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Formulation and Development of Nutritious Sattu-Based Cookies: A Functional Bakery Product

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Abstract: ***This study focuses on the preparation and quality assessment of sattu cookies made from sattu flour, a traditional and nutritious ingredient derived from roasted Bengal gram and wheat. Sattu is gaining popularity in modern baking due to its health benefits and distinct nutty flavor. Incorporating sattu into cookies offers a creative way to blend wholesome nutrition with delicious taste. The process of making sattu cookies involves formulating a nutritious and flavorful cookie using sattu, a roasted gram flour rich in protein, fiber, and essential nutrients. The formulation aims to optimize the ingredient composition to achieve a balance between taste, texture, and nutritional value. Sattu is combined with whole sugar, jaggery, and fats like butter, as well as flavor enhancers such as cardamom or nuts. The mixture is then shaped into cookies and baked at a temperature of 170-180˚C to create a crispy texture. The study investigated the relationship between the proportions of ingredients and their influence on the taste, texture, and aroma of the cookies. The sensory evaluation revealed a preference for Sample 5 and Sample 6, which were prepared using 5 grams of sugar and 5 grams of jaggery as sweeteners, along with milk and water, respectively. The findings suggest that specific combinations of ingredients can significantly enhance the taste and aroma of the cookies.***
Keywords: Sattu, Cookies, Jaggery, Physico-chemical properties, Health benefits.

I. INTRODUCTION

Nowadays, dietary habits, lifestyles, and environments are changing significantly. In the present era, consuming Western food has become a trend in India. People are increasingly adopting food preparations from foreign countries, such as various types of soups, oats, flakes, pasta, pizza, noodles, and other recipes. While these foods are gaining popularity, they often lack the nutritional value found in traditional Indian foods.

Sattu is one of the well-known traditional foods of India. It is not only consumed for its nutritional benefits but is also used as medicine for treating various diseases and as a dietary supplement for maintaining health and preventing ailments. Descriptions of sattu can be found in various classical texts of Ayurveda. Sattu can be made from different cereals or herbs, and it can consist of a single cereal or a mixture of several cereals and herbs.

A cookie (American English) or biscuit (British English) is a baked snack or dessert that is typically small, flat, and sweet. It usually contains flour, sugar, and some type of oil, fat, or butter. Cookies may also include other ingredients such as raisins, oats, chocolate chips, or nuts.

Sattu flour, a traditional and nutritious ingredient made from roasted Bengal gram and wheat, is gaining popularity in modern baking due to its health benefits and distinct nutty flavor. Incorporating sattu into cookies is a creative way to combine wholesome nutrition with delicious taste. These cookies are not only rich in protein and dietary fiber, but they also have a unique earthy sweetness that distinguishes them from conventional cookies. Perfect as a healthy snack, sattu cookies are ideal for those seeking a balance of flavor and health in their diet.

Whether enjoyed with a cup of tea or as a quick energy boost, sattu cookies are a delightful treat that bridges tradition and modern culinary innovation. They cater to health-conscious consumers by offering a wholesome snack option that combines traditional ingredients with modern baking techniques.

II. MATERIALS AND METHODS

This prospective comparative project was carried out at Department of Food Technology Ballarpur Institute of Technology, Ballarpur, Chandrapur, India from September 2023 to November 2024.

1) Study Design: Product development with various material compositions and evaluation of product for sensory analysis.
2) Study Location: Department of Food Technology Ballarpur Institute of Technology, Ballarpur, Chandrapur, India
3) Study Duration: September 2023 to November 2024.
4)

A. *Ingredients*

Sattu (Roasted Gram Flour):This serves as the primary base, offering a nutty flavor and high nutritional value. It is rich in protein, fiber, and essential minerals. Jaggery: A natural sweetener that enhances flavor and provides vital minerals. It also supports digestion and energy metabolism. Sugar:Adds sweetness, helps retain moisture, and controls gluten development, which affects the texture and softness of the cookies. Butter:Contributes flavor, tenderness, and structure. It also aids in aeration and improves the overall texture of the cookies. Baking Powder:Functions as a leavening agent, creating a light and airy texture by releasing carbon dioxide during baking.

B. *Method*

The ingredients were measured and mixed to form a consistent dough. The dough was then shaped into cookies and baked at a controlled temperature until golden brown. The final product was cooled and subjected to sensory and quality evaluation. The development of sattu cookies involves formulating a nutritious and flavourful cookies using sattu, a roasted gram flour rich in protein, fiber, and essential nutrients. The process includes optimizing the ingredient composition to balance taste, texture, and nutritional value. Sattu is blended with whole sugar and jaggery and fat like Butter, along with optimal flavour enhancers like cardamom or nuts. The mixture is shaped into cookies and baked to achieve a crispy texture.

This is the control sample for this particular study. This sample was calculated by performing various studies by varying the concentration and composition of ingredients. The control sample was made by taking those studies into consideration and as per the sensory and judge panel acceptance.

In other studies concentration of all the ingredients were changed varying from lowest to highest. Other studies were also done for making cookies more acceptable by various age group of people. According to a survey children like their cookies flavoured with chocolate chips. People of age group from 20-35 consumes healthy biscuit but also demands for flavoured cookies such as chocolate, coconut, Elaichi(cardamom) flavoured cookies. People of age group from 45-65 likes their cookies to be less sweet and simple flavoured which is not complicated, so for their convenience a particular study is also done in varying the amount of sugar in the study. Preparation of dough

To prepare sattu cookie dough, start combining dry ingredients, including sattu flour and pinch of baking powder, in a large mixing bowl. Separately, cream together soften butter, sugar powder, and jaggery until smooth and fluffy, ensuring the sweetener is fully incorporated. Gradually add the dry mixture to the creamed butter, mixing well to form a crumbly texture. Add milk/water a little at a time, to bind the dough with cardamom powder or a pinch of nutmeg for a traditional touch. Once prepared, the dough should be rested for 15-20 minutes to allow the ingredients to meld, ensuring the cookies bake evenly with a rich, wholesome flavour.

Figure.1 Sattu cookies

Moulding/ Shaping of cookies- Forming a continuous dough sheet and then cutting the dough pieces to the required size and shape and printing the design on the surface of the dough pieces are the method of forming the dough for a wide variety of biscuits and cookies. Cookies are shaped using cookie cutter or cutter roll. Scrap dough lifted after shaping of cookies is returned to make a dough sheet. Moulded cookies are placed on baking trays to be baked.

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Table 1. Experimental Trials for Sattu Cookie Formulations

Trial Code	Sattu (g)	Jaggery (g)	Sugar (g)	Butter (g)	Baking Powder (g)	Water (ml)	Baking Temp (°C)
Control (C)	25	5	5	13	0.5	10	170
Trial 1 (T1)	25	8	2	13	0.5	10	170
Trial 2 (T2)	25	10	0	13	0.5	10	170
Trial 3 (T3)	25	3	7	13	0.5	10	170
Trial 4 (T4)	25	6	4	13	0.5	10	170

C. Baking Process

In commercial production, most chemically leavened cookies are baked using band ovens, although reel ovens are still employed, particularly in small-scale bakeries where short production runs are common. During baking, cookies typically lose significant moisture, resulting in a final moisture content of less than 5%, which imparts a crisp texture and ensures good storage stability. Commercial cookies are generally high in shortening and sugar, contributing to their characteristic richness and shelf life. Unlike home-baked versions, milk and eggs are rarely used in large-scale cookie manufacturing.

D. Cooling Process

After baking, cookies must be cooled to near-ambient temperatures before packaging. This is usually achieved through a series of conveyor belts that transport the cookies over a period lasting approximately 1.5 to 2 times the baking duration. This gradual cooling serves two essential purposes: it ensures the cookies are cool enough for safe and effective packaging, and it helps minimize the internal moisture gradient. Without proper cooling, moisture concentrated in the cookie's center may migrate outward, potentially causing "checking" — a condition where fine hairline cracks develop after packaging.

E. Packaging Importance

Packaging plays a critical role in the cookie and biscuit production process. It not only ensures the safe and convenient delivery of products to consumers but also serves a marketing function by making the product visually appealing and easily recognizable. Effective packaging also provides essential product information, including the type, weight, ingredients, and manufacturer details. Furthermore, the shape and design of the package influence its shelf presentation and consumer appeal, impacting purchasing decisions at the point of sale.

F. Packaging Materials

A variety of packaging materials are used for cookies, each offering distinct advantages. Polypropylene films, particularly metallized oriented polypropylene (OPP) and biaxially oriented polypropylene (BOPP), are widely preferred due to their affordability, moisture barrier properties, and excellent sealing strength. Although cellophane, made from regenerated cellulose, offers superior transparency and low permeability, its higher cost has led to its gradual replacement by polypropylene films. Metallized films, such as aluminized polyester, combine the visual appeal of metal with the flexibility and durability of plastic, making them ideal for snack and biscuit packaging. Laminated materials, made by fusing layers such as paper, foil, and plastic, enhance packaging strength and performance. Although aluminium foil provides a complete barrier to moisture and gases, its cost and rigidity limit its standalone use, making it more viable when combined with materials like polyethylene or waxed paper.

III. RESULTS & DISCUSSION

A. Physico Chemical Properties of sattu Cookies

The texture of the sattu cookies varied significantly across the six trials depending on the composition of sattu, flour, and other ingredients like butter. Trials with a higher percentage of sattu (60% or more) resulted in cookies that were denser and more brittle. These cookies also had a distinct grainy texture, which can be attributed to the coarse nature of sattu. On the other hand, trials with a lower percentage of sattu (40% or less) produced softer cookies with better structural integrity. The moisture content also played a role; cookies made with butter retained more moisture, resulting in a softer bite. In all trials, baking duration and temperature consistency were crucial in ensuring uniformity across batches, with a slight browning noted in higher-sattu compositions. The flavour profile of the cookies was dominated by the nutty, earthy taste of sattu. In trials where jaggery was used as a sweetener, the cookies had a deeper, caramel-like sweetness that complemented the sattu well. In contrast, cookies sweetened with sugar had a sharper sweetness, which sometimes masked the natural flavour of sattu.

The addition of cardamom or fennel seeds in certain trials enhanced the aroma and gave a traditional touch, making them more appealing to those accustomed to regional flavours. From a nutritional perspective, sattu cookies were perceived as a healthier alternative to conventional cookies due to their high protein and fiber content. Trials with lower sugar and butter compositions received positive feedback from health-conscious tasters. However, the consumer appeal also depended on the target audience. For example, cookies with a slightly sweeter and softer profile were more appealing to children, while adults appreciated the grainy texture and natural sweetness of jaggery-based compositions. Over the six trials, the optimal composition was found to be a blend of 42% sattu with 8% sugar and 8% jaggery, combined with 22% butter and water for balance. This composition offered a good compromise between taste, texture, and health benefits.

Table 2. Physio-chemical properties of sattu cookies

Sr. No.	Factors	Result(in%)
1.	Moisture	3.33
2.	Ash	2.33

The analysis of sattu cookies revealed the following key physico-chemical characteristics:

1) Moisture Content: The cookies exhibited a moisture content of 3.33%, which is within the acceptable range for maintaining crisp texture and enhancing shelf life.

2) Ash Content: The ash content was found to be 2.33%, indicating a good level of mineral content contributed by ingredients such as sattu and jaggery.

These results suggest that the cookies have low moisture, ensuring better storage stability, and a relatively high ash value, reflecting the nutritional richness of the formulation. There is a progressive increase in both total plate count and yeast and mould count with higher dilution levels. Coliforms were absent in all tested dilutions, indicating good hygienic quality of the control sample.

B. Sensory Attributes

Trial 6 performed the best overall with a mean score of 8.97 and an impressively low standard deviation (0.07), indicating both high and consistent sensory quality across all parameters. Trial 5 also showed strong performance with an average score of 8.71, slightly lower consistency than Sample 6, but still highly rated in all attributes. Trial 1 had a solid mean of 8.62, with moderate consistency. It ranked third overall. On the lower end, Trial 4 was rated the least favorable across most attributes, with an average of 6.9, indicating general dissatisfaction among panelists.

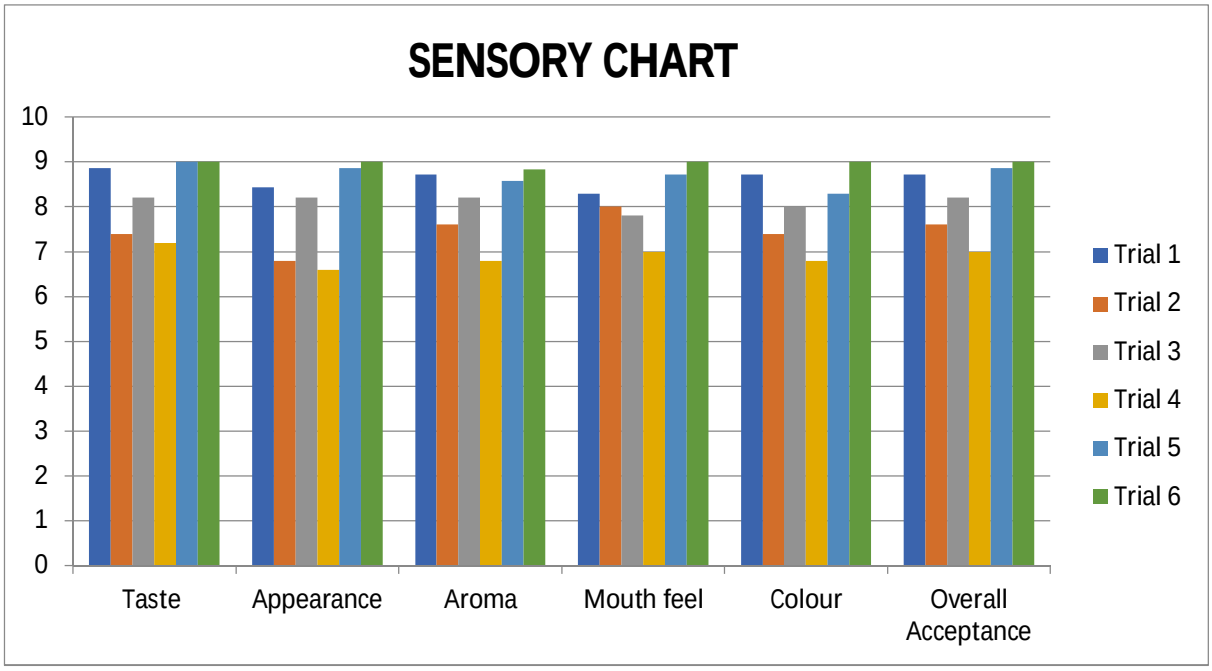

Fig.2 Sensory analysis by panelist

Table 3. Mean and SD. Showing in sensory analysis

Attribute	Mean	Std Dev	Min	Max
Taste	8.28	0.81	7.2	9.0
Appearance	7.98	1.04	6.6	9.0
Aroma	8.12	0.79	6.8	8.83
Mouth Feel	8.13	0.71	7.0	9.0
Colour	8.03	0.82	6.8	9.0
Overall Acceptance	8.23	0.79	7.0	9.0

Table 4. Attribute-Wise Insights

Attribute	Observation
Taste	Scored the highest average (8.28), indicating it was a strong determinant of acceptance.
Appearance	Had the lowest average (7.98) and highest variability, suggesting it was more subjective or inconsistent between trials.
Mouth feel	Consistently rated high (mean: 8.13), especially in Sample 6, possibly influencing overall acceptance.
Overall Acceptance	Closely tracked the mean performance of other attributes, especially Taste and Mouth Feel.

Trials 5 and 6 not only scored high but had low standard deviation, showing consistent preferences. Trial 2, despite being in the mid-tier, had the highest standard deviation (0.39).
The ANOVA test across trials resulted in:
F-statistic: 68.12
p-value: 1.84×10^{-15}
The very low p-value indicates that at least one sample's scores are significantly different from the others. This supports the observed ranking, where Samples 6 and 5 stand out significantly compared to the rest. Trial 6 is the clear top performer in all sensory dimensions and should be considered a benchmark or preferred formulation. Trial 5 is a close second and may be a good alternative, especially if it offers cost or ingredient advantages. Trial 4 requires reformulation or improvement, particularly in Appearance and Aroma.

Table 3. Microbial analysis of control trial

Dilution	Total Plate Count (CFU/ml)	Yeast & Mould Count (CFU/ml)	Coliform Count
10^{-2}	3.2×10^{2}	9.0×10^{2}	Nil
10^{-3}	2.4×10^{3}	8.0×10^{3}	Nil
10^{-4}	1.6×10^{4}	6.0×10^{4}	Nil
10^{-5}	1.4×10^{5}	5.0×10^{5}	Nil
10^{-6}	1.2×10^{6}	3.0×10^{6}	Nil
Mean	2.76×10^{5}	7.19×10^{5}	Nil
S.D.	4.97×10^{5}	1.30×10^{6}	Nil

Total Plate Count and Yeast & Mould Count both increased significantly with serial dilution, demonstrating an exponential microbial load in the trial. Yeast and mould counts were consistently higher than bacterial counts, which may be attributed to favorable conditions (e.g., moisture, sugar) in cookies that support fungal growth. The absence of coliforms in all dilutions indicates a high standard of hygiene during preparation, with no signs of fecal contamination—an important safety criterion for food products.

IV. CONCLUSION

The use of convection ovens for baking cookies remains a standard method in the food processing industry due to its efficiency, energy savings, and ability to produce consistent, high-quality baked goods.

In this study, sattu cookies—a nutritious alternative incorporating roasted gram flour—were developed and evaluated at various baking temperatures (165°C, 170°C, and 175°C) to determine the most suitable conditions for production. The findings revealed that higher baking temperatures contribute to increased nutritional loss, emphasizing the importance of temperature control. Based on sensory evaluation, moisture retention, and overall dough performance, it was concluded that a baking temperature range of 170–175°C is optimal for producing sattu cookies with desirable texture, flavor, and shelf stability.

Furthermore, the low moisture content (3.33%) achieved in the final product suggests excellent potential for extended shelf life. The absence of coliform bacteria and controlled microbial growth indicate good hygienic quality of the cookies. However, the impact of residual moisture on long-term storage stability warrants further investigation. Future research will focus on the storage behavior and shelf life of sattu cookies under varying packaging conditions and environmental factors.

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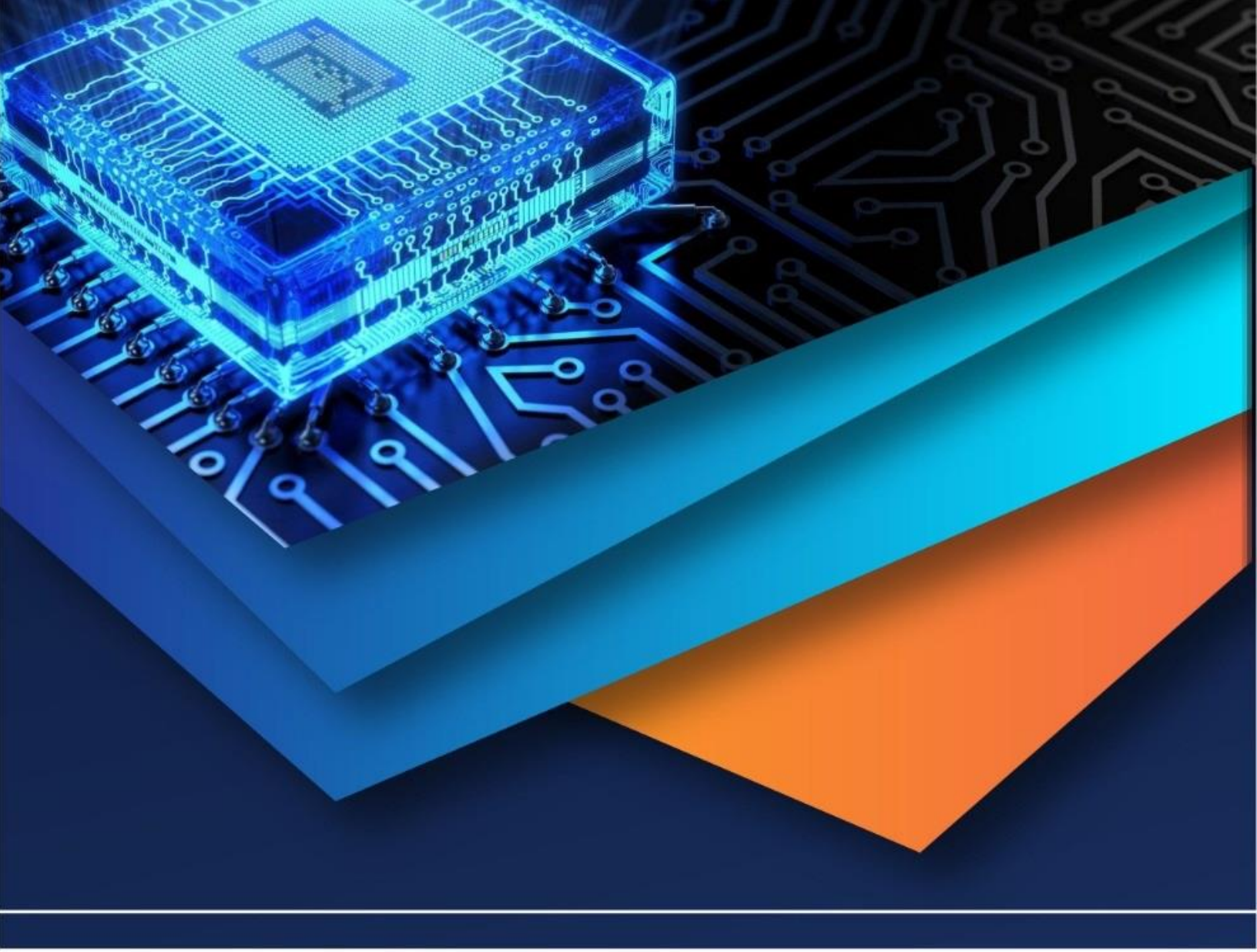

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