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Comprehensive Study of Profiling The Physicochemical Characteristics of Chili Powder From Three Varieties (Red Curly Chili, Red Bird's Eye Chili, and Ghost Pepper)

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A B S T R A C T

This research aimed to examine the physicochemical characteristics of chili powder from three varieties, namely curly chili (*Capsicum annuum*), bird's eye chili (*Capsicum frutescens*), and ghost pepper (*Capsicum chinense*), which were dried using a food dehydrator at 65 °C for 10 hours. Analyses included physical parameters (length, width, weight, and colour), chemical composition (moisture, ash, fat, protein, and carbohydrate content), and antioxidant activity measured by the DPPH method. The results showed significant differences in morphology and nutritional composition among the varieties. Curly chili exhibited the highest protein content (12.35%) and carbohydrate content (65.68%), while ghost pepper had the highest ash content (6.50%) and fat content (10.17%). In contrast, bird's eye chili generally fell within the intermediate range for most parameters. The antioxidant activity of all varieties showed high inhibition values (>80%), ranging from 81.33% to 86.46%, although the differences were not statistically significant. Thus, all chili powder varieties met the Indonesian National Standard (SNI) quality requirements and have the potential to be developed as functional food products with longer shelf life.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero hunger
SDG 3: Good health and well-being
SDG 8: Decent work and economic growth
SDG 12: Responsible consumption and production

1. INTRODUCTION

1.1. Research Background

Chili (*Capsicum sp*) is an essential horticultural commodity in Indonesia; however, its shelf life is limited due to its high moisture content. Therefore, postharvest processing, such as drying, is required to increase the product's added value and storage stability, notably by converting it into chilli powder. West Sumatra is renowned for its rich culinary traditions, with several of its dishes recognized among the world's best foods [1]. Chilli, however, is a perishable horticultural commodity due to its high water content and fluctuating prices, which often result in losses for farmers. Processing is thus necessary to extend its shelf life through efficient methods that maintain bioactive compounds. One widely applied technique is drying, a process that reduces moisture content to a safe storage limit. This method can inhibit microbial growth, preserve flavor and nutritional value, extend shelf life, and reduce product weight and volume, thereby lowering packaging, storage, and distribution costs. Hence, drying is considered an effective form of chili processing to ensure long-term availability [2].

Indonesia cultivates various chili varieties, including curly chili (*Capsicum annuum*), bird's eye chili (*Capsicum frutescens*), and ghost pepper (*Capsicum chinense*). Each variety exhibits distinct morphological traits, spiciness levels, and bioactive compound content. However, few studies have systematically compared the effect of drying on the characteristics of chili powder from these three varieties, particularly in terms of physical attributes (length, width, weight, thickness, and color), chemical composition (proximate analysis), and antioxidant activity using the DPPH method. This study provides new insights and innovations for developing chilli powder and extending its shelf life, while also offering profiling data on the physical and chemical characteristics of three chilli varieties (curly chilli, bird's eye chilli, and ghost pepper).

Curly chili, bird's eye chili, and ghost pepper are widely consumed by Indonesians, each with distinct characteristics. Curly chilli is known for its distinctive long, curly shape and moderate spiciness. It contains flavonoids, capsaicin, vitamin C, carotenoids, and phenolic compounds, such as gallic acid and caffeic acid, which are potential antioxidants [3]. Bird's eye chilli is small but high in capsaicin, producing intense pungency. Additionally, its anthocyanin, carotenoid, chlorophyll, and vitamin C contents make it a valuable source of bioactive compounds for functional foods [4]. Meanwhile, ghost pepper has the highest spiciness, characterised by its high capsaicin and flavonoid content, along with a distinctive, strong aroma [5].

Profiling is important for identifying differences in the content and characteristics of a given material. Chilli serves not only as a spice but also as a source of nutrients and antioxidants that contribute to overall health, with varying traits across types. The genus Capsicum comprises more than 200 varieties, distinguished by differences in size, shape, taste, and aroma. Carotenoid pigments are responsible for the characteristic red color of chili, where postharvest color stability is a determinant of quality and price. In bird's eye chili (Capsicum annuum), the color results from a combination of anthocyanins, carotenoids, and chlorophyll. Bioactive compounds such as polyphenols are also present in chili, including gallic acid (154.85 mg/kg), caffeic acid (26.19 mg/kg), p-coumaric acid (1.78 mg/kg), 4-hydroxybenzoic acid (0.36 mg/kg), trans-ferulic acid (0.05 mg/kg), and syringic acid, which have potential health benefits [6].

Indonesia has a diverse range of chili varieties widely cultivated, including curly chili (Capsicum annuum), bird's eye chili (Capsicum frutescens), and ghost pepper (Capsicum chinense). Each variety shows differences in morphology, spiciness, and bioactive compound content. However, systematic studies on the effects of drying on chili powder characteristics from these three varieties remain limited, particularly regarding physical aspects (length, width, weight, thickness, and color), chemical composition (proximate analysis), and antioxidant activity using the DPPH method. This research is expected to make a new contribution to chili development, particularly in extending its shelf life in powder form, while also providing comprehensive information on the physical and chemical profiles of these three varieties.

1.2. Literature Review

Chili peppers hold a significant position as a horticultural vegetable commodity with the largest cultivation area in Indonesia. Data compiled by the Central Statistics Agency and the Directorate General of Horticulture in 2019 indicate that the harvested area of chili peppers exceeds that of other vegetable commodities. Furthermore, Table 1 demonstrates that large chilli peppers are among the five vegetable commodities with the highest national production volumes, alongside mushrooms, potatoes, shallots, and cabbage [7].

Table 1. Production of Chili Peppers and Other Vegetables in 2019

No	Commodity	Production (tons)
1	Shallots	1.576.439
2	Cabbage	1.413.059
3	Potatoes	1.314.654
4	Bird's eye chili	1.374.215
5	Large Chili (group)	1.213.860
6	Mushrooms (group)	33,163

Studying the characteristics of chilli peppers is crucial, as their bioactive compounds can significantly impact human health. Chili peppers contain various polyphenols, including gallic acid (154.85 mg/kg), p-coumaric acid (1.78 mg/kg), 4-hydroxybenzoic acid (0.36 mg/kg), caffeic acid (26.19 mg/kg), trans-ferulic acid (0.05 mg/kg), and syringic acid [6]. Chilli fruits also contain various active chemical compounds, particularly phenolic compounds, predominantly flavonoids and capsaicin [8]. Multiple studies have demonstrated that chili peppers possess significant antioxidant activity. The presence of bioactive compounds such as capsaicin, flavonoids, and vitamin C contributes to their antioxidant capacity. This activity varies depending on the chili variety, extraction method, and plant growth conditions. For instance, studies on bird's eye chili extracts have shown that high levels of capsaicin and flavonoids play a crucial role in enhancing antioxidant activity. This highlights chilli peppers as a potential natural source of antioxidants that can be used in food and health [9].

Drying and powder preparation of chilli samples were carried out in a food dehydrator at 65 °C for 10 hours. The drying process aimed to reduce the chilli's moisture content to below the safe storage limit (<12%), thereby inhibiting microbial growth and extending shelf life while preserving nutritional and bioactive compounds. After drying, the chilli samples were ground in a stainless steel blender, then in a grinder, to obtain finer particles. The resulting powder was then sieved through a 60-mesh sieve to achieve a uniform particle size. This process produced chili powder with a consistent texture and quality, which was subsequently used for further physicochemical and antioxidant analyses.

Fig. 1 The drying process was carried out using a food dehydrator. The dried chillies were ground in a grinder, and the resulting chilli powder was sieved through a 60-mesh Sieve

1.2.1. Physicochemical Characteristics of Chili Powder

Chilli powders derived from different varieties exhibit variations in physicochemical properties, including proximate composition (moisture, ash, fat, protein, and carbohydrates) and colour attributes (L*, a*, b*, chroma, and hue). These characteristics are important indicators of product quality, consumer acceptance, and compliance with Indonesian National Standards (SNI).

1.2.2. Antioxidant Activity of Chili Powder

Chili is rich in bioactive compounds, including capsaicin, flavonoids, and vitamin C, which contribute to its antioxidant capacity. Antioxidant activity, as measured by the DPPH method, reflects the potential health benefits of chilli powder as a natural antioxidant source. The level of antioxidant activity also provides scientific justification for its development as a functional food ingredient.

1.3. Research Objective

This study aims to evaluate and compare the physicochemical characteristics and antioxidant activity of chili powders derived from three varieties—curly chili (Capsicum annuum), bird's eye chili (Capsicum frutescens), and ghost pepper (Capsicum chinense)—processed under controlled drying conditions. The research aims to provide comprehensive profiling to support the development of high-quality chilli powder products with extended shelf life and functional food potential.

2. MATERIALS AND METHODS

The materials used in this study were curly chili (Capsicum annuum var. longum), bird's eye chili (Capsicum frutescens), and ghost pepper (Capsicum chinense), as well as methanol, DPPH solution (2,2-diphenyl-1-picrylhydrazyl), ethanol, distilled water, and other analytical-grade reagents. Moreover, the instruments used included a digital balance, a food dehydrator, a stainless steel blender, a grinder, an 80-mesh sieve, extraction equipment (Soxhlet apparatus and rotary evaporator), a UV-Vis spectrophotometer, a Hunter Lab colourimeter, and other standard laboratory equipment. The samples used consisted of 3 types obtained from the same region in West Sumatra. The consideration in selecting the exact location was that the area is a chilli-producing centre, thus considered a central production area for chilli in West Sumatra. The samples were designated as curly chili (CK), bird's eye chili (CR), and ghost pepper (CS). Sampling was conducted in June 2025 without the use of preservatives. The research employed a descriptive and diplomatic research method with three samples. The data were calculated as the mean ± standard deviation.

3. RESULT AND DISCUSSION

3.1. Drying and Powder Preparation

Based on Table 1, it is evident that each chili variety responded differently to the varying drying temperatures and times. At 65 °C for 10 hours, curly chili (CK) and bird's eye chili (CR) had not yet reached a dried condition, while ghost pepper (CS) only showed a "moderately dried" state. This indicates that the temperature was relatively less optimal for reducing moisture content to a safe storage level, particularly for varieties with thicker flesh, such as curly chili. Under the treatment of 65 °C for 10 hours, bird's eye chili (CR) and ghost pepper (CS) reached the dried condition, while curly chili (CK) only achieved a moderately dried state. This phenomenon can be explained by morphological differences: curly chilli has thicker skin and flesh, resulting in a slower water diffusion rate than bird's eye chilli, which is small and thin-skinned [10]. Meanwhile, at 65 °C for 10 hours, all varieties (CK, CR, and CS) achieved the dried condition. This demonstrates that extending the drying time at a constant temperature significantly affects achieving the final moisture content. According to Sablani (2006), a combination of higher temperatures (60–70 °C) and longer drying times accelerates water evaporation and reduces the risk of microbial growth in food products [11].

Table 2. Drying time and temperature

Sample (Sample code)	Treatment (Temperature & time)		
	60°C & 7h	65°C & 7h	65 °C & 10h
Curly chili (CK)	Not dried	Moderately dried	Dried
Bird's eye chili (CR)	Not dried	Dried	Dried
Ghost paper (CS)	Moderately dried	Dried	Dried

Thus, it can be concluded that drying at 65 °C for 10 hours is the most effective condition for producing dried chili in all

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varieties. However, thicker-fleshed varieties require a longer duration to reach the stable storage moisture limit [12].

Chili Powder Preparation: All required materials were prepared, and the chili samples were sorted. Curly chili, bird's eye chili, and ghost pepper were cleaned under running water to remove dirt. The stems were removed, all chili varieties were air-dried or wiped with tissue and then dried in a food dehydrator at 65 °C for 10 hours, after 10 hours, the dried chilies were ground using a grinder until a fine powder was obtained, the chili powder was sieved using an 80-mesh sieve, and t he sieved chili powders from all three varieties were then packaged in plastic.

3.2. Color Measurement and Physical Analysis

Table 3. Color analysis of Chili Powder

Variety	L*	a*	b*	Hue (°)	Chroma	Color Interpretation
CK	37.82	36.44	21.82	31.0	55.65	Dominant red, slightly yellowish
CR	42.87	13.48	22.05	58.2	50.12	Yellowish-red (more yellow)
CS	53.89	26.74	29.36	47.8	67.15	Bright red-orange (vivid and intense)

Colour analysis of chilli powder revealed that each variety exhibited distinct visual characteristics, as determined by the parameters a*, b*, Hue, and Chroma. The measurements showed that curly chilli (CK) powder had an a* value of 36.44, a b* value of 21.82, a Hue of 31.0°, and a Chroma of 55.65, indicating a dominant red colour with a slight yellowish tinge. Meanwhile, bird's eye chili (CR) powder presented a lower a* value of 13.48, a b* value of 22.05, Hue of 58.2°, and Chroma of 50.12, corresponding to a yellowish-red appearance. In contrast, ghost pepper (CS) powder displayed an a* value of 26.74, a b* value of 29.36, a Hue of 47.8°, and the highest Chroma value of 67.15, resulting in a bright red-orange colour that appeared more vivid than those of the other varieties. These findings suggest that the drying and processing of chilli into powder significantly influence colour intensity, as indicated by increased brightness and differences in the dominance of the red and yellow spectra among varieties.

These results are consistent with previous studies, which report that the color parameters of dried or powdered chili products are strongly influenced by the degradation of carotenoid and anthocyanin pigments during drying and storage. Carotenoid pigments, particularly capsanthin and capsorubin, are the primary determinants of the red color in chili, while the presence of β-carotene contributes more to the orange-yellow hue. Topuz and Ozdemir (2007) demonstrated that changes in a* and b* values in chili powder are closely related to the drying method applied, with higher drying temperatures tending to reduce red intensity due to capsanthin degradation [13].

The present findings also support the observation that CR powder had lower red intensity compared to CK and CS, making it appear more yellowish. In addition, Díaz et al. (2019) emphasised that Hue and brightness values in chilli powder can serve as indicators of visual quality, as consumers generally prefer products with bright, stable colours [14]. In this study, the CS variety, with the highest Chroma value (67.15), was judged to have the best colour quality, as its powder appeared brighter and more visually appealing. This finding is consistent with Arias et al. (2000), who stated that the stability of carotenoid pigments in dried chili strongly influences consumer perception of quality [15].

Furthermore, colour variation among chilli varieties is influenced by genetic factors that determine the levels of dominant pigments. According to Wahyuni et al. (2013), genetic variation in chilli can result in significant differences in capsanthin, β-carotene, and anthocyanin content, ultimately leading to colour spectra ranging from deep red to orange-yellow. Therefore, the distinctive colour of CR powder compared to CK and CS was influenced not only by processing factors but also by genetic factors that limit the production of red pigments [16].

In conclusion, this study reinforces previous findings that a combination of drying processes, pigment degradation, and varietal diversity strongly determines the visual quality of chili powder. The bright colour of chilli powder, particularly the CS variety, demonstrates strong potential for consumer acceptance due to its visually appealing appearance, which also indicates relatively higher carotenoid content.

Table 4. Physical analysis (length, diameter, and weight of fresh chili)

Variety	Length (cm) ± SD	Diameter (cm) ± SD	Weight (g) ± SD
Curly Chili	11.88 ± 2.10	0.73 ± 0.11	2.59 ± 0.61
Ghost Pepper	5.90 ± 0.89	0.96 ± 0.20	3.42 ± 1.00
Bird's Eye Chili	3.14 ± 0.44	0.62 ± 0.11	0.77 ± 0.17

Based on Table 3, the physical analysis results showed significant differences among chilli varieties in length, diameter, and fruit weight. Curly chili had the highest average length (11.88 ± 2.10 cm), while bird's eye chili had the lowest (3.14 ± 0.44 cm). These distinct differences in fruit length are consistent with the morphological description of chili, where curly chili is characterized by its long and slender shape. In contrast, bird's eye chilli is short and has a smaller diameter [17]. Morphological variation is influenced by both genetic factors of the varieties and growing environmental conditions.

For the diameter parameter, ghost pepper exhibited the highest average diameter (0.96 ± 0.20 cm), which was significantly different from curly chili and bird's eye chili. This indicates that although ghost pepper is relatively short, its larger diameter gives it a plumper fruit. Similar findings were reported by Hidayat et al. (2020), who noted that differences in fruit diameter among chili varieties serve as key characteristics for identifying horticultural varieties [18].

Meanwhile, fruit weight measurements showed that ghost pepper had the highest weight (3.42 ± 1.00 g), which was significantly higher than that of the other varieties. In contrast, bird's eye chili had the lowest weight (0.77 ± 0.17 g). This demonstrates a positive correlation between fruit diameter and weight, as reported by Santoso et al. (2019), who found that the larger the diameter of chili fruits, the higher the fruit weight [19].

Furthermore, weight differences among varieties may also be related to factors such as water content, flesh structure, and fruit thickness [20]. Overall, these results reinforce previous findings that morphological variation among chilli varieties is diverse and significant. This finding is important as a reference for chilli profiling, the selection of high-quality fruits, plant breeding programs, the development of superior varieties, and the standardisation of horticultural products to meet market needs [21].

3.3. *Proximate analysis*

Table 5. Proximate Composition of Chili Powder

Sample	Moisture Content (%) (Mean ± SD)	Ash Content (%) (Mean ± SD)	Fat Content (%) (Mean ± SD)	Protein Content (%) (Mean ± SD)	Carbohydrate Content (%) (Mean ± SD)
CK	8.50 ± 0.13	5.10 ± 0.02	8.20 ± 0.05	12.35 ± 0.15	65.68 ± 0.15
CR	7.80 ± 0.10	5.85 ± 0.10	9.50 ± 0.10	11.90 ± 0.13	64.77 ± 0.10
CS	6.93 ± 0.04	6.50 ± 0.05	10.17 ± 0.08	11.50 ± 0.09	64.88 ± 0.05

Moisture content was determined by the gravimetric method, which measures the reduction in sample weight due to water evaporation at approximately 100 °C. Moisture is a crucial parameter for evaluating the quality of dried food products, such as chilli powder, as it significantly affects texture, flavour, shelf life, and product safety [22].

Data in Table 5 show that the highest moisture content was found in CK (8.50 ± 0.13%), followed by CR (7.80 ± 0.10%), while the lowest was observed in CS (6.93 ± 0.04%). These differences indicate variations in water content among chilli varieties, which may be influenced by factors such as pericarp thickness, tissue structure, and fibre content. Compared with quality standards, all chili powder samples still met the safety criteria. According to SNI 01-3709-1995 for chili powder, the maximum allowable moisture content is 12% to prevent mold growth and ensure stability during storage [23]. The highest value in this study (8.50%) was still well below the threshold, confirming that all chili powders complied with the national quality standard. These results are consistent with Widyawati et al. (2021), who reported that low moisture levels in chili powder improve storage stability and reduce the risk of quality deterioration [24]—similarly emphasized that varietal differences in chili affect water content due to variations in morphology and pericarp thickness, where thicker fruit tissues tend to retain more water. International studies also support these findings; for instance, Hwang et al. (2019) reported that moisture content is a key factor in determining the stability of colour, aroma, and functional properties of chilli powder during storage [25]. Ramesh et al. (2020) further demonstrated that low moisture (<9%) helps maintain the stability of carotenoid pigments responsible for the red colour of chilli powder, thereby preserving its sensory appeal for a longer period [26].

Ash content, which represents the total mineral composition of a food product, was determined by ashing at high temperatures. The results in Table 5 show that CS had the highest ash content (6.50 ± 0.05%), followed by CR (5.85 ± 0.10%), while CK had the lowest (5.10 ± 0.02%). These differences are likely due to varietal variation, as each chili variety has a distinct mineral content that depends on plant physiology, soil fertility, and growing conditions. According to SNI 01-3709-1995, the maximum permissible ash content in chili powder is 8% [23]. Thus, all treatments in this study were within the safe limits and conformed to the national quality standard.

Physiologically, lipid accumulation in chili fruits is localized in the mesocarp and seed tissues. Varieties with larger seed mass or lipid-storing tissues tend to have higher fat content after drying [27]. The fat content analysis in this study revealed significant differences among varieties: CS had the highest fat content (10.17 ± 0.08%), followed by CR (9.50 ± 0.10%), with CK being the lowest (8.20 ± 0.05%). These differences may be attributed to varietal genotypes, fruit physiology (including the flesh-to-seed ratio), and tissue composition that stores lipids [28]. This finding aligns with Kurniawan and Dewi (2020), who reported that certain chilli varieties, such as ghost pepper and bird's eye chilli, have higher lipid levels than curly chilli, resulting in distinct nutritional profiles [29]. International studies also indicate that the lipid content in chili is influenced by agronomic factors, such as soil fertility, fertilization, and drying conditions (temperature and duration), which may alter non-lipid mass losses and, consequently, affect the relative fat percentage [30].

Protein content analysis revealed significant variation among the three chili varieties. CK showed the highest protein content (12.35 ± 0.15%), followed by CR (11.90 ± 0.13%), while CS had the lowest (11.50 ± 0.09%). These findings suggest that each chili variety possesses unique genetic and environmental factors that affect protein biosynthesis in fruit tissues. The coefficient of variation (1.04%) indicated that the data were relatively homogeneous, making the results representative of the population. The higher protein content in CK may be attributed to genetic and physiological factors, as this variety typically produces longer fruits with relatively thicker flesh (Kurniawan, 2021). Drying treatment also influences the measurable protein content; although proteins are not volatile, excessively high drying temperatures may cause partial denaturation, slightly reducing protein values. Mulyani et al. (2018) reported that moderate drying temperatures (60–70 °C) can preserve protein levels in food without significant degradation. Thus, the slight differences observed among varieties may also be attributed to varietal responses to the drying treatment [32].

Carbohydrate content analysis revealed that all chili powder varieties had relatively high levels, ranging from 64.77% to 65.68%. The highest carbohydrate content was found in CK (65.68 ± 0.15%), followed by CS (64.88 ± 0.05%), while CR had the lowest (64.77 ± 0.10%). The low standard deviations (0.05–0.15) indicated consistent and homogeneous data, strengthening the reliability of the results. These findings align with the general characteristics of chilli fruits, in which carbohydrates are the most significant component after water. The carbohydrate content of dried chilli ranges from 60% to 70%, depending on the variety and drying method [33]. The higher carbohydrate content in CK may be associated with its longer fruit size and thicker flesh, which allow greater accumulation of structural and non-structural carbohydrates. Conversely, bird's eye chilli, with its smaller, thinner fruit, showed relatively lower carbohydrate levels [34]. Drying reduces moisture content, thereby increasing the percentage of solid components such as carbohydrates. Pratama

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et al. (2018) noted that moderate drying temperatures (60–70 °C) not only effectively reduce moisture content but also preserve carbohydrate stability [35].

3.4 Antioxidant Activity

The DPPH (1,1-diphenyl-2-picrylhydrazyl) antioxidant assay is a simple in vitro technique used to evaluate a sample's free radical-scavenging capacity. The principle of this assay is based on the reaction between the stable purple DPPH radical and antioxidant compounds capable of donating an electron or a hydrogen atom, resulting in a colour change to pale yellow, which is detected at 517 nm.

Table 5.Antioxidant Activity (%Inhibition) of Chili Powder

Treatment	Antioxidant Activity (% Inhibition) (Mean ± Standard Deviation)
CK	81.33 ± 6.89
CR	83.63 ± 10.51
CS	86.46 ± 8.43

The results of this study showed that all three chili extracts (CK, CR, CS) exhibited very high antioxidant activity based on the DPPH method, with average inhibition percentages of 81.33 ± 6.89% (CK), 83.63 ± 10.51% (CR), and 86.46 ± 8.43% (CS), respectively. Inhibition values above 80% consistently demonstrate the samples' strong ability to neutralise DPPH free radicals. Statistical tests (ANOVA and Tukey HSD, $\alpha = 0.05$) indicated that differences among the varieties were not significant; therefore, although CS had the highest mean, it cannot be considered statistically superior to CK or CR.

This phenomenon is consistent with previous findings that chilli peppers (Capsicum annuum L.) are rich in bioactive compounds, such as phenolics, flavonoids, and capsaicinoids, which play an important role in free radical scavenging [36]. Demonstrated that yellow paprika exhibited potent antioxidant activity, with an IC_{50} value of 302.8 ppm, which is still lower than the standard β-carotene. International studies further reinforce these results [37]. That variations in phenolic and capsaicinoid content among Capsicum varieties are closely correlated with antioxidant activity, as measured by DPPH assays [38].

Moreover, these results support the potential of chili peppers as functional food ingredients. Extracts from chili pericarps and seeds exhibit high antioxidant activity, which may provide health benefits, including the prevention of degenerative diseases associated with oxidative stress [39]. Therefore, although no significant differences were observed among the varieties, all chili extracts in this study have the potential to be developed as functional food ingredients with notable antioxidant benefits [40].

In conclusion, the data from this study demonstrated that curly chili tended to be superior in most nutritional parameters (moisture, fat, protein, and carbohydrate content), while ghost pepper had the highest ash content [41]. Overall, all chilli powder varieties tested complied with the national food quality standards (SNI), making them suitable for development into high-quality, safe-for-consumption chilli powder products with promising market potential.

4. CONCLUSION

Based on the results of this study, several conclusions can be drawn. First, drying chilli peppers at 65 °C for 10 hours produced chilli powder that meets the Indonesian National Standard (SNI), indicating that this drying method effectively preserves the raw material's physical and chemical properties. Second, proximate analysis revealed nutritional variations among the varieties: curly chili (Cabai Keriting) had the highest protein (12.35%) and carbohydrate (65.68%) content, while devil chili (Cabai Setan) exhibited the highest ash (6.50%) and fat (10.17%) content, as well as the brightest powder color; bird's eye chili (Cabai Rawit) generally fell in the intermediate range for most proximate parameters, reflecting variety-specific nutritional characteristics. Third, evaluation of antioxidant activity using the DPPH method showed that all varieties exhibited very high antioxidant activity (>80%) with no significant differences, indicating uniform bioactive potential across the samples. Fourth, these results confirm that all three chili powder varieties have potential as functional food products with extended shelf life, supporting their further development in the health food and functional supplement industries.

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