



Characteristics of Bangladesh Commercial Chicken Skin and Its Crispy Product Cooked with Different Methods

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Abstract— This study investigated chicken skin as a cost-effective protein source for crispy snacks, focusing on its physical characteristics and optimal cooking methods. Chicken skin samples were collected from four suppliers—BRAC, CP, Eon, and AG group—and assessed for physical quality, including color, texture, moisture content, and presence of feathers. Visual defects such as black, red, and yellow spots were counted per kilogram to evaluate quality and freshness, with the highest quality samples selected for further testing. The AG's chicken skin was selected for making the Crispy fried chicken skin product. The AG's chicken skins were cut into uniform square-shaped pieces and further cooked under three different cooking conditions: immediate frying, after marinating, and after storage at room temperature (20–25°C), cooling (0–4°C), and freezing (-20°C). The results showed that AG chicken skin was the best choice for producing Crispy fried chicken skin. The storage conditions prior to the cooking process significantly affected the quality of the resulting crispy skin product. Freezing has been shown to be the most effective storage method, maintaining the appearance, taste, and texture of the skin for a long period of time, whereas storage at room temperature and chilling can cause rapid deterioration, reduce crispiness, and develop undesirable sensory characteristics. Further research is needed to ensure consistent quality in large-scale production and further refinement of the frying technique for frozen chicken skin is recommended.

Keywords— Crispy Fried Chicken (CFC), Chicken skin, Crispy fried chicken skin, Marinated Chicken, Deep frying

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I. INTRODUCTION

The increasing price of meat has prompted the food industry to seek alternative protein sources, such as chicken skin. Chicken skin is utilized in meat products to enhance fat content and texture, but maintaining consistent crispiness is difficult due to variations in brands and cooking techniques [1]. Chicken skin is often discarded despite its high collagen content. It is a cost-effective raw material, containing approximately 40.36% fat and 9.76% protein [2]. Using chicken skin as a crispy snack was one of the proposed applications [3]. Meat can be cooked using methods like air frying, baking, deep-fat frying, and grilling. Cooking enhances the sensory properties by softening its texture, boosting flavor and color, and improving its aesthetic, nutritional, technological, and hygienic qualities [4]. Deep

frying, a long-standing and popular cooking method, involves immersing food in hot oil at 175–190°C. This technique improves sensory qualities, increases nutrient content, and effectively eliminates microorganisms, deactivates enzymes, and lowers water activity in food [5].

Marination is a well-established technique for enhancing the sensory attributes, culinary properties, and shelf life of meat. It improves flavor, color, juiciness, and tenderness while reducing cooking losses and off-flavors. As a non-thermal preservation method, specific marinade components inhibit microbial growth and oxidative processes. Additionally, marination increases the meat's water-holding capacity (WHC) [6]. Over the years, the marination process has been refined through careful ingredient selection, process control, and technological advancements, with tenderness being a critical quality trait [7].

This research aims to compare the physical characteristics of chicken skin from different suppliers and evaluate various cooking methods for crispy fried chicken skin.

We collected chicken skin samples from various suppliers and compiled them for evaluation. The samples were then cooked using three methods: marinating and storing at room temperature, marinating and keeping frozen, and marinating and keeping chilled. Cooked skin was evaluated for appearance, texture, and crispiness. The data was analyzed using summary statistics. The fried chicken industry is a major sector in the food industry, utilizing large quantities of processed chicken. Crispy fried chicken skin is a popular element in many cuisines, known for its distinctive texture and flavor that enhances the appeal and satisfaction of dishes [8]. Crispiness is a complex attribute influenced by various sensations and physical parameters, including molecular structure, manufacturing processes, and storage conditions [9].

The sensory attributes of crispy foods, such as chicken skin, are essential for consumer satisfaction. Comprehensive sensory evaluations, considering all aspects (appearance, odor, taste, texture), are effective for analyzing food quality. Numerous studies utilize overall acceptance to assess these sensory traits [10]. Crispy fried chicken skin, though often seen as indulgent, can provide nutritional benefits when eaten in moderation, as it contains essential fats important for a balanced diet [11]. Crispy fried chicken products have a notable cultural impact, especially in regions where they are a staple. They are linked to

comfort food and family gatherings, playing a role in social and cultural traditions. The enjoyment of crispy chicken transcends age and background, making it a universally loved food item [12]. This research differentiates chicken skin from various suppliers and compares cooking methods to achieve crispy fried chicken skin, presenting new opportunities for innovation and consumer satisfaction in the food industry. The findings are anticipated to provide valuable insights, enhancing the development and quality of crispy fried chicken skin products. The aim of this research is to enhance the production process for a commercially viable crispy fried chicken skin product by evaluating its performance under different conditions.

II. MATERIAL AND METHODS

A. Research Design

Schematic diagram research design shown in **Figure 1**. The initial phase of this study focused on identifying and evaluating potential suppliers for chicken skin samples. A comprehensive list of prospective suppliers was compiled through a combination of online research and expert recommendations, ensuring that the selected suppliers met the necessary industry standards for consistency and quality. Identification of the quality of the chicken skin samples received was carried out before the frying and storage process.

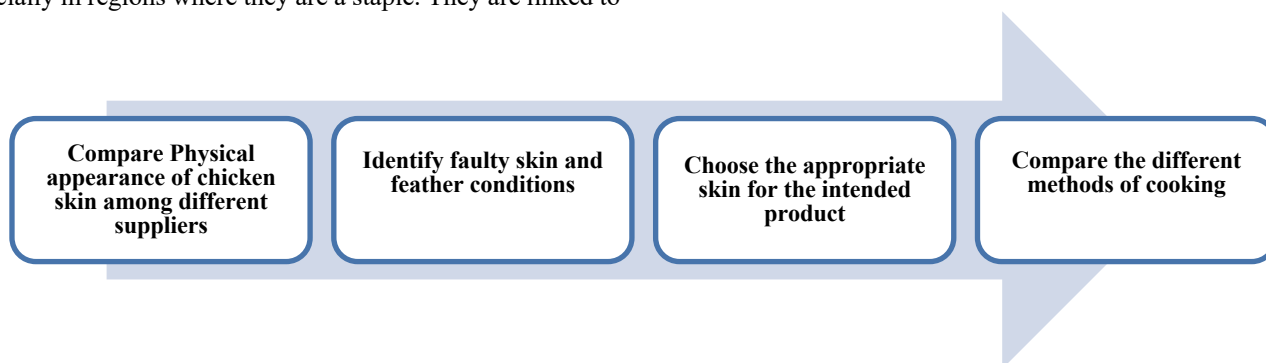


Fig. 1 Schematic diagram of the research design.

B. Sample Preparation

The suppliers of chicken skin included BRAC Group, CP, Eon, and AG. Chicken skin samples were requested from each of these companies and subsequently assessed based on several key physical characteristics. The fundamental physical attributes of the collected chicken skin samples, including color, texture, moisture content, and feather presence, were meticulously examined. Special attention was given to identifying visual defects such as black, red, and yellow spots, as these can significantly impact consumer acceptance and the product's aesthetic appeal [13]. To ensure consistent measurement and comparison among suppliers, the number of black, red, and yellow spots per kilogram of skin, as well as the number of feathers per kilogram, were documented. These

criteria were applied to select the supplier that provided the highest quality chicken skin, both in terms of appearance and freshness, for further testing.

The highest quality chicken skin was selected and prepared for the evaluation process. To maintain uniformity in subsequent examinations, one kilogram of chicken skin was collected and meticulously cut into identical, square-shaped pieces. This consistency in shape and size is essential for ensuring even cooking and generating reliable results when applying different cooking methods. Subsequently, various cooking techniques and storage conditions were applied to the prepared chicken skin pieces to evaluate their effectiveness and quality under different scenarios. The skin was subjected to three distinct cooking methods: immediate preparation, marination, and prior

storage at room temperature (20–25°C) [14], chilling (0–4°C), and freezing (-20°C) [15].

The conditions exemplify potential production scenarios, facilitating a comparative analysis of methods to determine the one that maximizes consumer satisfaction and crispiness. To attain a crispy texture, hot oil immersion was utilized to fry the chicken skin in each trial. Fresh soybean oil served as the frying medium, and the frying process was conducted using a gas stove and fryer basket [16]. During the frying process, a precision oil thermometer was employed to continuously monitor and maintain a constant frying temperature between 175°C and 190°C. This temperature range was selected based on previous research as it effectively achieves the desired level of crispiness without overcooking or burning the chicken skin [5]. Prior to frying, the oil was heated to the desired temperature, and the fryer basket was used to properly immerse the pieces of chicken skin in the oil. The chicken skin was fried for approximately one minute, monitored using a stopwatch. To ensure each batch achieved a crispy, golden-brown finish, the frying process was continuously monitored [17].

C. *Crispy Chicken Skin Analysis*

After the cooking process was completed, the fried chicken skin was carefully removed from the oil, drained of excess fat, and allowed to cool before being assessed [16]. The fried chicken

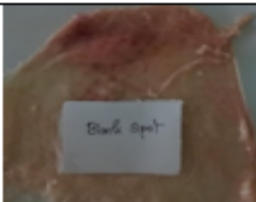


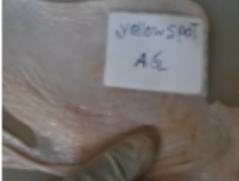


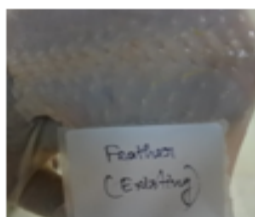

skin specimens were systematically evaluated for crispiness and overall sensory acceptability. The assessment focused on texture, flavor, and appearance to establish the optimal criteria for producing a high-quality product [17]. To determine the optimal procedure for producing crispy fried chicken skin, comparisons were made between fried specimens immediately, after marination, and following various storage conditions (room temperature, chilled, and frozen). The findings from these studies will inform decisions on production techniques for both small- and large-scale operations.

III. RESULT AND DISCUSSION

D. *Visual Comparison of Quality Parameters and Quantitative Evaluation among Chicken Skin from Suppliers.*

Customers often associate the freshness of chicken meat and skin with its color. The color of the meat can be assessed visually or using instruments such as colorimeters. For accurate visual assessment, panelists must undergo proper training [18]. According to **Table 1**, which provides a visual comparison, and **Figure 2**, the graphical representation of defects in chicken skin from different suppliers, it is observed that a comprehensive comparison of chicken skin samples from four suppliers namely Eon, AG, BRAC, and CP Group.

TABLE 1.
 VISUAL COMPARISON OF CHICKEN SKIN FROM DIFFERENT SUPPLIERS

Parameter	Picture (CP group)	Picture (Eon group)	Picture AG Group	Picture BRAC Group
Black Spot				
Yellow Spot				
Red Spot				
Feather				

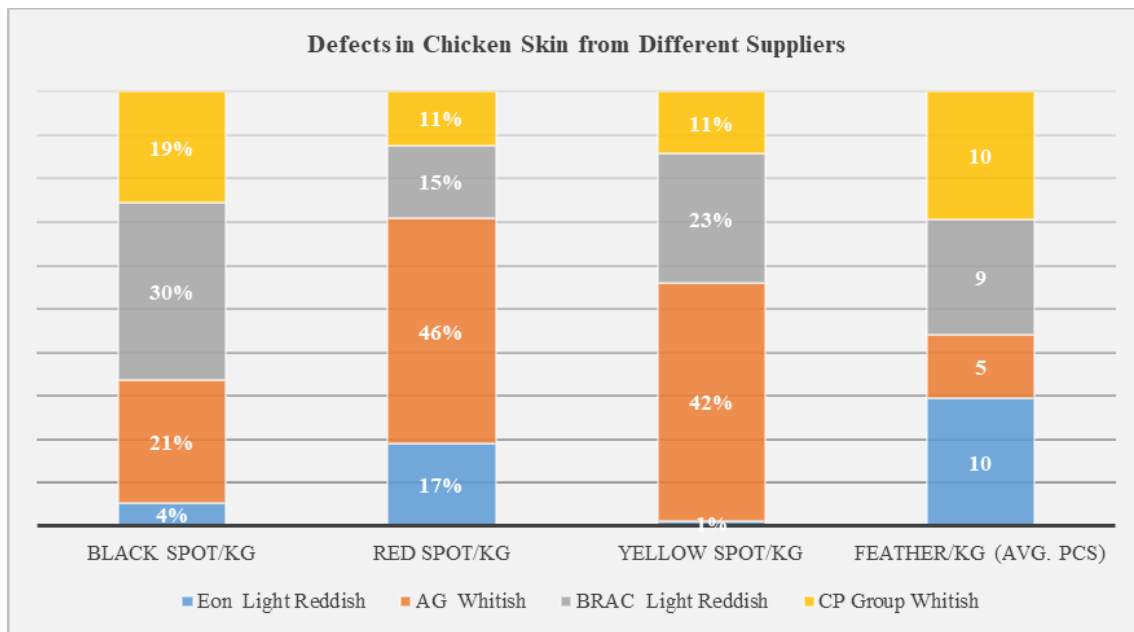


Fig. 2: Graphical Representation of Defects in Chicken Skin across Different Suppliers.

The acceptability and quality of chicken skin to produce crispy fried chicken skin were meticulously evaluated based on several critical factors. Each sample was thoroughly examined to assess the average number of feathers per kilogram, the percentage of black, red, and yellow spots per kilogram, and the overall physical appearance of the skin.

1. Black Spots

The presence of black spots, potentially resulting from improper handling or processing, serves as a critical indicator of chicken skin quality. Eon's chicken skin exhibited the lowest proportion of black spots, at only 4% per kilogram, signifying a higher-quality product. Conversely, BRAC's chicken skin displayed a 30% higher incidence of black spots, suggesting potential issues with processing or storage. AG and CP Group demonstrated intermediate black spot percentages, with 21% and 19% per kilogram, respectively.

2. Red Spots

The presence of red spots, which may indicate defects or blood stains, is another critical quality parameter for chicken skin. AG's chicken skin exhibited the highest percentage of red spots at 46%, which could negatively impact the product's visual appeal. In contrast, CP Group's chicken skin had the lowest percentage of red spots at 11%, making it a more visually appealing option. BRAC and Eon had intermediate red spot percentages, with 15% and 17%, respectively.

3. Yellow Spots

The occurrence of yellow spots, potentially resulting from fat deposits or inadequate washing, varied significantly among the samples. Eon's chicken skin exhibited the lowest percentage of yellow spots at 1% per kilogram, indicating superior processing standards. Conversely, AG's chicken skin had the highest

proportion of yellow spots at 42%, raising concerns about cleanliness and preparation. BRAC and CP Group displayed relatively high percentages of yellow spots, at 23% and 11% per kilogram, respectively.

4. Feather Count

The presence of feathers significantly impacts the texture and overall appearance of the finished product. The suppliers exhibited varying numbers of feathers per kilogram. Eon and CP Group had an average of 10 feathers per kilogram, which exceeds the ideal standard for well-cleaned and prepared chicken skin. BRAC's chicken skin, with 9 feathers per kilogram, also showed a noticeable presence of feathers. In contrast, AG demonstrated superior performance with only 5 feathers per kilogram, making it the optimal choice for producing high-quality crispy fried chicken skin.

5. Physical Appearance

An essential determinant of overall quality was the physical characteristics of the chicken skin samples. To achieve a visually uniform product, AG and CP Group provided chicken skin with a white appearance, generally perceived as more attractive. Conversely, the bright reddish hue of the samples from Eon and BRAC may be less appealing, contingent upon consumer expectations and preferences.

6. Chicken Skin Supplier Selection and Final Decision

Following a comprehensive analysis of the chicken skin samples from AG, BRAC Group, CP Group, and Eon, AG's chicken skin was identified as having the most desirable characteristics for producing crispy fried chicken skin. AG excelled in key areas, including the lowest number of black spots and the fewest feathers, although it had a relatively higher percentage of red and yellow spots. Moreover, its lighter physical appearance

aligned well with the visual requirements for the final product, making it an optimal choice for production.

Eon's skin samples did not meet our stringent requirements overall, and their high feather count disqualified them despite the relatively small proportion of black and yellow spots. Significant defects in BRAC's chicken skin, such as a high percentage of black spots and a large quantity of feathers, rendered it unsuitable for the production process. Although CP Group's chicken skin was considered a strong competitor, AG's superior aesthetic appeal and reduced feather content ultimately prevailed. In conclusion, the production process for the crispy fried chicken skin product has been approved for the use of AG's chicken skin. It was deemed the most suitable choice for both small- and large-scale production due to its balance of desirable qualities, including fewer defects and a more uniform appearance.

B. Evaluation of Chicken Skin and Storage Methods for Crispy Fried Skin Production

Appearance is a critical sensory quality attribute in both fresh and processed foods, significantly influencing product marketing and consumer perception. Key elements contributing to a product's overall visual appeal include size, shape, texture, mass, gloss, and color. Among these, the surface color of food is a primary consideration for consumers when determining product acceptability, serving as an essential tool in their decision-making process. Food color is affected by various chemical, biochemical, microbiological, and physical changes that occur during growth, maturation, postharvest handling, and processing. The importance of color in the food industry is underscored by its status as one of the most frequently assessed product quality attributes in postharvest handling and food processing research [19].

A quantitative evaluation of defects in chicken skin from various suppliers indicated that AG's skin was suitable for manufacturing crispy fried skin under different storage conditions. According to the supplier policy of the Skin Company, it is recommended that chicken skin be stored in freezing conditions to extend shelf life and maintain standard quality parameters over prolonged storage periods. For the evaluation of marinated chicken skin stored at room temperature, samples were initially brought to room temperature from a frozen state and kept at room temperature for approximately one hour before commencing the marination and storage experiments. For marinated chicken skin stored under chilled and frozen conditions, the samples were kept in a chiller and freezer, respectively, before beginning the experimental procedures.

1. Marinate and Store in Room Temperature

After marinating the chicken skin, it was kept at room temperature, and the following parameters were evaluated over a period of 14 days. The results are presented in **Table 2**. Room

temperature storage of poultry meat products can be effectively managed using aluminum foil sheets coated with polyethylene. This combination creates an efficient barrier against moisture and oxygen [20, 35].










According to **Table 2**, Marinated and Stored at Room Temperature, the following parameters were evaluated over a period of 14 days, with a detailed description provided below. On the first day, an evaluation was conducted one day after marinating, frying, and storing the chicken skin at room temperature, which yielded positive results across all key parameters. The chicken skin displayed an appealing appearance with a desirable golden-brown color, indicative of proper frying. Moreover, a crispy texture was observed, comparable to that of freshly fried chicken skin [21]. During the sensory evaluation, the odor was found to be pleasant and appealing, while the taste remained flavorful, presenting a well-balanced combination of marinated spices and the natural flavor of the chicken skin. The product's overall performance in terms of appearance, color, aroma, and crispiness was notably exceptional [10].

By the third day, the chicken skin retained much of its original quality. It maintained a visually appealing appearance with a fresh hint of golden-brown color. The crispiness was preserved, contributing to the product's overall desirable texture. No signs of spoilage or off-odors were detected, as the aroma remained pleasant. The product remained palatable, with no significant loss of flavor, indicating its continued suitability for consumption.

On the fourth day, the chicken skin performed well during sensory evaluation. The color remained in good condition, displaying a bright golden hue. Minimal changes were observed in the overall quality; both the aroma and taste remained intact. Importantly, the product maintained its crispness, a critical attribute for fried chicken skin, ensuring continued consumer appeal. At this stage, chicken skin was still considered valuable and acceptable for consumption.

On the fifth day, the first signs of quality decline began to emerge. The chicken skin retained a generally pleasant appearance, but there was a noticeable deepening of the brown color. This slight browning indicated potential oxidation or excessive air exposure during room temperature storage. While the odor remained acceptable, it began to change subtly. A slight oiliness was also observed. Although the product was still relatively good, the taste started to exhibit minor signs of flavor degradation. The crispiness of the product began to diminish, despite its continued appealing appearance.

TABLE 2.
 MARINATED AND STORED AT ROOM TEMPERATURE.

Day	Image after fry	Appearance, Smell and Taste	Day	Image after fry	Appearance, Smell and Taste
01 st		<ul style="list-style-type: none"> • Appearance is good • Color is okay • The smell and taste are good • Crispiness is ok 	08 th		<ul style="list-style-type: none"> • Color is not ok • Fresh color disappeared • Oily Smell is unpleasant • Crispiness reduced
03 rd		<ul style="list-style-type: none"> • Appearance is nice • Color is okay • The smell and taste are good • Good Crispiness 	10 th		<ul style="list-style-type: none"> • Color is not good • Blackish appearance • Oily Smell • Less Crispiness
04 th		<ul style="list-style-type: none"> • Appearance is satisfactory • Good color Smell and taste is good • Good Crispiness 	12 th		<ul style="list-style-type: none"> • Appearance lost its appeal • Bad taste and smell
05 th		<ul style="list-style-type: none"> • Appearance is good • A little deep brown color appeared • Smell and taste is moderate • Little oily smell found 	14 th		<ul style="list-style-type: none"> • Appearance is not acceptable • Became darker in color • Oily smell and taste make it worse • Loss of crispiness and taste
07 th		<ul style="list-style-type: none"> • Color is moderate • Fresh color disappearing • Smell and taste is unpleasant • Oily smell originates • Become less crispy 			

By the seventh day, the quality of the chicken skin had deteriorated more noticeably. The previously vivid and fresh color had begun to fade, replaced by a less vibrant and less appealing tone. The freshness was diminishing, and the skin's appearance was becoming less desirable. The onset of rancidity was indicated by an unpleasant oil-based smell [22]. In addition to the unfavorable odor, the taste had also declined, detracting from the overall flavor profile. The chicken skin was no longer as crispy, which further detracted from its appealing texture. Due to these deteriorating sensory characteristics, the product was deemed unfit for human consumption at this stage [23].

The eighth day saw a continued decline in the product's quality. The chicken skin had darkened from a medium brown to an unappealing black, indicating further deterioration. Its appearance was no longer visually acceptable, and the unpleasant odor had intensified, becoming more overpowering and uncomfortable. This resulted in a significantly inferior flavor, making the product unpalatable. The characteristic crispiness of fried chicken skin had also notably diminished, reducing its appeal from a textural perspective [9].

By the tenth day, the deterioration was significantly more pronounced. The chicken skin had turned a pronounced gray, clearly indicating that the product had exceeded its shelf life. The color had faded, and any trace of freshness was replaced by an overpowering greasy odor. The taste had degraded, with the oily smell negatively impacting the overall flavor profile. The crispness had almost entirely vanished, leaving a limp, greasy texture that was far from acceptable [24].

On the twelfth day, the chicken skin had become entirely unsuitable for human consumption. The appearance had darkened significantly, with a greasy surface and a dull, lifeless hue. An unpleasant sour odor indicated advanced spoilage. The taste had also deteriorated, with an unappealing oily residue and noticeable off-flavors [25]. Additionally, the crispness had completely disappeared, further diminishing the product's desirable texture and flavor.

By the fourteenth day, the chicken skin had reached its lowest point. The appearance, characterized by an excessively oily and burnt exterior, was entirely unsatisfactory. The color had turned excessively dark, and any semblance of freshness had vanished. The flavor had deteriorated to the point of being unpalatable, with an overpowering oily smell dominating the sensory assessment. Furthermore, the crispiness, a crucial component of the product's original appeal, had completely disappeared, leaving behind a soggy, disagreeable texture. By this point, the product had lost all of its appealing qualities and was deemed entirely unsuitable for human consumption.

An analysis of fried, marinated chicken skin stored at room temperature for 14 days revealed a gradual decline in quality. During the initial four days, the product exhibited stable characteristics in terms of color, appearance, crispness, and flavor. However, by the fifth day, signs of deterioration began to emerge, leading to a decline in both visual and sensory

attributes. By Day 7, the chicken skin had lost some of its crispness and developed an unpleasant flavor and odor. By Day 10, the product had turned black and emitted a strong oily smell, rendering it unusable. The final evaluation on Day 14 confirmed that the chicken skin was no longer fit for consumption and had completely lost its desirable qualities.

To ensure the viability of the product and the safety of consumers, it is essential to maintain appropriate storage conditions for fried chicken skin and restrict room temperature storage to a maximum of four to five days.





2. *Marinate and Keep Frozen Condition*

After marinating the chicken skin, it was kept at a frozen temperature, and the following parameters were evaluated over a period of 15 days. The results are presented in **Table 3**. One of the most prevalent practices in the food industry for the long-term preservation of various meat types, including poultry, pork, and beef, is storing fried chicken skin at a temperature typically around (-18 °C). This low temperature effectively inhibits bacterial growth, thereby extending the shelf life of meat products. Consequently, the freezing process facilitates the distribution of frozen meat products over considerable distances, promoting international trade and ensuring a consistent year-round supply. In contrast, refrigeration primarily serves as a temporary display solution in retail settings and is suitable for home use [26].

On the first day following marination, frying, and freezing, the chicken skin was evaluated and found to be in excellent overall condition. Post-frying, the chicken skin exhibited a delightful golden-brown color, characteristic of well-fried chicken. It possessed a genuinely crispy texture, providing the ideal crunch required for fried chicken skin products [27]. There were no unpleasant aftertastes or signs of spoilage; the aroma was clean and pleasant. The flavor achieved a harmonious balance between the marinade's enhancement and the inherent richness of the chicken skin, resulting in a favorable reception. In conclusion, the product was deemed highly satisfactory regarding appearance, taste, and texture on the first day following freezing and frying, as it successfully maintained its desired sensory characteristics.

By the fifth day of frozen storage, minor variations in the physical properties of the chicken skin were observed. While some small imperfections were noted in appearance, the overall quality remained acceptable. Twisted or curled portions of the fried chicken skin, a common occurrence following frying and freezing, were present. The color retained its attractive golden-brown hue, albeit slightly less vivid than on day one. The aroma remained fresh, with no indications of rancidity or spoilage. Additionally, the crispiness of the chicken skin was deemed satisfactory, maintaining its firm, crunchy texture and overall palatability [28]. Despite minor aesthetic adjustments, these changes were not significant enough to negatively impact on the product's overall acceptance.

TABLE 3.
 MARINATED AND STORED AT FROZEN TEMPERATURE.

Day	Image After Frying	Appearance, Smell and Taste	Day	Image After Frying	Appearance, Smell and Taste
01 st		<ul style="list-style-type: none"> • Appearance is ok • The color is nice golden brown • The smell and taste are good • Crispiness is ok 	10 th		<ul style="list-style-type: none"> • Some are a little curly, some are okay. • Crispiness remains good
05 th		<ul style="list-style-type: none"> • A little twisted • Color is satisfactory • No problem with smell • Crispiness acceptable 	15 th		<ul style="list-style-type: none"> • Some are little twisted, some are okay. • Color is ok. • Crispiness is suitable • Smell is ok

On the tenth day of frozen storage, minor modifications in the chicken skin's appearance were observed. Some pieces exhibited twisting or curling, but these changes did not detract from the product's aesthetic appeal. Such alterations are common when previously frozen chicken skin is fried, as the frying process can cause minor physical deformation. The color of the chicken skin remained consistent with previous days, retaining its pleasant golden-brown hue. Importantly, there was no noticeable loss of texture, and the skin's crispiness remained unchanged, indicating that the desired crunch was not affected by freezing. In terms of smell and taste, the chicken skin continued to perform well, with no unpleasant odors detected and no noticeable deterioration in flavor. Consequently, despite minimal curling in appearance, the flavor, aroma, and texture of the product remained suitable for consumption.

By the fifteenth day of frozen storage, the chicken skin exhibited more noticeable physical changes in appearance. While some sections retained an almost regular form, others were distinctly twisted. This twisting likely resulted from the skin shrinking or curling in certain areas due to moisture loss or changes in fat structure during freezing and frying [29]. The color of the fried chicken skin remained acceptable, retaining an attractive golden-brown appearance despite physical modifications. There were no unpleasant odors indicative of oxidation or spoilage, suggesting that freezing preserved the product's integrity. The crispness of the chicken skin was also maintained, providing the same desirable crunch observed in

previous evaluations. Although some portions lost visual appeal due to twisting, the flavor, aroma, and texture remained unchanged.




The evaluation of fried and marinated chicken skin stored in a freezer for 15 days demonstrated that freezing effectively preserved the product's quality, particularly in terms of flavor, aroma, and texture. On Day 1, the chicken skin exhibited an excellent golden-brown color, sufficient crispiness, and a pleasant flavor and aroma. By Day 5, minor visual modifications, such as slight twisting of some pieces, were observed; however, the color, aroma, and crispiness remained satisfactory. On Day 10, some pieces continued to curl, but the overall crispness, flavor, and aroma were still acceptable. By Day 15, additional twisting was noted, yet the chicken skin retained its color, crispiness, and appealing texture.

Overall, the product maintained its quality for up to 15 days in frozen storage, exhibiting only minor changes in appearance and no significant alterations in crispiness, flavor, or aroma. This indicates that fried, marinated chicken skin can be effectively stored frozen without substantial quality degradation, facilitating longer-term preservation and consumption.

3. *Marinate and Keep Chilled Condition*

After marinating the chicken skin, it was kept at chilled temperature, and the following parameters were evaluated over a period of 3 days. The results are presented in **Table 4**.

TABLE 4.
 MARINATED AND STORED AT CHILLED TEMPERATURE.

Day	After Frying	Remarks	Day	After Frying	Remarks
01 st		<ul style="list-style-type: none"> • Unpleasant Color • The taste is bad • Burned flavor burn 	03 rd		<ul style="list-style-type: none"> • Blackish Color • The taste is bad • Products become blister
02 nd		<ul style="list-style-type: none"> • Blackish Color • The taste is bad • More Burned flavor 			

The growing demand for ready-to-eat fast meals provided by the food service industry has emphasized the significance of both cooked-chilled and cooked-frozen products. Chilled products, in particular, offer an effective preservation method that ensures product quality and safety. When stored under controlled conditions with a final core temperature maintained between 0 and 3°C, these products can achieve an extended shelf life, making them a valuable solution for the industry [30].

On the first day of examining marinated and fried chicken skin stored in Chilled conditions, the findings were notably inadequate. The chicken skin exhibited an unnatural and lifeless color, indicative of inferior quality. Instead of achieving the expected golden-brown hue post-frying, the skin displayed a less appealing tone, suggesting that the chilling process may have compromised its ability to fry uniformly. Furthermore, the chicken skin exhibited an undesirable off-flavor, characterized by a burnt taste rather than the rich, savory flavor typically associated with fried chicken skin. This unappealing flavor significantly diminished the product's overall acceptability, rendering it unsuitable for human consumption. The presence of a burnt flavor may be attributed to inconsistencies in frying, potentially caused by the impact of chilled storage on the moisture and fat content of the skin [31]. Overall, the preliminary findings indicated that chilling had adversely affected the product's appearance and flavor from the beginning.

On the second day, the marinated and fried chicken skin showed further deterioration due to the adverse effects of chilled storage. The skin had darkened significantly, indicating improper frying, and its overall appearance worsened. The nearly blackened surface suggested overcooking or potential changes in the skin's composition caused by the chilling process, making it more susceptible to burning during frying. Consequently, the product lost its aesthetic appeal, a critical factor for consumer acceptance. The flavor of the marinated and fried chicken skin showed no improvement from the first day, with the burnt flavor becoming more pronounced. This intensified burnt taste indicated that the chilling process continued to negatively impact on the product, likely affecting the skin's moisture and fat balance during frying. Consequently, the product's flavor quality deteriorated, and its blackened appearance rendered it unsuitable for consumption by the second day.

By the third day, the quality of the marinated and chilled chicken skin had further declined. The blackish color observed on the second day had worsened, indicating continued deterioration of its aesthetic appeal. The frying process appeared to have intensified the adverse effects of chilled storage, resulting in a highly unappealing product. The flavor remained unsatisfactory, with a pronounced burnt taste and an overall unpleasant profile, rendering the product undesirable for consumption. Blisters also emerged on the skin, further detracting from its appearance and taste. The development of

blisters was likely due to an uneven frying process, where retained moisture expanded under heat, causing the skin's surface to rupture and blister [32]. This physical defect further compromised the product's texture, detracting from its previously appealing appearance.

An evaluation of fried and marinated chicken skin stored in a chiller for three days revealed significant quality deterioration. On Day 1, the chicken skin exhibited an unattractive color, poor taste, and burnt flavor. By Day 2, these issues had intensified, with the burnt flavor and unpleasant taste becoming more pronounced, and the color turning somewhat black. By Day 3, the quality had further declined, with the skin developing blisters, a darkened appearance, and a persistently inappropriate taste. These findings indicate that marinated chicken skin intended for frying should not be stored under chilled conditions. Such storage results in progressive quality degradation, rendering the product increasingly unsuitable for consumption due to unacceptable color, unpleasant flavor, and physical defects such as blistering.

C. Summary of Fried Chicken Skin Storage Conditions and Quality Assessment

The study on the storage and quality evaluation of marinated and fried chicken skin demonstrates distinct differences in the product's behavior when stored at room temperature, in a chiller, and frozen. Over time, the physical appearance, taste, texture, and overall acceptability of the chicken skin varied uniquely depending on the storage conditions.

1. Room Temperature Storage: Rapid Deterioration in Quality

The quality of marinated and fried chicken skin rapidly declined when stored at room temperature, particularly after five days. Initially, the chicken skin retained its color, crispness, and pleasant aroma. However, noticeable spoilage occurred after the sixth day, with the color changing to a deep brown, indicating overcooking or spoilage, and the skin darkening significantly, resulting in an unpleasant appearance. Upon extended exposure to room temperature, chicken skin exhibited a noticeable and unpleasant oily odor, indicative of the onset of rancidity [33]. The skin's crispness significantly diminished, resulting in a limp and soggy texture [22]. By the fifth day, the overall sensory qualities had deteriorated, with the flavor becoming unpleasant and unappealing. These findings highlight the rapid spoilage that occurs when chicken skin is stored at room temperature, leading to a loss of desirable attributes in a relatively short time.

2. Chilled Storage: Gradual Deterioration with Blistering and Burnt Taste

The marinated and fried chicken skin stored under chilled conditions exhibited a gradual decline in quality over several days. Initially, the negative changes were less pronounced compared to room temperature storage. However, the fried skin developed a blackish hue early on, likely due to changes in moisture or fat content. By the second day, a distinct burnt

flavor emerged, worsening as the chilling process disrupted heat distribution during frying. By the third day, blistering was observed, likely caused by trapped moisture expanding under high heat, which adversely affected the appearance and texture. Despite the slower deterioration compared to room temperature, the development of blisters and burnt flavor rendered the product unsuitable for extended storage.

3. Frozen Storage: Preservation with Minor Physical Alterations

The marinated and fried chicken skin stored under frozen conditions demonstrated superior preservation, maintaining an appealing color, flavor, and crispiness over an extended period. On the first day, the product exhibited a golden-brown appearance with satisfactory taste and texture. However, after several days of freezing, minor physical alterations such as curling and twisting were observed, which impacted the skin's structure. These changes presented challenges during frying, resulting in uneven cooking. Despite these issues, frozen storage was more effective than room temperature or chilled conditions in preserving the product's overall quality and sensory attributes.

Meat stored improperly deteriorates quickly, resulting in sensory defects and spoilage. The storage environment significantly influences the shelf life and quality of fried chicken skin [34]. Room temperature storage results in rapid spoilage, characterized by an unpleasant oily smell, darkened appearance, and loss of crispiness and taste. Chilled storage slows down deterioration but causes blistering, a burnt taste, and color changes. Frozen storage effectively preserves appearance, taste, and texture for longer periods, although it introduces physical alterations such as curling and twisting, complicating the frying process. Overall, freezing is the most effective method for maintaining quality, though adjustments in frying are necessary to address these physical changes.

IV. CONCLUSION

A comprehensive evaluation of chicken skin from four suppliers identified AG's chicken skin as the best option for producing Crispy fried chicken skin due to its superior quality and minimal imperfections, such as fewer black spots, red spots, and feathers, along with a desirable whitish hue. Storage conditions were also assessed, revealing that room temperature and chilled storage led to rapid deterioration, causing the product to lose its crispiness and develop undesirable sensory characteristics. In contrast, freezing proved to be the most effective storage method, preserving the skin's appearance, flavor, and texture over an extended period, despite some physical alterations like curling and twisting that complicated the frying process. To ensure consistent quality in large-scale production, further refinement of frying techniques for frozen chicken skin is recommended. In conclusion, AG's chicken skin is the optimal choice for production, and freezing is the best method for maintaining product quality.

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CONFLICT OF INTEREST

No potential conflicts of interest are disclosed by the authors.

USE OF ARTIFICIAL INTELLIGENCE (AI) TOOLS STATEMENT

We used Grammarly (Grammarly Inc., 2025) to improve the clarity and grammar of the manuscript. The authors reviewed and approved all changes.

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