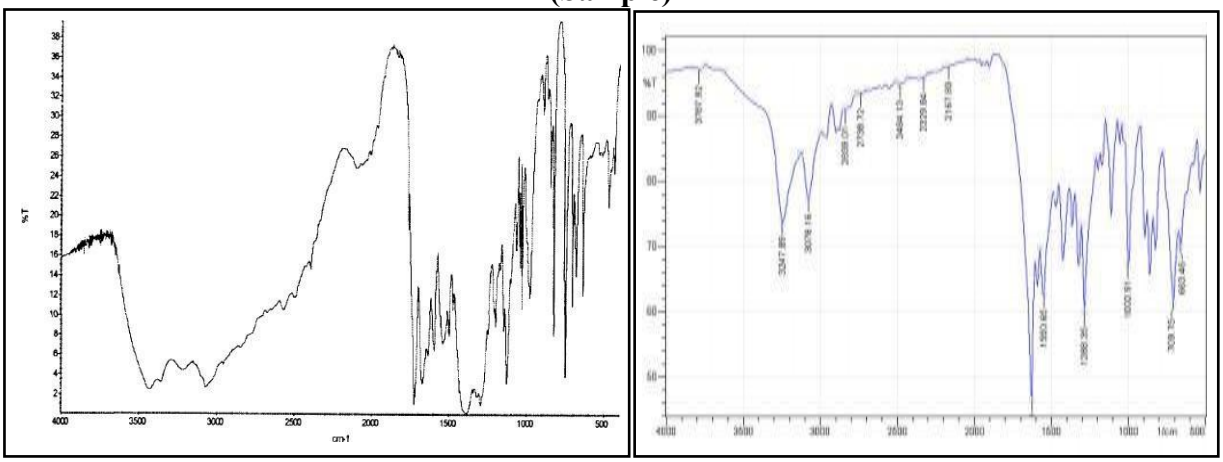


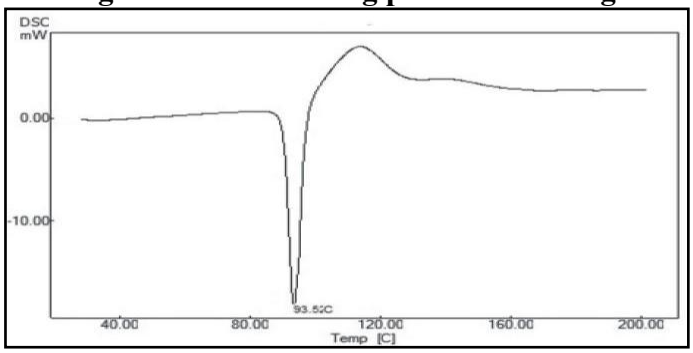
Table 2: IR spectra analysis

Sr. no.	Reported peaks (cm^{-1}) in standard drug	Observed peak (cm^{-1}) of sample drug	Inference
1	1290(1300)	1295	O-NO2stretching
2	1060(1075)	1002	C-0stretching
3	1653(1650)	1550	CO-NH
4	1371(1310)	1388	Aromatic pyridine Tertiary amine
5	3244(3320)	3347	N-H stretching
6	1724(1700)	1824	C=0 stretching

Differential Scanning Calorimetry

The DCM was subjected to DSC acc. to the procedure mention using (Perk in Elmer Thermal Analyzer) and thermogram was obtained and enthdothermic peak was matched with the melting point of the drug.

Figure 3: DSC melting point of the drug.



Loss on Drying:

LOD of the sample drug was performed acc. to the procedure mention According to USP monograph of Nicorandil, % loss of the drug should not be more than 1% of its weight and the result of LOD of Nicorandil is shown in Table 3.

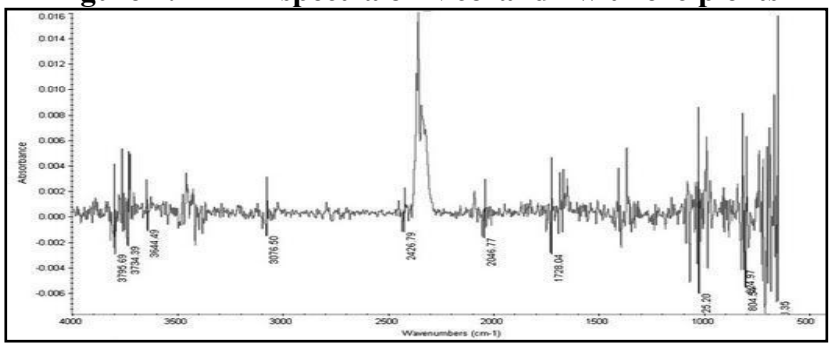
Table 3: % Loss on Drying of Nicorandil

S. No.	Wt. of drug before Drying (gm)	Wt. of drug Drying (gm)	LOD (%w/w)	Average LOD (%w/w)
1.	1.024	1.016	0.58	0.53
2.	1.026	1.019	0.48	

Compatibility Study by FTIR:

FTIR spectra were recorded to assess the compatibility of the drugs and excipients. Study was performed acc. to the procedure. The FTIR Spectra are represented in figure 4.

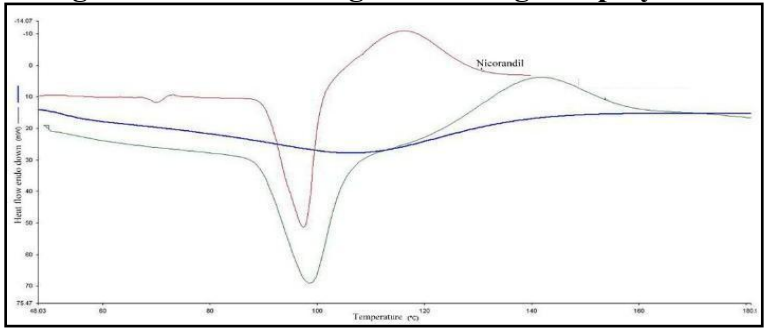
Figure 4: FT-IR spectra of Nicorandil with excipients



Compatibility Study by DSC:

Study was performed acc. to the procedure. The DSC thermograms of Nicorandil and physical mixture of Nicorandil, PVA and HPMC-15 aregivenin the figure 5.

Figure 5: DSC thermogram of drug and polymers



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Optimization and Evaluation of Placebo Films Composition of Polymeric Films:

The films used in the Preformulation trial were made using HPMC-15, HPMC-50, PVA, PVP, and Eudragid RL-100 alone, as well as in combination with HPMC-15/PVA and HPMC-50/Eudragid using the method outlined in section 4.6. Table displays the composition of the placebo. Film flexibility, tensile strength, percentage elongation, dissolving time, and disintegration time were assessed for the prepared. The findings showed that the films' tensile strength, flexibility, elongation percentage, dissolving time, and disintegration time were all varied. For the picture to have the right qualities, optimization is therefore required.

Table 4: Composition of Placebo Films

Ingredients	F1	F2	F3	F4	F5	F6	F7	F8
HPMC-5	2%w/v	-	-	-	-	-	-	-
HPMC-15	-	2%w/v	-	-	-	-	-	-
HPMC-50	-	-	2%w/v	-	-	-	-	-
HPMC: Eudragid RL-100							1:1%	
PVA	-	-	-	2%w/v	-	-	-	-
PVP	-	-	-	-	2%w/v	-	-	-
HPMC:PVA	-	-	-	-	-	1:1%w/v	-	-
PEG-400	3%w/v	3%	3%w/v	3%w/v	3%w/v	3%w/v	3%w/v	3%w/v
Tween80	0.2ml	-	-	-	-	-	-	-
Ethanol q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s	q.s
Water q.s	100ml	100ml	100ml	100ml	100ml	100ml	100ml	100ml

Table: Evaluation of Film Forming Polymers and Combination of Polymers

Evaluation Parameters	**HPMC-50**	**PVP**	**HPMC-50/ Eudragid RL-100**	**HPMC-15/PVA**
Film forming capacity	Good	Very poor	Good	Good
Appearance	Transparent, No stickiness	-	Transparent	Transparent
Film flexibility	Moderate	-	moderate	Moderate
Tensile strength	Poor to moderate	-	Poor to moderate	Moderate
% elongation	Poor	-	moderate	Moderate to high
Disintegration Time (sec)	49	-	30	32
Dissolution time (sec)	240	-	160	190
Thickness (mm)	0.150	-	0.280	0.260
Folding endurance	>800	-	600	500

Conclusion

We came to the conclusion that the herbal anti-acne gel is a very efficient composition with little negative effects after carefully reviewing the papers in our study. Our Research looked at the amounts of different natural herbs used in anti-acne gel formulations, as well as how they were evaluated. Our study's objective is to present comprehensive details on the various herbs and

excipients used in the herbal anti-acne gel. The stability, safety, and effectiveness of a herbal anti-acne gel may be ascertained by evaluating the assessment parameters.
Using readily available low viscosity film formers, such as HPMC E15, Polyvinyl Alcohol, and a combination of HPMC-15: PVA and HPMC-50: Eudragid RL-100, fast dissolving Nicorandil films were created. Solvent casting was used to effectively create the optimized rapid dissolving films, which included the drug and HPMC E15, Polyvinyl Alcohol, and a combination of HPMC-15:PVA and HPMC-50: Eudragid RL-50 in concentration ranges of 2%, 2.5%, 1:1.5%, and 2:0.5%w/v. Better films in terms of physicochemical parameters including tensile strength, percentage elongation, folding endurance, and flexibility were produced when PEG 400 was utilized as a plasticizer. When taken as a sweetener, aspartame effectively covers up the bitter taste of the medication nicorandil.

Reference

1. Grace R. Cosmeceuticals: Functional food for the skin. Nat Food Merchandiser. 2002;23:92-99.
2. Ray C, Trivedi P, Sharma V. Acne and its treatment lines. International Journal of Research in Pharmaceutical and Biosciences. 2013;3(1):1-16.
3. Thiboutot D. Regulation of human sebaceous glands. Journal of Investigative Dermatology. 2004;123(1):1-12. https://doi. org/10.1111/j.1523-1747.2004.t01-2-.x
4. Hassan KAM, Eltayb N. Eucalyptus oil as a treatment for acne. Pharmanest: International Journal of Advances in Pharmaceutical Sciences. 2013;4(4):557-566.
5. Amrita G, Greeshma N, Deepa M, Poornima E. A review on antiacne potential of medicinal plant extracts against Propionibacterium acnes. International Journal of Pharma Bioscience. 2012;3(3):987 997.
6. Mohan PK, Sreelakshmi G, Muraleedharan CV, Joseph R. Water soluble complexes of curcumin with cyclodextrins: Characterization by FT-Raman spectroscopy. Vibrational Spectroscopy. 2012;62:77 84. https://doi.org/10.1016/j.vibspec.2012.05.002
7. Meena M, Figueiredo NR, Trivedi K. Aloe vera–An update for Dentistry. Journal of dentofacial sciences. 2013;2(4):1-4.
8. Borate SR, Mundada AS. Simultaneous Estimation of Curcumin and Vitamin E in Bulk and Cosmeceutical Formulation by UV Spectrophotometry. International Journal of Pharmaceutical Quality Assurance. 2023;14(3):637-641. DOI: 10.25258/ijpqa.14.3.30
9. Surjushe A, Vasani R, Saple D. Aloe vera: a short review. Indian journal of dermatology. 2008;53(4):163-166.
10. Singh AR, Kalirajan K. Antimicrobial activity of turmeric natural dyeagainst different bacterial strains. Journal of Applied Pharmaceutical Science. 2012:210-212. https://dx.doi.org/10.7324/JAPS.2012.2624
11. Joshi GA, Kumar RA, Tupsakhare DI. Emulgel: As a novel drug delivery system using indomethacin. An International Journal of Advances in Pharmaceutical Sciences. 2014;5:2221-2228.
12. Madan J, Singh R. Formulation and Evaluation of Aloevera Topical Gels. International Journal of Pharmaceutical Sciences. 2010;2(2):551-555.
13. Ramachandra CT, Rao PS. Processing of Aloe vera leaf gel: a review. American Journal of Agricultural and Biological Sciences. 2008;3(2):502-510.
14. Mustafa AM. Facile Synthesis and Antioxidant Activity of Pyrimidine Derivatives via Thienyl Chalcones Under Phase Transfer Catalysis Method. International Journal of Drug Delivery Technology. 2022;12(2):558-563. DOI: 10.25258/ijddt.12.2.16
15. Gurjar NB, Barot BS, Shelat PK. Development and evaluation of cinnamon and aloe-vera containing herbal antiacne gel. International Journal of Pharmacy and Industrial Research. 2012;2(4):446-451.

16. Hassan F, Al-Saffar AZ, Al-Shanon AF. Antioxidant Enzymes Level Detection in Cisplatin Treated Iraqi Lung Cancer Patients and In-vitro Estimating the Cytotoxic and Reactive Oxygen Species Generation in A549 Cell Line. International Journal of Pharmaceutical Quality Assurance. 2020;11(1):32-37. DOI: 10.25258/ijpqa.11.1.5
17. A-Ani ZSM, Abdulmawjood SA, Al-Hussain AOA, Al-Bajari SA. Synthesis and Biological Activity of few Pyrimidines Derivatives against Hepatic Injury Stimulated by Carbon Tetrachloride in Male Rats. International Journal of Drug Delivery Technology. 2022;12(4):1496-1501. DOI: 10.25258/ijddt.12.4.02
18. Bhuiyan MA, Hoque MZ, Hossain SJ. Free radical scavenging activities of Zizyphus mauritiana. World journal of agricultural sciences. 2009;5(3):318-322.
19. Reller LB, Weinstein M, Jorgensen JH, Ferraro MJ. Antimicrobial susceptibility testing: a review of general principles and contemporary practices. Clinical infectious diseases. 2009;49(11):1749-1755. https:// doi.org/10.1086/647952
20. Sharma K, Agrawal SS, Gupta M. Development and Validation of UV spectrophotometric method for the estimation of curcumin in bulk drug and pharmaceutical dosage forms. International Journal of Drug Development & Research. 2012;4(2):375-380.
21. Bhramaramba R, Babu IS, Deepthi CD. Formulation and evaluation of herbal gel containing Terminalia chebula Retz., Leaves Extract. Scholars Academic of Journal Pharmacy. 2015;4(3):172-126.
22. Kurosaki, Y., Hisaichi, S., Hong, L., Nakayama, T., Kimura, T., 1989a. Enhanced permeability of keratinized oral-mucosa to salicylic acid with 1-dodecylacycloheptan-2-one (Azone). In vitro studies in hamster cheek pouch. International Journal of Pharmaceutics. 49(1), pp-47-55.
23. Mandel, I.D., and Wotman, S., 1976. The salivary secretions in health and disease, Oral Sci. Rev., 8, 25- 47.
24. Saini S, Nanda A, Monika Hooda M, ―Fast dissolving films (fdf) , innovative drug delivery system.‖ Pharm. onl., 2011, 2,919-928.
25. Mishra, R and Amin, A., 2009. Formulation development of taste masked rapidly dissolving films of cetrizine hydrochloride. Pharm Tech. 48-56.
26. Bansal S., Bansal M. and Garg G. (2011), formulation and evaluation of fast dissolving film of an antihypertensive drug. International Journal of Pharmaceutical, Chemical and Biological Sciences,3(4), 1097-1108.
27. Maheswari K. M., Devineni P. K., Deekonda S., Shaik S., Uppala N. P., and Nalluri B, N. (2014), Development and Evaluation of Mouth Dissolving Films of Amlodipine Besylate for Enhanced Therapeutic Efficacy, Journal of Pharmaceutics.
28. Habuchi Y, Nishimura M, Watanabe Y. 1987; Electrophysiologic effects of nicorandil, a new antianginal agent, on action potentials and membrane currents of rabbit atrioventricular node. Arch Pharmacol 335:567-574.

GCRG-PP000109

CERTIFICATEOF PARTICIPATION

THIS CERTIFICATE IS PRESENTED TO

SHIVANGNI RATHORE

From FACULTY OF PHARMACY, P.K. UNIVERSITY, SHIVPURI M.P.

For his/her active participation in **Online Mode** in the **International Conference** on **"Formulation and Evaluation of Herbal Anti-acne Creams" (ICDDS-2025)** organized by **GCRG COLLEGE OF PHARMACY, Lucknow (U.P.) India** on **Saturday, 22ND February 2025.**

PROF.(Dr.) DINESH CHANDRA
PRINCIPAL & CONVENOR
GCRG COLLEGE OF PHARMACY,
BKT LUCKNOW

PROF. A.N. SINGH
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16th March 2024

ICERIPLST/PH/2024/1395

Certificate of Appreciation

This is to certify that Dr/ Mr/ Ms

Shivangni Rathore

of **Faculty of Pharmacy,P.K. University Shivpuri M.P.**

has presented a poster / oral presentation on **Formulation and Evaluation of Herbal Anti-acne Gel.**

in the Conference organized by Career Point School of Pharmacy, CPU Kota, Rajasthan.

Prof (Dr) M. K. Gupta
Vice Chancellor (Off.)
Dean Pharmacy,
CPU, Kota

Mr. Kamal Arora
Registrar
CPU, Kota

Mr. Lav Sharma
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Ref. No. /Career/Herb/2023/92 Date: 23/06/2023

IDENTIFICATION CERTIFICATE

This is to certify that, I have identified the plant specimen given by candidate **Shivangni rathore** from faculty of Pharmacy, P. K. University (M.P)

Plants

1. Plant Name: *aloe barbandensis*
   Family: Liliaceae
2. Plant Name: *curcuma longa*
   Family: Zingiberanceae
3. Plant Name: *osmium senctum*
   Family: Libiatae
4. Plant Name: *aardikachta indica*
   Family: Maliaceae
5. Plant Name: *nyctathesarbor-tristis*
   Family: Oleaceae
6. Plant Name: *camellia sinensis*
   Family: theaceae

Herbarium number: is given by Department of Botany Career College, Bhopal.

Dr. Jaswinder Mehta

(Dept. of Botany)
Career College, Bhopal