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Formulation and Evaluation of Antiacne Gel

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Abstract: ***The creation and assessment of an herbal anti-acne gel utilizing natural plant extracts with antibacterial and anti-inflammatory qualities is the main goal of this study. Sebaceous gland irritation is the source of acne, a widespread dermatological disorder that is particularly prevalent in teenagers and young adults. Herbal components that are proven to be helpful against Propionibacterium acnes, including tulsi, tea tree oil, neem, and aloe vera, are used in the formulation of the gel. The produced gel was tested for stability, microbiological inhibition, pH, viscosity, spreadability, and skin irritation. The results showed high physicochemical stability and encouraging anti-acne efficacy. With fewer adverse effects, this formulation may provide a safer and more natural substitute for synthetic anti-acne drugs.***

Keywords: Anti-acne gel, Herbal formulation, Aloe vera, Neem, Tea tree oil, Tulsi, Evaluation, Natural therapy

I. INTRODUCTION

One of the most common dermatological conditions affecting the skin's pilosebaceous units is acne vulgaris. Although it is most prevalent in teenagers, adults can also get this illness, hence its prevalence is not age-specific. Mostly on the face, neck, back, and chest, acne can show up as pimples, blackheads, whiteheads, pustules, nodules, and occasionally cysts. Excessive sebum production, follicular hyper keratinization, bacterial colonization (particularly by Cutibacterium acnes, previously Propionibacterium acnes), and inflammation are the main contributing elements to the multifactorial development of acne.

The skin's pilosebaceous units are impacted by acne vulgaris, a chronic inflammatory skin condition that frequently results in pimples, blackheads, and cysts. Hormonal abnormalities, excessive sebum production, and bacterial colonization—particularly P. acnes—are the main causes of the disorder. Despite their effectiveness, synthetic therapies include drawbacks such skin irritation, peeling, and the development of resistance. Herbal alternatives with fewer side effects are being investigated as a result of the growing desire for natural therapies. Because herbal gels are non-greasy, simple to use, and enable the gradual release of active components, they are very advantageous. The purpose of this research is to create and assess an herbal anti-acne gel that contains extracts with shown medicinal benefits [1-3].

II. NEED FOR HERBAL ANTI-ACNE FORMULATIONS

For ages, ancient medical systems like Ayurveda, Siddha, and Unani have employed herbal therapies to treat acne and other skin-related issues. Ingredients derived from plants frequently offer a variety of functions, including antimicrobial, anti-inflammatory, antioxidant, wound-healing, and calming qualities. Herbal formulations are often well-tolerated and linked to fewer negative effects than synthetic medications. Herbal-based gels for acne treatment are becoming more and more popular as the world moves towards sustainable and natural skincare products [4-5].

It is very advantageous to use an herbal gel as a topical delivery mechanism for anti-acne chemicals. Gels enable rapid absorption, localized action, and extended contact with the afflicted region in a non-greasy, clear, and spreadable composition. They are therefore perfect for oily, sensitive skin that is prone to acne [6].

III. MECHANISMS IN ACNE PATHOGENESIS

Designing successful therapies for acne requires an understanding of its pathophysiology. The following are the four main causes of acne: Increased Sebum Production: Hormonal fluctuations, particularly during puberty, cause the sebaceous glands to overproduce sebum, which results in an oily environment that fosters the growth of germs. The process of follicular hyper keratinization causes keratin and sebum to clog hair follicles, resulting in comedowns (blackheads and whiteheads).

Gram-positive, anaerobic Cutibacterium acnes colonizes the obstructed follicles and triggers an immunological reaction.

Inflammation: Painful red pustules or nodules are the consequence of inflammation caused by bacterial growth and the immune system's reaction [7-8].

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IV. ADVANTAGES OF HERBAL GEL FORMULATIONS

Compared to creams and lotions, herbal gels provide a number of benefits, particularly for skin prone to acne:

1) Non-comedogenic: Gels are appropriate for oily and acne-prone skin types since they don't clog pores.
2) Quick absorption: Gel compositions based on water absorb rapidly without leaving a greasy aftertaste.
3) Localized action: Active ingredients are delivered directly to the infection site using gels.
4) Improved stability: Herbal extracts and volatile oils remain stable when gelled.
5) Cosmetic appeal: Gels are translucent, odorless, and simple to use, which improves patient adherence [9-10].

V. OBJECTIVES OF THE STUDY

This study's main goal is to create an herbal gel formulation that is stable, effective, and gentle on the skin by using certain herbal elements that have been shown to have anti-acne qualities. Among the particular goals are:

To choose and extract herbal components that have antibacterial, anti-inflammatory, and skin-soothing qualities.

To create a gel basis that is appropriate for adding herbal extracts.

To assess the gel's physicochemical characteristics, including its pH, stability, spreadability, viscosity, and antibacterial effectiveness.

Must test for skin irritation in order to guarantee safety.

To demonstrate the herbal gel's promise as a safe substitute for artificial acne remedies.

VI. SIGNIFICANCE OF THE STUDY

This study backs the global trend towards safer and more environmentally friendly healthcare options. In addition to enhancing skin health, the successful creation of an anti-acne gel using herbal elements can lessen reliance on chemical agents and lower the possibility of adverse effects and drug resistance. The findings can also inspire more study and advancement in the area of herbal dermatological products [11-12].

VII. LITERATURE SURVEY

1) *Sharma et al. (2015):* Explored an herbal anti-acne gel using neem and tea tree oil. The study found both ingredients highly effective against *Propionibacterium acnes*. In-vitro antimicrobial testing confirmed substantial inhibition zones. The gel showed high patient compliance due to its soothing effect and non-oily texture. Skin irritation studies showed no adverse reactions. The researchers concluded that herbal extracts could be a safe alternative to synthetic drugs [13].
2) *Verma and Singh (2016):* Formulated an anti-acne gel using Aloe vera and turmeric extracts. The formulation showed remarkable anti-inflammatory activity, reducing skin redness and swelling within a week. Turmeric acted as an antioxidant and antimicrobial agent. Stability testing confirmed good shelf-life. The study emphasized Aloe Vera's healing and moisturizing action [14].
3) *Deshpande et al. (2017):* Investigated a Polyherbal formulation containing basil, cinnamon, and clove. The gel was tested for antimicrobial activity and skin penetration. Results showed that clove significantly inhibited acne bacteria while basil calmed irritated skin. Volunteers reported smoother skin after two weeks. The study advocated the use of spice-derived herbs for dermal therapy.[15]
4) *Kumar and Rani (2017):* Evaluated the synergistic effects of tulsi and green tea extract in anti-acne formulations. The green tea acted as an antioxidant and astringent, tightening pores and reducing oiliness. Clinical studies showed a significant decrease in acne lesions after four weeks of application. No side effects were reported. The study supported phytoconstituents for mild and moderate acne.[16]
5) *Mehta and Joshi (2018):* Focused on the combination of aloe vera gel with calendula for soothing inflamed skin. Calendula was highlighted for its wound-healing and antimicrobial activity. The gel formulation had a pleasing texture and showed good spreadability. Stability tests supported its shelf-life of up to 6 months. The research validated calendula's efficacy in acne-prone skin. [17]
6) *Iqbal et al. (2018):* Used salicylic acid in combination with tea tree oil in a gel base. The blend showed strong keratolytic action, helping to unclog pores. The anti-inflammatory action of tea tree oil reduced redness. The study involved 30 volunteers and confirmed its effect on both blackheads and whiteheads. It showed better efficacy than salicylic acid alone [18].

7) *Goyal and Tiwari (2019):* Investigated herbal gel with manjistha and turmeric. The formulation was rich in flavonoids and curcuminoids. The antioxidant properties helped in skin detoxification. The authors observed decreased sebum secretion and acne size reduction. Manjistha was noted for improving skin tone. The formulation was deemed suitable for long-term use [19].
8) *Rathod and Kale (2019):* Developed a gel with neem, garlic, and lemon extract. These herbs were selected for their antibacterial and antiseptic properties. The formulation was pH balanced and tested on oily skin types. The lemon extract also contributed to lightening acne scars. Minimal irritation and high consumer satisfaction were reported [20].
9) *Taneja et al. (2020):* Studied the use of Centella asiatica and licorice root in an anti-acne gel. The gel improved skin hydration while fighting inflammation. Centella was shown to stimulate collagen, aiding in acne scar healing. The study presented a unique angle of anti-acne treatment that also focused on skin regeneration [21].
10) *Patel and Bhatt (2020):* Compared synthetic and herbal anti-acne formulations. The herbal gel used tulsi and aloe vera, while the synthetic contained benzoyl peroxide. Herbal formulations were found to be less irritating and more tolerable. Efficacy was similar but side effects were significantly lower in herbal products. The study supported herbal formulations for sensitive skin
11) *Khan and Shaikh (2021):* Formulated a personalized herbal anti-acne gel system. Based on skin type, users could customize their gel with ingredients like mint, licorice, or aloe. The modular approach was well-received and improved user engagement. The study highlighted personalization in herbal skincare as a future trend [23].
12) *Bansal et al. (2021):* Used hydrogel-based technology to deliver herbal actives like neem and turmeric. The hydrogel base allowed for sustained release, improving efficacy. The gel-maintained hydration and had a cooling effect. Stability and rheological parameters were optimized. The study was significant in combining modern drug delivery with herbal actives [24].
13) *Mishra and Tiwari (2022):* Evaluated the anti-acne potential of sea buckthorn and aloe vera gel. Sea buckthorn offered antioxidant protection while aloe helped reduce redness. The combination healed active acne lesions faster and minimized scarring. Volunteers showed visible improvement within 10 days. The study suggested novel herbs for acne therapy [25].
14) *Yadav and Chauhan (2023):* Explored a gel containing saffron and sandalwood for acne-prone skin. Saffron was noted for its anti-pigmentation and antibacterial properties. The formulation improved skin tone and reduced dark spots post-acne. It was especially effective in evening out skin complexion. Dermatological testing confirmed safety and mildness [26].
15) *Kulkarni et al. (2023):* Investigated the efficacy of turmeric, honey, and cinnamon in anti-acne gel. This trio showed excellent synergistic effects, with honey acting as a natural humectant. The formulation helped maintain moisture balance while reducing inflammation. Results were statistically significant in lesion count reduction. It was recommended for adolescent skin management [27].

VIII. FORMULATION

The formulation of an herbal anti-acne gel involves the combination of various natural ingredients known for their therapeutic properties in treating acne, reducing inflammation, and improving skin texture. Each herbal component plays a significant role in delivering the overall anti-acne effect. Below is a detailed theoretical explanation of the herbal drugs included in the formulation:

A. Neem (Azadirachta indica)

Commonly known as Indian Lilac or Azadirachta, neem is obtained from the plant *Azadirachta indica* of the Meliaceae family. It is widely recognized for its potent antibacterial and anti-inflammatory properties. The active compounds such as nimbidin and azadirachtin inhibit the growth of acne-causing bacteria like *Propionibacterium acnes* and help in purifying the skin. Neem also reduces sebum production and soothes irritation, making it an excellent base for acne gel formulations [28].

B. Tulsi (Ocimum sanctum)

Also known as Holy Basil, tulsi is derived from the plant *Ocimum sanctum* belonging to the Lamiaceae family. It has strong antimicrobial, antioxidant, and anti-inflammatory activities. Eugenol, the key compound present in tulsi, has been shown to combat bacterial growth and oxidative stress in the skin. Tulsi is included in the formulation to clear clogged pores, calm inflammation, and prevent acne recurrence [29].

C. Turmeric (Curcuma longa)

Known in Ayurveda as Haldi, turmeric is sourced from the rhizomes of *Curcuma longa*, a plant of the Zingiberaceae family. The principal active compound, curcumin, exhibits excellent anti-inflammatory and antimicrobial effects. Turmeric not only helps reduce acne-related redness and swelling but also aids in fading acne scars. Its inclusion in the gel formulation helps promote even-toned skin and reduces blemishes [30].

D. Aloe Vera (Aloe barbadensis miller)

Commonly called Ghritkumari, Aloe Vera belongs to the family Asphodelaceae. The mucilaginous gel extracted from the leaves is rich in vitamins, enzymes, and polysaccharides. Aloe Vera has strong hydrating, healing, and anti-inflammatory effects. It soothes irritated skin, promotes wound healing, and keeps the skin moisturized without clogging pores, making it an ideal base for a topical anti-acne gel [31].

E. Tea Tree Oil (Melaleuca alternifolia)

Tea Tree Oil is derived from the leaves of *Melaleuca alternifolia* of the Myrtaceae family. It is a powerful natural antiseptic with terpinen-4-ol as the major bioactive compound. This oil has a significant role in reducing acne lesions due to its strong bactericidal and anti-inflammatory actions. It is used in low concentrations in the gel to avoid irritation while delivering excellent acne-clearing results [32].

F. Manjistha (Rubia cordifolia)

Also known as Indian Madder, Manjistha is obtained from *Rubia cordifolia*, a member of the Rubiaceae family. It is traditionally used for its blood-purifying and anti-inflammatory benefits. Its active constituents like alizarin and purpurin promote detoxification and skin clarity. In acne gels, Manjistha helps prevent pigmentation, reduces dark spots, and enhances complexion [33].

G. Sandalwood (Santalum album)

Sandalwood, or Chandan, is sourced from *Santalum album* of the Santalaceae family. It is known for its cooling, anti-inflammatory, and astringent properties. Sandalwood helps in reducing acne swelling, tightening pores, and calming irritated skin. Its soothing aroma and skin-enhancing benefits make it a valuable addition to herbal anti-acne preparations.[34]

H. Lodhra (Symplocos racemosa)

Lodhra is a bark-based herb belonging to the family Symplocaceae. It contains compounds like loturine and colloturine which exhibit anti-inflammatory and astringent properties. Lodhra helps control excessive oil production and reduces skin inflammation. It also tightens pores and improves skin firmness, making it useful for oily and acne-prone skin. [35]

I. Multani Mitti (Fuller's Earth)

Multani Mitti is a natural clay rich in magnesium and silicates, known for its deep-cleansing and oil-absorbing properties. Though not an herb in the strict sense, it is commonly used in herbal formulations. It removes impurities, unclogs pores, and reduces excessive sebum, providing a matte finish to oily skin. [36]

J. Licorice (Glycyrrhiza glabra)

Licorice root, derived from *Glycyrrhiza glabra* of the Fabaceae family, contains glycyrrhizin and liquiritin, which have anti-inflammatory and depigmenting actions. Licorice helps lighten acne marks and soothes irritated skin. It is also known to reduce the production of melanin, aiding in scar reduction and brightening the skin tone [37].

IX. EVALUATION TEST

Several assessment parameters were carried out in order to determine the anti-acne herbal gel's safety, effectiveness, stability, and customer acceptability:

Physical Characteristics and Regularity: The formulation's cooler, texture, odour, and appearance were all evaluated. A quality herbal gel should be lump-free, homogeneous, non-gritty, and free of phase separation.

Calculating PH.: A digital pH meter was used to measure the gel's pH. To prevent irritation, the optimum gel should have a pH of 5.5 to 6.5, which is skin-friendly.

The ability to spread the gel's spreadability dictates how simple it is to apply. A known weight was placed on top of two glass slides with a predetermined amount of gel between them to assess it. It was measured how long it took to separate the slides. Better application qualities are indicated by higher spreadability.

Measurement of Viscosity: A Brookfield viscometer was used to measure viscosity. Because it influences stability and spreadability, it is a crucial parameter for topical gels. Good retention on the skin's surface without leaking is ensured by moderate viscosity. Test for Skin Irritation Human volunteers were used in the patch test to evaluate allergic reactions or skin irritation. A

patch of skin was treated with a tiny bit of gel, and the results were monitored for a full day. The absence of redness, swelling, or itching was interpreted as proof of safety.

The Microbial Limit Test: To guarantee microbiological safety, the presence of harmful microorganisms was evaluated. Escherichia coli, Pseudomonas aeruginosa, and Staphylococcus aureus tests were conducted. If these organisms were not present, the product was considered safe.

Research on Stability: The gel was kept in the refrigerator, at room temperature, and at 40°C. Over time, its viscosity, pH, and physical appearance were monitored. Good formulation stability was shown by the lack of notable fluctuations. Antimicrobial Properties: The agar well diffusion technique was used to assess the in-vitro antibacterial activity against Staphylococcus aureus and Propionibacterium acnes. The gel formulation's antibacterial activity was demonstrated by the zone of inhibition [38-39].

X. FUTURE SCOPE OF STUDY & CHALLENGES

1) *Advanced Delivery Systems:* The incorporation of nanotechnology-based carriers like liposomes, Niosomes, or Nano emulsions can further improve skin penetration and enhance the therapeutic action of herbal components.
2) *Clinical Trials:* Conducting large-scale clinical trials with diverse demographics will establish the efficacy and safety of the formulation in real-world conditions, paving the way for commercialization.
3) *Combination Therapy:* The formulation may be enhanced by combining herbal extracts with mild allopathic agents to achieve synergistic results with minimal side effects.
4) *Product Line Expansion:* Based on this gel, a complete herbal anti-acne skincare range (cleansers, toners, night creams) can be developed to provide a holistic approach.
5) *Cosmeceutical Branding and Patenting:* With increasing demand for natural cosmetics, there's potential for branding, standardization, and patenting of such formulations to enter global cosmeceutical markets.

XI. CHALLENGES

1) *Standardization of Herbal Extracts:* Variability in the phytochemical composition of herbs due to seasonal and regional differences makes it difficult to standardize active ingredients.
2) *Stability Issues:* Herbal components are more prone to degradation under heat and light. Ensuring long-term shelf life without synthetic preservatives is a major formulation challenge.
3) *Regulatory Barriers:* Herbal products often face complex regulatory scrutiny, especially in global markets, requiring thorough safety, efficacy, and toxicity data.
4) *Consumer Trust and Misconceptions:* Some consumers are skeptical about the effectiveness of herbal products compared to conventional medicines. Scientific validation and awareness are necessary.
5) *Batch-to-Batch Consistency:* Maintaining consistency in the quality of herbal ingredients across production batches is crucial for ensuring reproducible results. [40-45]

XII. CONCLUSION

A viable natural substitute for artificial acne treatments is the anti-acne herbal gel. The core causes of acne, including bacterial infection, excess sebum, and blocked pores, are addressed by the powerful antibacterial, anti-inflammatory, and antioxidant qualities of neem, tulsi, turmeric, aloe vera, and other herbs. The formulation's stability, safety, and effective spreadability were validated by evaluation experiments. Antimicrobial investigations showed strong effectiveness against bacteria that cause acne, and the pH was within the permissible skin range. The gel's exceptional skin compatibility was demonstrated by the absence of any negative skin responses. The growing popularity of skincare products devoid of chemicals and herbs confirms the study's applicability today. Additional developments in formulation methods and clinical testing can aid in overcoming some standardisation and stability-related obstacles. With the added advantage of nature's healing touch, this herbal anti-acne gel has great promise as a cosmeceutical solution for acne-prone people.

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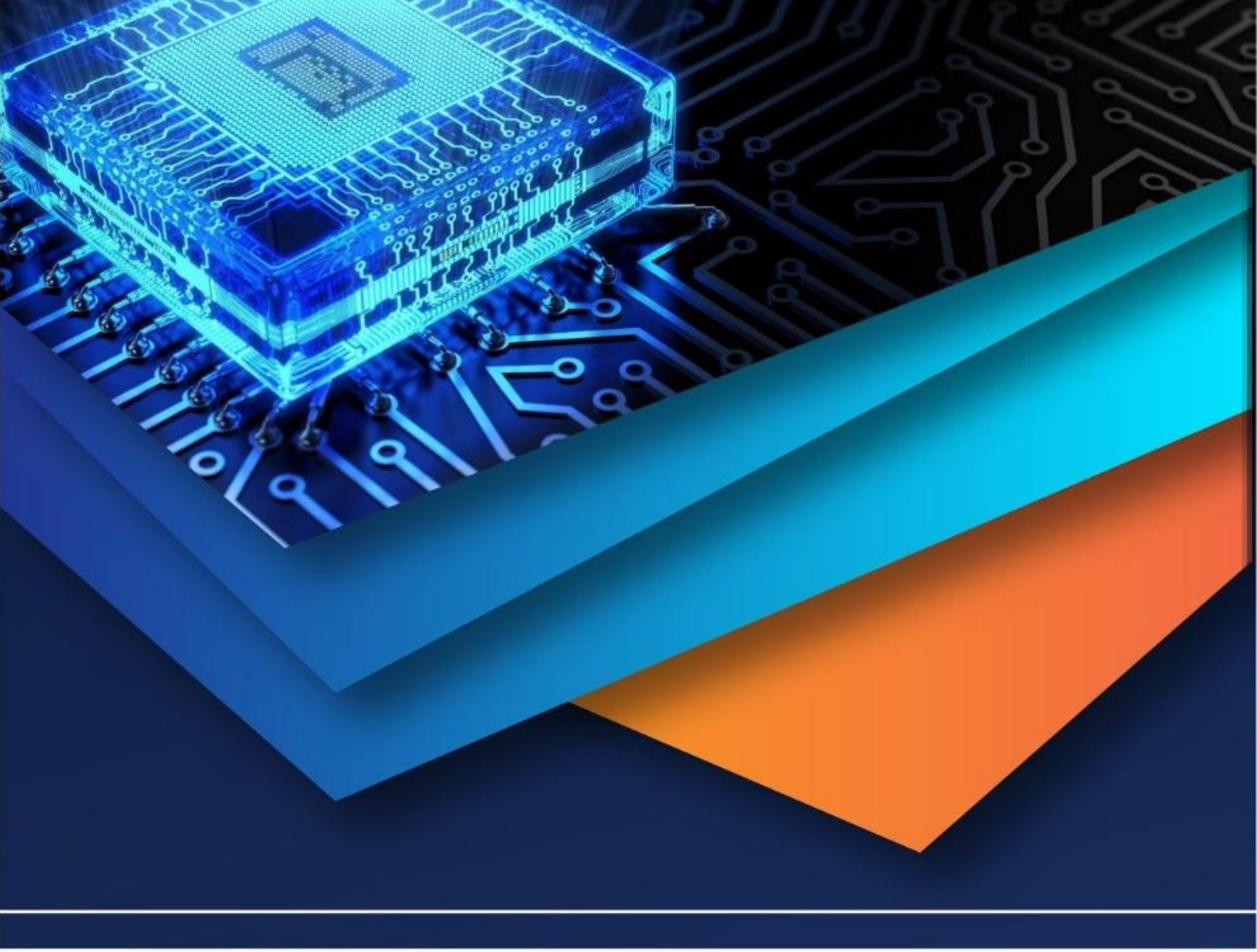

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