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Tamarind Seed Gum-Based Herbal Antimicrobial Face Mask Incorporated with Charcoal and Aloe Vera

Fida Sherin P[1], Dr. Nisy S[2], Jomol F[2] , Fathima Nidha M[4], Nusna T N[5], Keerthana P[6]
[1, 3, 4, 5, 6]*Post Graduate Students, Department of Microbiology, Sree Narayana Guru College, Coimbatore, Tamil Nadu*
[2]*Professor Department of Microbiology, Sree Narayana Guru College, Coimbatore, Tamil Nadu*

Abstract: ***Face masks have gained immense popularity due to their purported benefits in skincare and hygiene. This study aimed to prepare face masks using a combination of tamarind seed gum, charcoal, and Aloe Vera and evaluate their antimicrobial activity against facial microflora. The preparation involved the extraction of tamarind seed gum and its incorporation with charcoal and Aloe Vera gel to form a cohesive mask. Chemical characterization of Tamarind seed gum revealed the presence of fourteen components by GC-MS. Predominant microorganisms isolated from face were identified as Staphylococcus sp, Micrococcus sp. The antimicrobial study revealed the excellent antimicrobial potential of all the components of face mask. The finding suggests the potential of these natural ingredients in formulating effective and safe face masks for skincare applications. Our study contributes to the development of natural and effective skincare product by harnessing the antimicrobial potential of tamarind seed gum, Aloe Vera and charcoal extracts.***

Keywords: Tamarind seed gum, Face mask, Antibacterial

I. INTRODUCTION

Natural gums are polysaccharides produced by plants, bacteria, or algae. They are extracted from plant exudates or seed coatings. Gums like guar gums, xanthan gums, tamarind seed gum, and locust bean gum serve as thickeners and stabilizers in food, pharmaceuticals, and cosmetics. Tamarind seed gum, derived from the endoplasm of tamarind seeds, is a natural polysaccharide with versatile applications in various industries. It extracted from the endosperm of tamarind seed after processes like dehusking, grinding, and purification. The gum contains mostly galactoxyloglucan polysaccharides, with galactose, xylose and glucose and small amount of protein, lipids and minerals. It appears white to pale yellow, odourless, and tasteless. The gum dissolves in cold water to form viscous solutions and gels when heated tamarind seed gum serves as a thickener, stabilizer, emulsifier (Kumar.V.*et.,al* 2013). Tamarind seeds, derived from the fruit of the tamarind tree (*Tamarindus Indica*) are valued for industrial, medicinal, and agricultural uses. The seeds are enclosed in sticky brown pulp. (Gopi.k *et., aI* 2015). They contain polyphenols, flavonoids, tannins, and polysaccharides. Tamarind seed polysaccharide (TSP) is used in pharmaceuticals, textiles, and food industries due to its gelling, thickening, emulsifying, and stabilizing properties. Research shows tamarind seed extracts have antimicrobial, anti-inflammatory, and wound healing effects. They are also promising as biopesticides and plant growth promoters in agriculture (Vanka, K. *et al.,al* 2012) Aleo vera is perennial succulent from the Asphodelaceae family, widely grown in warm climates and known for its thick, gel-filled leaves. Traditionally aloe vera is used for wound healing, anti-inflammatory, antimicrobial, and analgesic effects. It is often found in skin care products for its soothing and moisturizing benefits, and its juice is consumed for digestive health (Eshun K.*et al*.,2004) . Charcoal, a black residue from pyrolyzed organic materials, is widely used for toxin absorption in medicine and in cosmetics for cleansing and anti-aging (Bhattacharya T.K.*et al* 2021; Suresh kumar P. *et al* 2018)

Microorganisms from the face are isolated by collecting samples using saline-moistened swabs, skin scrapings, or adhesive tape. The samples are streaked on selective media like blood agar, MacConkey agar, and sabouraud agar, then incubated to allow microbial growth .Pure colonies are obtained by subculturing and identified through colony appearance and biochemical tests. This process helps understand the facial microbiome and its role skin health.(Grice E.A *et.,al* 2011).Tamarind seed gum, charcoal, and aloe vera show antimicrobial activity against facial microorganism. Tamarind seed gum can inhibit bacteria like *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa,* and fungi such as *Candida albicans* . Its antimicrobial action may work by damaging cell membranes, blocking enzymes, and preventing microbial adhesion and biofilm formation (Thakur.R *et.,al* 2019).

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Activated charcoal and aloe vera has strong antimicrobial, anti inflammatory activity and healing effects against bacteria such as *Staphylococcus aureus, E.coli* and fungi like *Candida albicans*. A face mask made from tamarind seed gum (TSG), charcoal and aloe vera provide multiple skin benefits. (Gopi.k *et.,al* 2015). Creating face mask using this herbal products provides a natural and effective way to cleanse, purify, and nourish the skin, leaving it looking and feeling refreshed

II. MATERIALS AND METHODS

A. Isolation of predominant bacteria from face.

The sterile swabs were gently pressed against the selected area of face: forehead, cheek, chin to collect bacteria . Swabs were transferred into nutrient agar plates and incubated at 37°C for 24 hours.(Ogai, K., *et al.,*. 2018).

B. Identification of bacteria.

The predominant bacteria isolated from the face were identified based on colony morphology, staining, motility, and biochemical tests(Cappuccino, J. G., & Sherman, N.*et al*., 2014).

C. Collection and processing of Tamarind seed

Tamarind seeds used in our study was obtained from Menonpara, Palakkad Kerala. Seeds were dried at 150^0 temperature and seed coat was separated and powdered. The prepared tamarind seed powder was stored at low temperature till use. (Singh, V., & Nath, A.*et al*., 2012).

D. Tamarind Seed Gum Extraction

20 gram Tamarind seed powder was soaked in 200ml distilled water for 24 hours to release mucilage. The mixture is heated at 80°C for 30 minutes at water bath, then centrifuged at 5500 rpm for 8 minutes . The supernatant was discarded and ethyl alcohol was added to separate the gum, which was collected and stored at room temperature in air tight container.(Rishabha Malviya *et al*., 2021)

E. Chemical Characterisation of Tamarind Seed Gum Extract

a) *GCMS Analysis*

Extracted tamarind seed gum was characterised by GC-MS (Gas Chromatography Mass Spectrometry) at Microtech lab and Research, Coimbatore.

b)*Test for Carbohydrate*

To 5 ml of Tamarind seed gum 2 drops of alpha naphthol and 1drop of concentrated H_2SO_4 were added. Formation of violet colour at the junction of the two liquids indicates the presence of carbohydrates in tamarind seed gum .(Rishabha Malviya, Sonali sundram, Shivkanya fuloria *et al.,* 2021)

c)*Test for tannins*

To 5 ml Tamarind seed gum in a test tube . 1ml of five percentage Ferric chloride was added and boiled for 5 minutes. Absence of greenish precipitate indicates no tannins are present in tamarind seed gum.(Khin Htay Win *et al*.,2019)

F. Preparation of extract

a) *Ethanolic Extract of Tamarind Seed Gum*

The tamarind seed gum was air dried and powdered .10gm of tamarind seed gum were mixed with 1000 ml of ethanol and kept two days in room temperature . The mixture was filtered , and the filtrate was evaporated at 60°C . The dried extract was dissolved in DMSO before performing antimicrobial test. (Omji Porwal,Adbul kalam azad *et al*., 2021)

b) *Ethanolic Extract of Charcoal*

Charcoal was powdered and mixed with 100ml of 70%of ethanol, kept for two days at room temperature . The mixture was filtered, and extract was dried at 50°C .After evaporation, the dried extract was dissolved in DMSO before antimicrobial test. (Bansal, R. C., & Goyal, M.*et al*., 2005).

c) *Extraction of Aloe Vera using ethanol*

Fresh Aloe vera leaves were rinsed, sliced into small segments and shade dried for 5-7 days .The dried leaves were powdered , and ten gram was mixed with 100 ml of 70% ethanol and kept at room temperature for four days .The mixture is filtered and the filtrate evaporated at 40°C. The dried extract dissolved in DMSO before antimicrobial test.(Rubina Lawrence,Priyanka Tripathi *et al*.,2009)

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G. Determination of Antimicrobial Activity of Tamarind seed gum, Aloe vera and charcoal.

The antimicrobial activity of Tamarind seed gum, Aloe vera and charcoal was studied against bacteria isolated from face by well diffusion method. The inoculum standardized to 0.5 McFarland standard and swabbed on to sterile Mueller-Hinton agar plates. After drying for ten minutes, wells were cut and 10 µl extracts of tamarind seed gum, aloe vera and charcoal were added to wells. Plates were incubated at 37°C for 24 hours, and zone of inhibition were noted for antimicrobial effectiveness. (Doughari, J. H. *et al*.,2006).

H. Preparation of antimicrobial face mask

Extracted tamarind seed gum was mixed with powdered Aloe vera and Charcoal to 1:1:1 proportion. Applied on face and kept for 10 minutes then wash out.

III. RESULT

1) *Isolation of predominant bacteria form face*: Bacteria from face were isolated by using sterile swab technique. Number of isolated bacterial colonies were observed and counted on each plate. (Fig. 1) Bacterial colonies with distinct morphologies were selected for identification

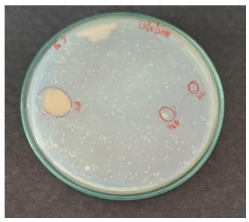

Fig 1: Total heterotrophic bacterial count

2) *Identification of bacteria*: Identification of bacteria is done by performing various tests including Colony morphology analysis, staining techniques, motility test, biochemical tests. The predominant bacteria Identified as *Staphylococcus sp* and *Micrococcus sp* (Fig.2 – Fig.3)

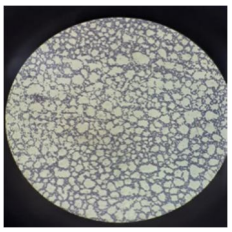

Fig2:Gram positive cocci

Fig 3: Biochemical test-Oxidase test, Methyl red test, Citrate test, Voge's proskauer test, TSI test, Nitratre test, Urease test ,Catalase test

3) *Collection and processing of Tamarind seed*: Tamarind seed powder was obtained after crushing the seed. The obtained seed powder has fine powdery texture and colour ranges from light beige to pale yellow. It has a mild, neutral odor. Making it slightly acidic to neutral. It is insoluble in cold water but can swell and form a gel when mixed with hot water.(Fig.4)

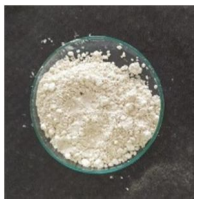

Fig 4: Tamarind seed powder.

4) *Tamarind Seed Gum Extraction*: The extracted tamarind seed gum colour ranges from off-white to light yellow or beige. It has a neutral odor, though it may carry a slight earthy or plant-like scent.(Fig.5)

Fig 5: Tamarind seed gum.

5) *Chemical Characterisation of Tamarind Seed Gum Extract* - Carbohydrates and tannins: Tamarind seed gum found to Pposess carbohydrates and tannin. (Fig:6)

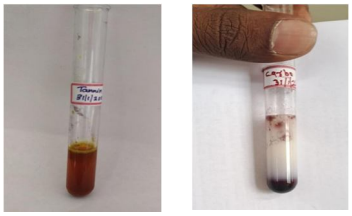

Fig 6: Positive result for tannin and carbohydrate

6) *Chemical Characterisation of Tamarind Seed Gum Extract* -GC-MS: analysis of Tamarind seed gum found to contain 13 major chemical constituents (Table 1) which include 2 4-Di-tert-butylphenol, Tetracosane, Squalene,_Neophytadiene, Heneicosane, Nanaocosane, 13-Docosenamide, Hexadecanoic acid, methyl ester, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol , Ethyl oleate, 1-Hexacosanol, Decanoic acid, 1 n-Nonadecanol-1.(Fig: 7)

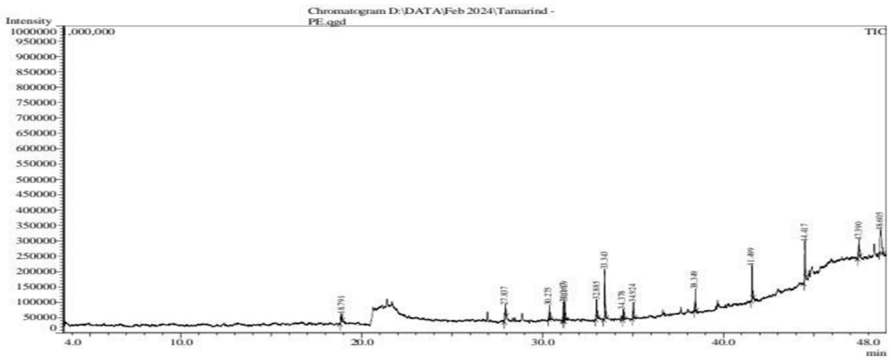

Fig 7:GC-MS: a chemical characterisation of tamarind seed gum extract by GC-MS analysis

SI No	Area % IN PEAK	COMPONENTS	PROPERTIES
1	2	2 4-Di-tert-butylphenol	Broad-spectrum antimicrobial, antioxidant, anti-inflammatory, and cytotoxic properties
2	4.47	Tetracosane	Antioxidant, anti-inflammatory, and cytotoxic properties
3	4.80	Squalene	Antioxidant, anti-inflammatory, and antitumor properties.
4	4.87	Neophytadiene	Anti-inflammatory, antioxidant, antimicrobial and anticancer properties
5	2.98	Heneicosane	Antimicrobial, anti-inflammatory, and antipyretic properties.
6	3.79	Nanaocosane	Microbicidal and anti-inflammatory properties
7	4.75	13-Docosenamide	antibacterial, anticancer, antioxidant and anti-inflammatory properties.
8	3.25	Hexadecanoic acid	Strong anti-inflammatory agent, antioxidant, antibacterial, antifungal, and anticancer properties.
9.	15.47	3,7,11,15-Tetramethyl-2hexadecen-1-ol	Antimicrobial, anti-inflammatory, and antioxidant properties.
10	3.42	Ethyl oleate	Antimicrobial, antioxidant, and anticancer properties.
11	6.08	1-Hexacosanol	Antimicrobial, antioxidant, larvicidal and repellent properties
12	5.49	Decanoic acid	Anti-inflammatory , anti-tumor, and antimicrobial properties
13	5.51	1 n-Nonadecanol-1	Antibacterial, antifungal, anti-inflammatory properties

Table 1: Components and properties of tamarind seed gum by GC-MS analysis

7) *Preparation of extract*: Ethanoic extract of tamarind seed was found to be a brownish colour and is naturally viscous due to its polysaccharide content, aloe Vera was found to be yellowish brown colour and have gel consistency nature, charcoal was found to black in colour due to the presence of carbon compound. (Fig:8 – Fig:10)

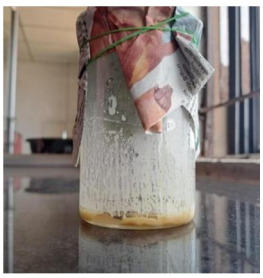

Fig 8: Tamarind seed gum extract.

Fig 9: Aloe Vera extract

Fig10: Charcoal extract

H. *Determination of Antimicrobial Activity*: Antimicrobial activity of tamarind seed gum, Charcoal, Aloe vera was conducted against the isolated bacteria *Staphylococcus* sp and *Micrococcus* sp. All the three samples were found to possess antibacterial activity with a maximum zone size of 25 mm against Tamarind seed gum extract.(Fig:11- Fig: 12), (Table 2).

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Fig11: Antimicrobial activity against *Micrococcus sp*

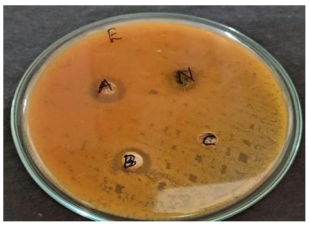

Fig12: Antimicrobial activity against *Staphylococcus sp*

Extract	Zone of inhibition	
	Staphylococcus	*Micrococcus*
Tamarind seed gum extract	25 mm	15 mm
Aloe Vera extract	20 mm	13 mm
Charcoal extract	10 mm	12 mm

Table 2: Antimicrobial analysis of face mask components

8) Preparation of antimicrobial face mask: Natural Antimicrobial face mask composed of tamarind seed gum, aloe vera and charcoal was prepared (Fig: 13) and applied as face mask. The prepared natural face mask found to possess soothing, and hydrating skin and thus promote healthy skin.

Fig 13: Face mask prepared using tamarind seed gum, aloe Vera, Charcoal.

IV. DISCUSSION

Tamarind Seed Gum derived from tamarind seed endosperm contains polysaccharides (xyloglucans of glucose & xylose). (Bhawana Sharma, Shiv Charan Sharma and Afroz Alam *et al*., 2021). It has high viscosity and is used as a thickener, stabilizer, and emulsifier. Also shows adhesive properties useful in food, textile, cosmetic, and pharmaceutical industries (Rhishabha Maviya *et al*., 2021). Aloe Vera gel is Provides hydration and soothing effect on skin. Has anti-inflammatory, antibacterial, and antifungal properties. Reduces acne, irritation, and promotes wound healing by increasing collagen production. Also gives a cooling effect (Radha M H *et al*., 2015). Activated Charcoal was Possesses high adsorption capacity due to its porous structure. Helps remove impurities, toxins, and excess oil. Provides deep cleansing, unclogs pores, and prevents acne. Facial Microorganisms Include bacteria like *Staphylococcus sp*. And *Micrococcus sp.,* forming part of the skin microbiome and maintaining skin balance. Antimicrobial Activity is tested using the well diffusion method. Zone of inhibition confirmed effectiveness against microorganisms (Ching Y.C *et al*., 2017)The latest work of Vineet joshi and Ravi ranjana indicate the result that the herbal face mask is a promising alternative to chemical-based skincare products, offering natural therapeutic benefits along with consumer safety and acceptability. This formulation holds potential for large-scale production and commercialization. (Vineet joshi Ravi ranjana et al., 2025)

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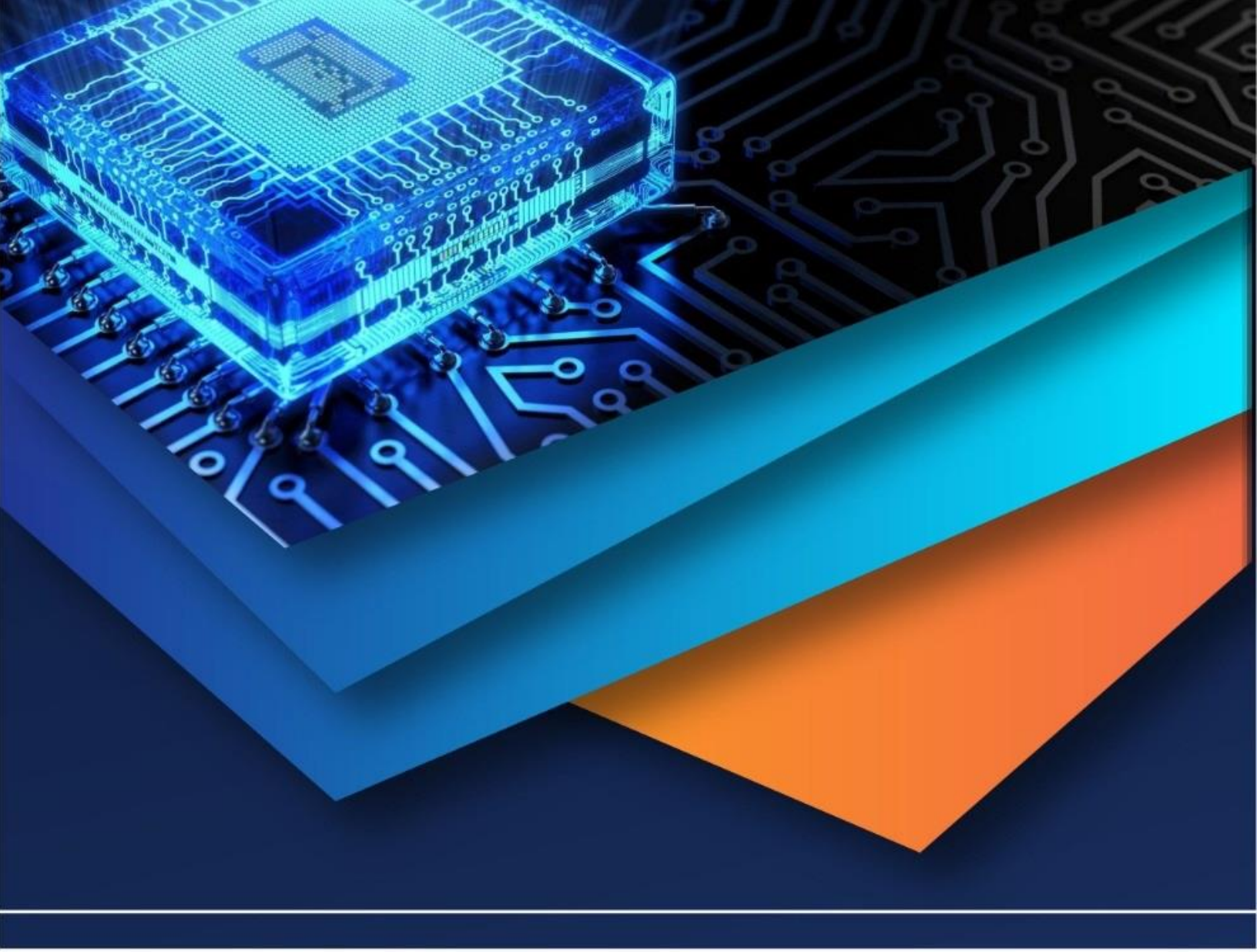

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