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Development of Flattened Rice Crispy Wafers

Lilesh H.Pustode[1], Prashant S. Watkar[2], Apeksha A. Mutthawar[3], Sakshi S.Bodhe[4], Pranjali D. Wasnik[5]
[1, 2]*Assistant professor,* [3, 4, 5]*Research Scholar, Department of Food Technology, BIT, Ballarpur, 442701*

Abstract: ***Flattened rice crispy wafer, derived from immature sticky rice, is characterized by its high nutritional value and bioactive compounds. Given its health benefits, this rice variant has been employed as a functional ingredient in various food products. The present study aimed to investigate the properties of sticky rice flour with varying substitutions of flattened rice flour, ranging from 0% to 100%, in the formulation of Daifuku. The flattened rice flour exhibited a green-yellow hue and demonstrated a notably low amylose content of 3.34%. The starch granules of this flour revealed the presence of pigments associated with phenolic compounds and/or chlorophyll. In terms of pasting properties, the peak viscosity, trough viscosity, and breakdown of flattened rice flour were all lower compared to those of sticky rice flour. FTIR spectral analysis indicated that the flattened rice flour predominantly consisted of sticky rice polysaccharide structures. Notably, Daifuku prepared with 75% flattened rice flour received the highest sensory scores across all evaluation criteria, particularly in overall acceptance and texture. Furthermore, nutritional analysis revealed that Daifuku containing flattened rice flour had elevated levels of calcium, iron, and vitamin B1 compared to the control Daifuku. Therefore, the advantageous properties of flattened rice flour suggest its potential for further development in the creation of nutritional food products.***
Keywords: Flattened Rice, Crispy Wafers, Air fryer, Muffle furnace, Chili powder, Chilli flakes, Salt, Roasted dalia,

I. INTRODUCTION

The Technology of Wafers and Waffles: Operational Aspects is the definitive reference book on wafer and waffle technology and manufacture. It covers specific ingredient technology (including water quality, rice flour, flattened rice, cumin, sesame seed, turmeric, salt, fried gram) and delves extensively into the manufacturing elements and technological themes in wafer manufacturing, including no/low sugar wafers, hygroscopic wafers, filling, and enrobing. The book explains, in detail, operating procedures such as mixing, baking, filling, cooling, cutting, and packaging for every type of wafer: flat and shaped. It serves as a complete reference book on wafer and waffle technology and manufacturing, being the first of its kind. It addresses specific ingredient technology, including water quality and rice flour, and covers manufacturing and quality assurance processes.

The text provides an insightful look into the scientific aspects of wafer and waffle baking, catering to both artisans and professionals engaged in bakery product manufacturing. Its main goal was to conduct instrumental tests to distinguish between various quality levels of crispy wafer products and to examine connections between instrumental measurements and sensory attributes. A series of tests, including a cutting test with recorded sound emissions and a thorough sensory analysis, were performed using nine different wafer brands that represented a range of qualities.Moreover, it describes Flattened Rice Crispy Wafers as a delightful and crunchy snack created from flattened rice, also known as "poha" in India. This ingredient is often roasted or fried to achieve a light and airy texture that is ideal for wafer-making. The wafers frequently receive added flavorings, such as salt or spices, catering to a variety of palates. Due to the easy digestibility and adaptability of flattened rice, it serves as an excellent base for crafting these light, satisfying wafers. Their combination of crunchiness and subtle flavor makes them a favored choice for snacking, often enjoyed alongside tea or coffee. Flattened Rice Crispy Wafers are sometimes designed in various shapes and sizes, reflecting traditional crispy snacks while showcasing the distinct qualities of flattened rice.

A. Health Benefits of Flattened Rice (Poha)

1) Facilitates Easy Digestion: Poha, made from flattened rice, is renowned for its high fiber content, significantly aiding the digestive process. This fiber acts as a gentle facilitator for smooth digestion, helping to prevent common issues such as bloating, gas, and indigestion. Its light texture and easy digestibility make poha an ideal breakfast choice, enabling a comfortable and energizing start to the day without overwhelming the digestive system.

2) Rich Source of Nutrient-Dense Carbohydrates: The carbohydrates found in poha are not just any carbs; they are complex, nutrient-rich carbohydrates that provide a steady and sustained release of energy throughout the day. This slow-release property prevents spikes in blood sugar levels, making poha an excellent fuel source for both the body and mind, allowing for improved focus and stamina without the risk of unhealthy fat accumulation.

3) Supports Blood Sugar Management: One of the significant advantages of poha is its ability to help regulate blood sugar levels. The soluble fiber within poha slows down the absorption of sugars into the bloodstream, providing a stabilizing effect on blood sugar, which is especially beneficial for individuals managing diabetes. This characteristic not only aids those with diabetes but also supports overall metabolic health by preventing sudden energy crashes.
4) Iron-Rich Nutritional Profile: Another critical benefit of poha is its substantial iron content, which is vital for the production of hemoglobin in red blood cells. This makes poha a valuable dietary addition for individuals at risk of iron deficiency or anemia. Pregnant and breastfeeding women, in particular, can significantly benefit from incorporating poha into their meals to help meet their increased iron requirements for optimal health during pregnancy and lactation.
5) Naturally Gluten-Free: For those who are gluten-sensitive or have celiac disease, poha presents a wonderful culinary option as it is naturally free from gluten. This allows individuals to enjoy a delightful and nutritious meal without the worry of adverse reactions associated with gluten consumption. Poha can be creatively combined with various herbs, vegetables, and spices, making it a versatile dish that caters to different palates.
6) Low-Calorie Yet Satisfying: Poha stands out as a low-calorie food choice, making it particularly appealing for those who are conscious of their weight management efforts. Despite its low-calorie content, poha provides a sense of fullness, allowing individuals to enjoy a hearty meal without contributing significantly to their overall caloric intake. This characteristic makes it an excellent option for a guilt-free breakfast or snack.
7) Therapeutic Probiotic Properties: The traditional preparation of poha often involves a fermentation process, which is beneficial in cultivating a rich array of probiotics. These probiotics contribute to a healthy gut microbiome, enhancing digestion and promoting better gastrointestinal health. A balanced gut flora can result in improved nutrient absorption and a strengthened immune system, underlining poha's role in overall wellness. Poha is not just a delicious and versatile ingredient; it also offers a plethora of health benefits that make it an excellent choice for a varied and nutritious diet. Whether enjoyed as a breakfast staple or a light meal, its rich nutritional profile can significantly enhance one's overall health.

II. MATERIAL AND METHODOLOGY

A. *Material Used*

Table 1. Material Used for the preparation of Flattened rice crispy wafers

Material	Weight
Flattened rice	100g
Roasted dalia	50g
Cumin	1g
Turmeric	2g
Chilli flakes	2g
chilli powder	2g
Salt	1g

1) Flattened Rice: Also called poha, these are dehusked rice grains that are flattened into thin, light flakes; quick to cook and commonly used in Indian snacks and breakfasts.
2) Roasted Dalia: Roasted, coarsely ground wheat (broken wheat or fada), or sometimes roasted split chickpeas (chana dal); used in healthy dishes and snacks for its nutty flavor.
3) Cumin: An aromatic spice made from dried seeds of the Cuminum cyminum plant; known for its earthy, warm flavor and digestive properties.
4) Turmeric: A bright yellow spice from the root of the Curcuma longa plant; it has a warm, bitter taste and is prized for its color, flavor, and medicinal benefits. Chilli Flakes and Chilli Powder: Chilli flakes are crushed dried chilies offering a medium-hot, smoky taste, while chilli powder is finely ground chilies often mixed with other spices for a spicier, more uniform heat.
5) Salt: A mineral composed mainly of sodium chloride; essential for enhancing the flavor of foods.

B. Equipment Use

1) Weighing Machine: Used for measuring ingredients accurately.

2) Induction: A type of cooking range that uses electromagnetic fields for heating.

Table 2. Equipment usedUsed for the preparation of Flattened rice crispy wafers

SR.NO	EQUIPMENT USED
1.	Weighing Machine
2.	Induction
3.	Mixer
4.	Air Fryer
5.	Knife

3) Mixer: Used for mixing, whipping, or beating ingredients.

4) Air Fryer: A kitchen appliance that cooks food by circulating hot air, resulting in a crispy exterior and tender interior with minimal oil.

5) Knife: A basic kitchen tool used for chopping, slicing, and mincing ingredients.

FLOWCHART OF FLATTENED CRISPY WAFER

Raw material

↓

Dry-roasted poha and gram (5 min)

↓

Grinding (powder form)

↓

Added spices in grinded powder

↓

Mixing all the materials

↓

Spreading and Shaping

↓

Air fryer (10 to 12 min at200°c)

↓

Cooling and Packaging

C. Methodology

1) Preparation of flattened rice wafers

The selected raw materials include flattened rice, roasted *dalia*, turmeric, cumin, *chilli* flakes, and salt. To prepare the ingredients, dry roast the gram and flattened rice for about 5 to 7 minutes. After roasting, grind both the roasted *dalia* and flattened rice into a fine powder. Then, add the spices, including turmeric, cumin, *chilli* flakes, *chilli* powder, and salt, to the ground mixture. Mix all the ingredients thoroughly and then prepare the dough.

2) Spreading

Flatten the poha mixture by hand using a rolling pin or a flat surface. Use a machine specifically designed for spreading poha mixture evenly. Use a screen or a sieve to spread the poha mixture evenly.

3) Shaping

Shape the flattened poha mixture into desired shapes using a mold or by hand. Use a machine to mold the poha mixture into uniform shapes. Cut the flattened poha mixture into desired shapes using a cutter or a knife. Preheat the air fryer to 200°C. Place the poha wafers in a single layer in the air fryer basket. Cook for 10-12 minutes or until crispy and golden brown. Shake the basket halfway through cooking to ensure even cooking. Check the wafers for crispiness and cook for additional time if needed.

4) Cooling:

After frying or air frying, immediately transfer the poha wafers to a cooling tray or a wire rack. Ensure good air circulation around the cooling tray to help wafers cool evenly. Allow the wafers to cool completely, which may take about 30 minutes to an hour.

5) Packaging

Store the cooled poha wafers in airtight containers to maintain freshness. Use food-grade packaging materials, such as plastic bags, paper bags, or cardboard boxes. For a longer shelf life, consider nitrogen flushing to remove oxygen from the packaging.

Label the packaging with relevant information, such as ingredients, nutritional facts, and storage instructions.

III. RESULT AND DISCUSSION

A. Moisture Content

From the above sample Sensory 5 is better in all overall sample with the 5th sample we go for analysis

3gm of the flattened rice wafers sample was taken in petri plate and the weight was measured, the petri plates with samples are placed in hot-air oven for drying that with at temperature 105 degree Celsius after three hours the sample was taken out and cooled in desicator weight was taken and again place in the hot air oven to retrieve the sample and rewed after half an hour until the constant weight was obtained for last three readings.

Estimation of Moisture Content
3gm sample was taken in a petri plate
↓
Weight was taken
↓
Dried in a hot air oven at 105 °C for 3 hours
↓
Cooled in a desiccator and the constant weight was taken.
↓
Moisture content was calculated by using the formula.

B. Ash Content:

Total Ash value: 3g of flattened rice wafers sample was taken to burn the sample after charring the crucible, and was placed in a muffle furnace for ignition at 550 °C for 4 hours. The crucible was taken outside and cooled in a desiccator. The sample was ignited again after every half an hour until a constant weight was obtained accepted by the difference of Where, Weight of sample + crucible =30.013gm

$$\text{Ash content\%} \frac{\textbf{\textit{Weight of Ash}}}{\text{weight of sample}} \times 100$$

Estimation of Ash Content

Take 3 gm of flattened rice wafers in a crucible
↓
Ignit the sample in Muffle furnace at 5500C for 4 hours
↓
Cool it in the Desiccator for 15 mins and note the Constant Weight
↓
Calculate the ash content by using formula.

C. Estimation of Fat

3 gm sample was weighed and packed in a thimble the prepared thimble was weighed to cross- check the weight of the sample. The thimble was then enclosed in a big cellulose thimble and then it was placed in a Soxhlet extraction tube, 250 ml of petroleum ether, was added to the Soxhlet extraction tube containing the sample. The heating mantle was turned on and the temperature was set at 60°C.

Petroleum ether gets evaporated and condensed and falls over the sample drop by drop and the speed of dropping should be 150 drops per minute. When clear color petroleum ether was seen in Soxhlet after 612 hours, the assembly was turned off. The round bottom flask containing the solvent was separated from the assembly to recover the solvent. The solvent was recollected by using the downward distillation unit for the next use and the round bottom flask holding the extracted fat sample was dried in a hot air oven at 105 "C until all the solvent was removed after drying the RBF was cooled in a desiccator and the weight was taken until the last three successive reading shows the difference less than 0.001 gm. A 5-gram sample underwent initial weighing and was then enclosed within a thimble. Subsequently, the thimble, now containing the sample, underwent an additional weighing to verify the sample's weight. The thimble, housing the sample, was then inserted into a larger cellulose thimble. This combined setup was carefully positioned within a Soxhlet extraction tube. To facilitate the extraction process, 250 ml of petroleum ether was introduced into the Soxhlet extraction tube containing the sample. Upon activating the heating mantle and setting the temperature to 60°C, the petroleum ether underwent a cycle of evaporation, condensation, and dripping over the sample at a controlled rate of 150 drops per minute. Once the petroleum ether, now visibly clear, was observed in the Soxhlet after 6-12 hours, the entire assembly was deactivated. The round bottom flask, holding the solvent, was then separated from the apparatus to recover the solvent. The reclaimed solvent

underwent further processing using a downward distillation unit for subsequent use. Meanwhile, the round bottom flask containing the extracted fat sample underwent a drying process in a hot air oven set at 105°C until all the solvent was completely removed.

Percent crude fat was calculated as under:

$$\%\text{Crude fat} = \frac{\text{Weight of Fat}}{\text{weight of sample}} \times 10$$

D. Estimation of Protein

The protein content of the samples was determined utilizing the Kjeldahl method. Initially, 2 grams of the sample underwent digestion with 5 grams of a digestion mixture, comprising 10 parts potassium sulfate and 1 part copper sulfate, along with 20 ml of concentrated sulfuric acid. This digestion process continued in a Kjeldahl flask until the contents achieved a state of being carbon-free. The resulting digested sample was then adjusted to a final volume of 100 ml. A 10 ml aliquot of the digested sample was subjected to distillation with 20 ml of 30 percent sodium hydroxide. The liberated ammonia from this process was collected in a solution containing 20 ml of 2 percent boric acid, enriched with 2-3 drops of a mixed indicator. This indicator was a combination of 0.1% methyl red and 0.1% bromo-cresol green, dissolved in 95 percent ethyl alcohol, with a ratio of 1:5, respectively.The entrapped ammonia was subsequently titrated against 0.1N hydrochloric acid. The nitrogen content in the sample was then calculated using the following expression:

E. Estimation of Carbohydrate

The percent carbohydrates were calculated by subtracting the sum of moisture, protein, fat, ash and fiber from 100.

% CHO = 100 - (% Moisture + % Protein + % Fiber + % + Ash)

F. Shelf-Life Study

According to our research by doing sensory analysis we observe that the Flattened rice wafer has a shelf life of 2 to 3 week at room temperature after 3 months we observe some changes in taste, texture, aroma and flavor.So we observe that it's better to use before 3 week.

Table 3. Nutritional analysis of Flattened rice crispy wafers

Factors/ parameters (%)	Result
Moisture content	3.5%
Ash Content	2.5%
Crude Fat	7%
Crude Fiber	0.9%
Protein	8g
Carbohydrate	65%
Energy	326.9g

Calcium	15mg
Sodium	11.9mg
Sugar	0.5%

The nutritional analysis of the product reveals a well-balanced composition suitable for a healthy snack. With a low moisture content of 3.5%, the product demonstrates good shelf stability and reduced risk of microbial spoilage. The ash content of 2.5% indicates a moderate presence of minerals. It contains 7% crude fat and 8g of protein per 100g, contributing to its energy density and making it a satiating option. The carbohydrate content is relatively high at 65%, primarily from natural sources like tamarind and dates, while the sugar content remains low at just 0.5%, suggesting minimal added sugars. The fiber content is slightly low at 0.9%, which could be enhanced for added digestive benefits. The energy value of 326.9 kcal per 100g makes it a good source of quick energy. Additionally, the product is low in sodium (11.9 mg) and contains a modest amount of calcium (15 mg), making it a heart-friendly option. Overall, the product offers a nutritious profile with potential for further enhancement in mineral and fiber content.
Trial 1 consistently received the highest scores across all sensory parameters, indicating superior consumer preference. This suggests that the formulation or processing method used in Trial 1 was the most favorable.Taste and mouthfeel scored particularly high in Trial 1, reflecting a positive sensory experience that likely influenced the strong overall acceptance. Appearance, aroma, and colour also performed well in Trial 1 compared to the other trials, indicating uniform quality.
Sensory analysisof Flattened Rice Crispy wafers

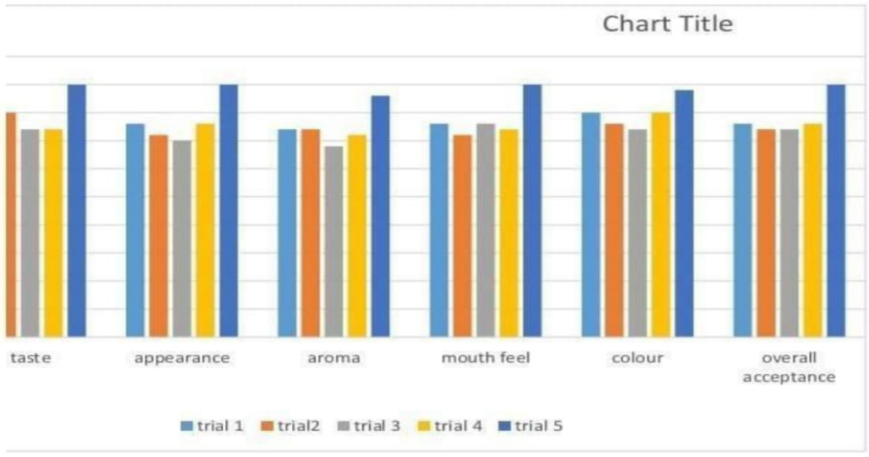

Figure 1. Sensory analysis graph of prepared Flattened rice crispy wafers

Trials 2 to 5 showed lower and relatively similar ratings across all attributes. Their scores are moderately close to each other, with slight variations, but consistently fall below those of Trial 1.The lowest scores across some parameters (notably appearance and aroma) appear in Trial 4 and Trial 3, which could point to formulation or processing issues (e.g., texture inconsistencies, off-flavors, or dull color).The overall acceptance is highest in Trial 1, correlating with its superior performance in all individual sensory attributes.

Figure 2. Flattened Rice Crispy Wafers

IV. CONCLUSION

Preparing flattened rice crispy wafers involves a straightforward process that requires six key ingredients and steps. After dry roasting flattened rice (poha), you mix it with spices or any desired flavorings. Then, form the mixture into thin wafers and dry them thoroughly in an air fryer until they are crisp. These wafers can be stored in airtight containers for future use and enjoyed as a light snack, a side dish, or a unique accompaniment to meals.

This preparation combines tradition with creativity, offering a delightful way to use flattened rice in a versatile form. Flattened rice crispy wafers, made from flattened rice (poha), are a delicious and crunchy snack that has gained popularity globally. With their unique texture and flavor, they offer a tasty alternative to traditional potato chips. The air fryer method provides a healthier option, requiring minimal oil while maintaining crispiness.

Overall, flattened rice crispy wafers are a delicious, nutritious, and convenient snack option that brings together a unique blend of taste, texture, and nutrition. With customizable flavors, an air fryer method, and eco-friendly packaging options, they are well-positioned to meet the growing demand for healthier and more convenient snack options.

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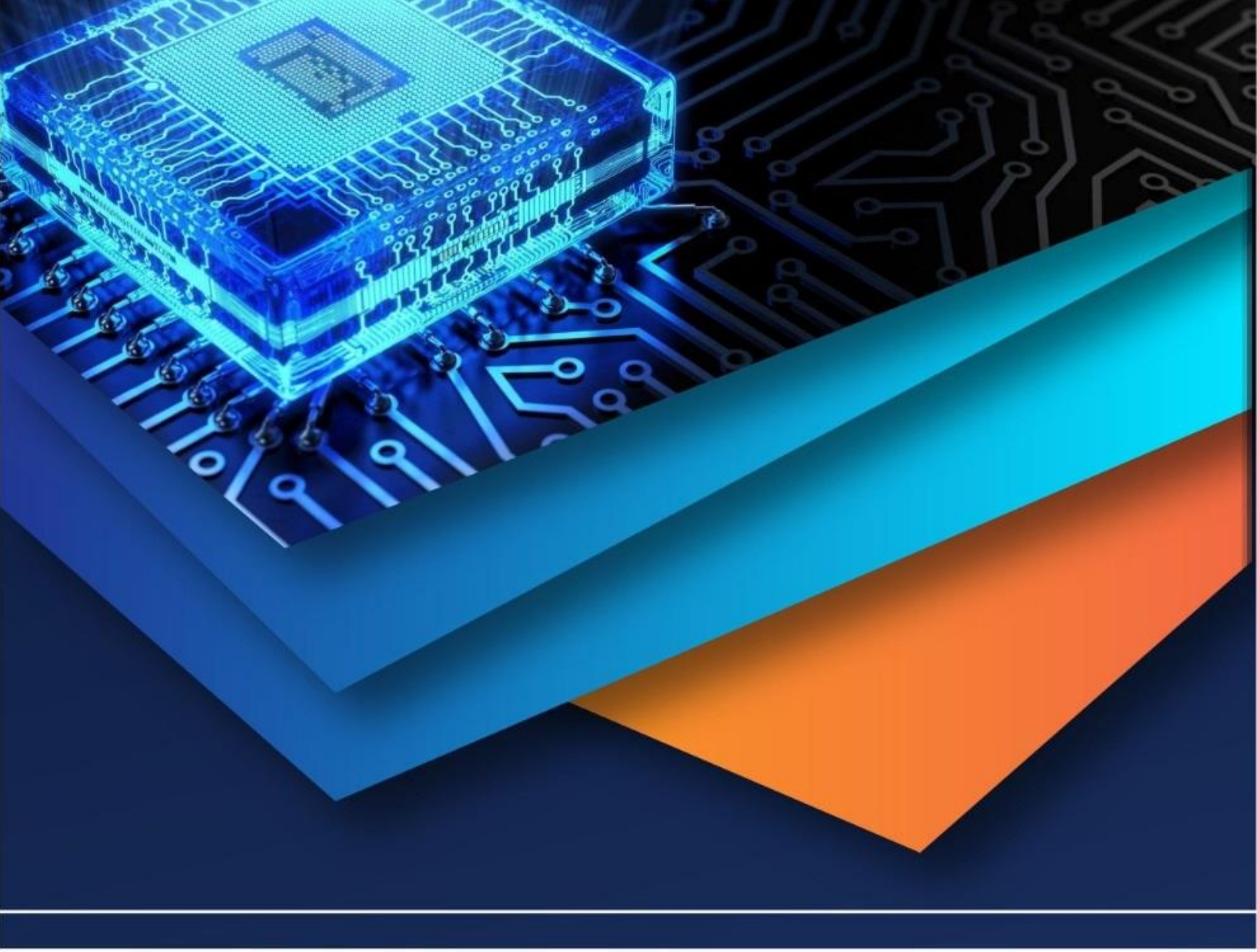

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