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NUTRITIONAL CONTENT AND ORGANOLEPTIC ACCEPTANCE OF DANGKE AND PUMPKIN BASED CHIPS AS A SNACK FOR SCHOOL AGE CHILDREN

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Abstract
Background: School-age children require balanced nutrition to support growth and development; however, the consumption of low-nutrient snacks remains a concern. This study aimed to analyse the nutritional content and acceptance levels of chips made from a combination of dangke and pumpkin as a healthy, local food-based snack alternative for school-age children. **Method:** The study employed a laboratory experiment with a quantitative approach. The study tested three formulations: F0 (0 g pumpkin), F1 (30 g pumpkin), and F2 (60 g pumpkin). Nutritional analysis covered protein, fat, carbohydrate, and vitamin A content, while organoleptic testing involved 30 untrained panellists using a 1–5 hedonic scale. **Results:** The results showed that F0 had the highest fat (32.16%) and carbohydrate (51.75%) content, F1 had the highest protein content (9.77%), and F2 had the highest vitamin A content (399.82 µg/100 g). In the organoleptic test, F0 received the highest scores for colour (4.33 ± 0.606) and taste (4.53 ± 0.681), while F1 received the highest scores for aroma (4.27 ± 0.785) and texture (4.47 ± 0.629). Statistical analysis indicated no significant differences ($p>0.05$) in colour, aroma, taste, or texture among formulations F0, F1, and F2. Thus, the three formulations did not differ significantly in terms of panellist acceptance, despite descriptive differences in mean values. **Conclusion:** This study demonstrates that chips combining dangke and pumpkin have the potential to be developed as a local food-based snack alternative with favourable nutritional content and acceptance levels. Future research is recommended to develop formulation variations and conduct testing on the product's physical characteristics and quality.

Introduction

In Indonesia, nutritional issues among school-age children remain a concern due to their impact on growth and development. According to the 2023 Indonesian Health Survey (SKI), the prevalence of stunting among preschool and primary school-aged children (5–12 years) reached 18.7%, while the prevalence of obesity in this age group stood at 19.7%.

Nutritional issues are also evident in Parepare City; data from the 2018 Basic Health Research (Riskesdas) indicate that the prevalence of overweight among primary school children aged 5–12 years in Parepare City reached 15.6%. Furthermore, the high consumption of unhealthy school snacks particularly those high in sugar and fat is a factor requiring attention. Consequently, there is a need to provide more nutritious food options or snacks by utilizing locally available ingredients that can be developed into value-added food products [1].

Local food products with development potential include dangke and pumpkin. Dangke is a specialty food from Enrekang Regency made from cow or buffalo milk and is known as Enrekang cheese [2]. In Enrekang Regency, the milk is preserved or processed as a product called "Dangke" or "Enrekang Cheese" which has high nutritional value [3]. Dangke contains 4.7 g of carbohydrates, 13.32 g of protein, 14.02 g of fat, 9.72 g of crude fiber, and 56.08 g of water per 100 g. This protein content makes dangke a potential protein source for the development of nutritious snacks. However, its high moisture content makes it susceptible to microbial growth, resulting in a relatively short shelf life. Processing it into chips can reduce moisture content, inhibit microbial growth, and extend shelf life, while also creating a crispy texture and a form that is more convenient and appealing to school-aged children [4].

Pumpkin (*Cucurbita moschata*) also has potential as a nutritious food source, as it is rich in β-carotene, a provitamin A, that plays a role in eye health, growth, and the immune system [5]. Every 100 g of pumpkin flesh contains 26 kcal of energy, 1.0 g of protein, 0.1 g of fat, 6.5 g of carbohydrates, 0.426 mg of vitamin A, 9.0 mg of vitamin C, 21 mg of calcium, 44 mg of phosphorus, and 0.8 mg of iron [6]. Pumpkin can be processed into various products, such as chips, thereby offering the potential to enhance value-added and promote food diversification. A combination of dangke and pumpkin was selected due to their complementary nutritional profiles: dangke serves as a source of protein, while pumpkin provides β-carotene [7].

Chips are popular among children and teenagers as a snack. Therefore, they can be developed into a convenient, crunchy snack with improved nutritional value for school-aged children [8]. Furthermore, some school snacks are still found to contain food additives such as colorings, sweeteners, and preservatives that do not meet regulatory requirements [9]. Chips made from a combination of dangke and pumpkin offer an alternative that leverages the natural savory flavor of dangke, potentially reducing the need for additional seasonings [10]. Meanwhile, the β-carotene in pumpkin provides an attractive natural yellow color and has the potential to reduce the need for artificial coloring. However, high-temperature processing particularly frying, can affect β-carotene stability through thermal degradation [11]. Therefore, increasing the amount of pumpkin does not always result in a proportional increase in vitamin A after processing.

Chips were selected due to their convenience, ease of consumption, and the crispy texture favored by school-aged children. Processing ingredients into chips also reduces moisture content, potentially extending shelf life. This study employed three formulations: F0 (0 g), F1 (30 g), and F2 (60 g) of pumpkin. The addition of 30 g and 60 g served as treatment levels to observe changes in the product's nutritional content and organoleptic characteristics. Although dangke and pumpkin have been used separately in various food products, research on combining them into chips as a nutritious snack for school-aged children remains limited. This study offers novelty through the development of chips combining dangke and pumpkin, alongside an evaluation of protein, fat, carbohydrate, and vitamin A content, as well as organoleptic acceptance among school-aged children. The study aimed to analyze the protein, fat, carbohydrate, and vitamin A content, as well as the organoleptic acceptance, of chips combining dangke and pumpkin. The research hypothesis posited that varying the amount of added pumpkin would influence nutritional content but would not result in significant differences in organoleptic acceptance among the formulations.

Materials and Methods

This study employed a laboratory experimental method with a quantitative approach. The research involved three formulations: F0 (0 g pumpkin), F1 (30 g pumpkin), and F2 (60 g pumpkin). The addition of 30 g and 60 g served as incremental treatment levels to observe changes in nutritional content and organoleptic characteristics resulting from the increased pumpkin quantity.

Materials and Preparation

The main ingredients used were 150 g of fresh dangke and pumpkin (*Cucurbita moschata*) specifically 30 g for formulation F1 and 60 g for F2 while formulation F0 contained no pumpkin (0 g). The fresh dangke was obtained from a production site in Cendana District, Enrekang Regency, whereas the pumpkin was purchased fresh from the market. The pumpkin was peeled, washed, cut into pieces, steamed for 10–15 minutes until soft, and then mashed into a puree. The 150 g of dangke was cut into pieces and blended with 130 ml of cow's milk before being mixed with the other ingredients.

Chip Production Process

The production process was carried out sequentially, comprising ingredient preparation, dough mixing, shaping, and frying. The mashed dangke was mixed with the other ingredients according to the specific formulation. Pumpkin was added at levels of 0 g for F0, 30 g for F1, and 60 g for F2. All ingredients were mixed until homogeneous, and the resulting dough was shaped and flattened. The dough was then fried in oil at 170–180°C for 3–5 minutes until cooked and crispy. Finally, the chips were drained and cooled prior to nutritional analysis and organoleptic testing.

Figure 1 Dangke and pumpkin combination chips of formulations F0, F1, and F2

Nutritional Content Analysis

Nutritional content analysis covered protein, fat, carbohydrates, and vitamin A. Protein was analyzed using the Kjeldahl method, fat via the Soxhlet method, and carbohydrates using the Luff–Schoorl method, while vitamin A was analyzed using UV-Vis spectrophotometry. Analyses were performed once for each formulation; consequently, the nutritional content data are presented descriptively, and no inferential statistical analysis was conducted to compare nutritional content across formulations. The vitamin A analysis utilized a pure vitamin A (retinol) standard involving extraction with an organic solvent, followed by absorbance measurement at a wavelength of 450 nm in accordance with laboratory procedures.

Organoleptic Testing

Organoleptic testing was conducted with 30 untrained panelists consisting of school-aged children. Each panelist evaluated formulations F0, F1, and F2 based on color, aroma, taste, and texture using a 1–5 hedonic scale, supplemented by a "Smiley Face Scale" visual aid to help panelists understand the levels of preference. A score of 1 indicated strong dislike, while a score of 5 indicated strong liking. Samples were presented in random order to minimize assessment bias. Panelists were provided with water between sample evaluations to cleanse the oral cavity and reduce the carry-over effect before assessing the next sample.

Data Analysis

Nutritional content data were analyzed descriptively, as each formulation was analyzed only once. Organoleptic data were analyzed using One-Way ANOVA to determine differences in the level of preference among formulations. If significant differences were found, the analysis proceeded with Duncan's Multiple Range Test (DMRT) at a significance level of 5% ($p < 0.05$).

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Research Period

Analyses of protein, fat, carbohydrate, and vitamin A content were conducted at the Feed Chemistry Laboratory, Department of Animal Nutrition and Feed Science, Faculty of Animal Science, Hasanuddin University. Organoleptic testing was carried out in Lapadde Urban Village, Parepare City, involving 30 untrained panelists. The research was conducted from June 23 to 29, 2026.

Research Samples

The research samples consisted of product samples and a panel of participants. The product samples were chips made from a combination of dangke and pumpkin. The panel comprised 30 untrained participants selected using a purposive sampling technique. These participants were students in grades IV, V, and VI at SD Negeri 62 Parepare, aged 9–12 years; they were willing to participate and had obtained consent from their teachers or guardians. Additionally, they had no history of allergies to dangke, eggs, pumpkin, or other ingredients used in the study, and were in good health with no impairments to their senses of taste or smell. Acceptability testing was conducted using an organoleptic test questionnaire with a five-point hedonic scale. Participants were asked to rate four sensory attributes: color, aroma, taste, and texture. Ratings were based on a 1–5 scale: score 1 (dislike extremely), score 2 (dislike), score 3 (neutral/moderately like), score 4 (like), and score 5 (like extremely).

Table 1 Formulation of chips dangke and pumpkin

Ingredient	F0	F1	F2
Dangke (g)	150	150	150
Pumpkin (g)	0	30	60
Glutinous rice flour (g)	180	180	180
Cow's milk (ml)	130	130	130
Egg (butir)	1	1	1
Granulated sugar (g)	60	60	60

Results

Nutritional analysis was conducted to determine the levels of fat, protein, carbohydrates, and vitamin A in each formulation of a local food product a chip snack combining dangke and pumpkin while organoleptic testing aimed to assess panelists' acceptance of the product's color, aroma, taste, and texture.

Table 2 characteristics of organoleptic test panelists

Panelist Characteristics	Number(n)	Percentage (%)
Age (Years)		
9 years	7	23.3
10 years	10	33.3

Panelist Characteristics	Number(n)	Percentage (%)
Age (Years)		
11 years	9	30.0
12 years	4	13.4
Grade		
IV	12	40.0
V	9	30.0
VI	9	30.0
Sex		
Male	7	23.3
Female	23	76.7
Total	**30**	**100**

Based on Table 2, the 30 panelists (100%) were elementary school students in grades 4–6, aged 9–12 years. The largest group of panelists was 10 years old (33.3%) and from grade 4 (40.0%); the group comprised 23 females (76.7%) and 7 males (23.3%). These characteristics align with the study's target demographic school-aged children as potential consumers of the dangke and pumpkin combination chips thereby enabling them to evaluate the product's level of acceptance.

Table 3 Nutritional content analysis results of dangke and pumpkin combination chips

Sample Code	Crude Fat (%)	Crude Protein (%)	Carbohydrate (%)	Vitamin A (µg/100 g)
F0	32.16	9.58	51.75	302.89
F1	29.54	9.77	51.35	398.69
F2	32.04	9.35	50.72	399.82

Based on Table 3, laboratory analysis results indicate variations in the nutritional content of each formulation of dangke and pumpkin chips. Fat content ranged from 29.54% to 32.16%, protein from 9.35% to 9.77%, and carbohydrates from 50.72% to 51.75%. Vitamin A content showed an increase from 302.89 µg/100 g in F0 to 398.69 µg/100 g in F1 and 399.82 µg/100 g in F2. However, the increase in Vitamin A from F1 to F2 was relatively small, amounting to 1.13 µg/100 g. Protein and carbohydrate contents tended to decrease in F2, whereas fat content showed fluctuations across the formulations.

Table 4 Organoleptic test results for dangke and pumpkin chips

Parameter	Mean hedonic test score of samples		
	F0	**F1**	**F2**
	Mean± SD	**Mean± SD**	**Mean± SD**
Color	4.33 ± 0.606 ^{a}	4.30 ± 0.952 ^{a}	3.93 ± 0.907 ^{a}
Aroma	4.23 ± 0.728 ^{a}	4.27 ± 0.785 ^{a}	4.03 ± 0.999 ^{a}

Parameter	Mean hedonic test score of samples		
	F0	F1	F2
	Mean± SD	Mean± SD	Mean± SD
Taste	4.53 ± 0.681 [a]	4.40 ± 0.855 [a]	4.23 ± 0.898 [a]
Texture	4.30 ± 0.651 [a]	4.47 ± 0.629 [a]	4.13 ± 1.008 [a]

Note: Values are presented as mean ± SD. Values followed by the same letter in the same row indicate no significant difference based on One-Way ANOVA (p > 0.05).

Based on Table 4, all formulations received acceptance scores falling within the "liked" category. Descriptively, F0 exhibited the highest scores for color and taste, whereas F1 achieved the highest scores for aroma and texture. F2 tended to have lower acceptance scores than F0 and F1 across all attributes, particularly regarding color. Despite descriptive differences in mean values, One-Way ANOVA results indicated no significant differences (p > 0.05) in color, aroma, taste, or texture among F0, F1, and F2. Thus, increasing the addition of pumpkin up to 60 g did not result in a significant difference regarding the organoleptic acceptance of the chips.

Discussion

Nutritional Content Analysis of Dangke and Pumpkin Combination Chips

Based on Table 3, laboratory analysis results indicate variations in the nutritional content of each formulation of dangke and pumpkin combination chips. Fat content ranged from 29.54% to 32.16%, protein from 9.35% to 9.77%, carbohydrates from 50.72% to 51.75%, and vitamin A from 302.89 to 399.82 µg/100 g. These differences in values descriptively indicate changes in nutritional composition associated with the addition of pumpkin. However, as statistical analysis of the nutritional content was not performed, the differences between formulations cannot be declared statistically significant.

The fat content was 32.16% for F0, 29.54% for F1, and 32.04% for F2. The relatively high fat value in F0 is thought to be related to the absence of added pumpkin, resulting in a comparatively larger proportion of dangke, milk, and eggs ingredients that contribute to fat content within the formulation. Additionally, the frying process can lead to oil absorption into the product matrix, thereby influencing the final fat content. Research results [12]. The results for the dangke-moringa sticks indicate that processed dangke products can have a relatively high fat content specifically 42.93% and highlight the importance of considering raw materials and processing methods when determining a product's nutritional profile. Discrepancies between those findings and the current study may stem from differences in ingredient composition and product type. The relatively similar fat content observed in formulations F0 and F2 suggests that the addition of pumpkin did not result in a consistent change in fat levels. Consequently, differences in fat content across formulations should be interpreted as descriptive variations rather than evidence that one formulation is superior in terms of fat content.

The protein content was 9.58% for F0, 9.77% for F1, and 9.35% for F2. Although F1 exhibited the highest numerical protein value, the difference between F0 and F1 was only 0.19%. This relatively small difference is insufficient to conclude that F1 holds a protein advantage over F0. The protein value in F1 is likely attributable to an ingredient composition that retains protein contributions from dangke, milk, and eggs. Conversely, the decrease in protein content observed in F2 may be linked to the increased proportion of pumpkin, which has a relatively lower protein content than the animal-based ingredients used. Incorporating larger amounts of ingredients with lower protein content can result in a dilution effect on the protein proportion derived from the primary ingredients.

These results align with the study by [13] on the use of pumpkin (Cucurbita moschata) puree in the production of probiotic firm yogurt, which demonstrated that increasing the proportion of pumpkin puree significantly affected protein content. Protein levels decreased from 11.69% in the control treatment (without pumpkin puree) to 9.99%, 9.37%, 7.77%, 5.68%, and 4.43% as the proportion of pumpkin puree increased. This pattern is consistent with the current study, where the protein content of F2 (9.35%) was lower than that of F0 (9.58%) and F1 (9.77%) following the addition of 60 g of pumpkin. Thus, there is a descriptive trend of decreasing protein content in formulations with higher pumpkin additions, although this reduction cannot be deemed statistically significant if the statistical test results do not indicate a significant difference.

Descriptively, the carbohydrate content decreased from 51.75% in F0 to 51.35% in F1 and 50.72% in F2. The relatively higher carbohydrate value in F0 is thought to be associated with the absence of added pumpkin, resulting in a relatively larger proportion of glutinous rice flour a source of carbohydrates. The decrease in carbohydrate values in F1 and F2 may be linked to changes in the proportions of ingredients used in each formulation. Since carbohydrates were calculated using the "by difference" method, the value represents a calculation based on the other analyzed nutritional components. However, as this study did not present data on moisture and ash content, the decrease in carbohydrates cannot be specifically attributed to an increase in moisture or ash levels. Therefore, the changes in carbohydrate content observed in this study are best discussed as a trend related to formulation composition rather than as evidence of a specific underlying mechanism.

The results of this study can be compared with those of study [14], which examined the addition of pumpkin puree to gluten-free arrowroot cookies. That study utilized pumpkin puree in various formulations and analyzed proximate composition, including carbohydrate content. The results showed that the selected formulation containing pumpkin puree had a carbohydrate content of 49.61 g/100 g. These findings indicate that the use of pumpkin puree can influence the product's nutritional composition, although changes in carbohydrate levels cannot be directly attributed solely to the addition of the puree, given that carbohydrate content is calculated based on other proximate components. This aligns with the findings of the present study, where carbohydrate content descriptively decreased from 51.75% in F0 to 51.35% in F1 and 50.72% in F2.

Vitamin A content showed an upward trend with the increased addition of pumpkin: rising from 302.89 μg/100 g in F0 to 398.69 μg/100 g in F1 and 399.82 μg/100 g in F2. This trend can be attributed to the inclusion of pumpkin (Cucurbita moschata) in the formulation. These findings align with a study [15] on the use of pumpkin puree in flake production, which reported a vitamin A content of 102.50 mg per 100 g of flakes. That study demonstrated that pumpkin puree could serve as an ingredient in developing vitamin A-rich food products.

However, the increase in vitamin A content from F1 to F2 was only 1.13 μg/100 g. This indicates that increasing the pumpkin content from 30 g to 60 g did not yield a rise in vitamin A levels proportional to the increase in the amount of pumpkin used. Thus, although the pumpkin content in F2 was double that of F1, the resulting increase in vitamin A in the final product was relatively small. This suggests that the increase in vitamin A content does not always occur in direct proportion to the quantity of added ingredients and may be influenced by the product processing method. Vitamin A levels were not measured before and after frying, nor were frying temperature and duration specifically analyzed. Consequently, the frying process may have influenced vitamin A content, potentially contributing to the minimal increase observed between F1 and F2. However, this effect cannot be confirmed, as it was not specifically tested in this study.

Overall, the nutritional analysis revealed distinct patterns across the formulations. F0 exhibited the highest numerical values for fat and carbohydrates; F1 showed the highest numerical value for protein; and F2 displayed the highest numerical value for vitamin A. However, since statistical analysis of the nutritional content was not performed, these values cannot be used to claim that one formulation is statistically superior to another. Instead, the results are more appropriately used to indicate trends in nutritional content changes resulting from varying proportions of dangke and pumpkin.

Contribution to Meeting the Nutritional Needs of School-Age Children

Chips made from a combination of dangke and pumpkin have the potential to contribute to meeting the nutritional needs of school-age children. Research results indicate that a 50 g serving of the F1 product contains approximately 4.89 g of protein and 199.35 μg of vitamin A. Consequently, a 50 g serving of F1 can supply approximately 8.7–10.0% of the protein requirements and about 33.2% of the vitamin A requirements for children aged 10–12 years. These figures are based on the Recommended Dietary Allowances (AKG) for school-age children: 56 g/day of protein for boys and 60 g/day for girls aged 10–12 years, and 600 μg/day of vitamin A. Therefore, this product serves as a snack alternative that not only provides energy but also contributes to the protein and vitamin A intake of school-age children.

Organoleptic Evaluation of Dangke and Pumpkin Chips

Based on Table 4, all formulations achieved mean scores above 4.00, placing them descriptively in the category of being liked by the panelists. Regarding the color parameter, F0 obtained a mean score of 4.33 ± 0.606, F1 scored 4.30 ± 0.952, and F2 scored 3.93 ± 0.907. For the aroma parameter, F1 obtained a mean score of 4.27 ± 0.785, F0 scored 4.23 ± 0.728, and F2 scored 4.03 ± 0.999. Regarding the taste parameter, F0 obtained a mean score of 4.53 ± 0.681, F1 scored 4.40 ± 0.855, and F2 scored 4.23 ± 0.898. Meanwhile, for the texture parameter, F1 obtained a mean score of 4.47 ± 0.629, F0 scored 4.30 ± 0.651, and F2 scored 4.13 ± 1.008. Although there were differences in mean values at a descriptive level, all formulations shared the same letter notation (a) for each organoleptic parameter. Statistical analysis results indicated no significant differences ($p > 0.05$) among F0, F1, and F2 regarding color, aroma, taste, and texture. Therefore, the differences in mean values between formulations can only be interpreted as descriptive differences rather than statistically significant differences in the level of preference.

Regarding the color parameter, F0 achieved the highest mean score, while F2 achieved the lowest. Descriptively, the decrease in the score for F2 is thought to be related to the addition of pumpkin, which can impart an increasingly intense yellow to orange color. This finding aligns with research [16] regarding cookies substituted with pumpkin puree and mung bean flour, which indicated that the addition of pumpkin puree could influence the product's color characteristics but did not result in significant differences in color preference scores among treatments. These results align with the present study, in which F2 recorded the lowest color preference score; however, the addition of up to 60 g of pumpkin could not be statistically shown to reduce color acceptance.

Regarding the aroma parameter, F1 yielded the highest mean score, whereas F2 yielded the lowest. Descriptively, the score for F1 suggests a balance between the distinctive aroma of dangke and the natural aroma of pumpkin. In the case of F2, the higher quantity of pumpkin likely made the pumpkin aroma more pronounced. This finding is consistent with research [17] regarding waffles enriched with pumpkin puree. The results indicate that varying the amount of pumpkin puree can influence the product's aroma characteristics. Thus, although descriptive differences in aroma scores were observed among the formulations in this study, the addition of up to 60 g of pumpkin did not show a significant effect on aroma acceptance.

Regarding the taste parameter, F0 received a descriptively higher score, whereas F2 received a lower score. This outcome can be attributed to the distinctive savory flavor of dangke, which is more pronounced in F0. School-aged children are generally accustomed to various snacks characterized by savory flavors and crunchy textures. Furthermore, changes in flavor or the introduction of new tastes can influence children's acceptance, as many tend to prefer familiar flavors. In F1, the savory dangke flavor blends with the natural taste of the pumpkin, resulting in continued high acceptance. Conversely, the higher pumpkin content in F2 yields a sweeter taste and a stronger pumpkin aroma, which descriptively lowers the level of preference. This finding aligns with previous research [18] regarding MOCAF flour cookies substituted with pumpkin puree, the results indicate that varying the amount of pumpkin puree affects panelist acceptance of flavor attributes, with specific formulations proving more acceptable in terms of taste and overall acceptance. Thus, adding an appropriate amount of pumpkin can help maintain the product's flavor acceptability.

Regarding texture parameters, F1 achieved the highest average score, while F2 achieved the lowest. Descriptively, the addition of 30 g of pumpkin in F1 appears to have resulted in a composition that preserved the product's crispness. Conversely, the higher quantity of pumpkin in F2 likely increased the moisture content, potentially compromising the product's crispness. As this study utilized pumpkin puree, the findings can be compared with research [19] which incorporated pumpkin puree at various levels of addition into the product and evaluated its textural characteristics using both instrumental and sensory methods. The results indicated that increasing the amount of pumpkin puree could affect the product's textural characteristics. Thus, variations in the amount of pumpkin in the formulation can influence both textural characteristics and product acceptance.

Overall, organoleptic test results indicate that adding up to 60 g of pumpkin did not result in significant differences regarding organoleptic acceptance. However, descriptively, F2 showed the lowest mean scores across all parameters color, aroma, taste, and texture. This observation should be considered when determining the limit for pumpkin addition during product development. Thus, although F2 remained within the "liked" category and showed no statistically significant difference, increasing the pumpkin content to 60 g revealed a descriptive trend toward lower acceptance. This demonstrates that developing functional food products requires balancing increased nutritional content with the sensory acceptance limits of the target consumers.

Based on a combination of nutritional and organoleptic results, F1 may be considered a relatively balanced formulation from a descriptive standpoint, as it yielded the highest numerical protein content alongside the highest mean scores for aroma and texture. Meanwhile, F2 could be considered if the primary formulation goal is to achieve a descriptively higher Vitamin A content. However, neither of these observations represents a statistically proven advantage, as the nutritional content was not statistically analyzed and the organoleptic parameters showed no significant differences.

Study Limitations

This study has several limitations. First, the analysis of nutritional content is presented descriptively; thus, it is not yet known whether the differences in nutrient content among the formulations are statistically significant. Second, the study did not measure β-carotene levels before and after the frying process, so β-carotene retention during processing could not be directly determined. Third, frying temperature and duration were not analyzed as factors influencing nutrient retention, particularly that of β-carotene. Fourth, shelf-life testing was not conducted; consequently, the stability of nutritional content and organoleptic characteristics during storage remains unknown. Fifth, no in vivo tests or direct interventions involving children were performed, so the health benefits of consuming the product cannot be concluded. Therefore, future research should include testing for vitamin A retention before and after processing, shelf-life analysis, control of frying temperature and duration, and intervention studies to determine the product's contribution to the nutrient intake of school-aged children.

Conclusion

The nutritional content of the dangke and pumpkin combination chips varied across formulations. Descriptively, the addition of pumpkin tended to increase vitamin A content, whereas protein and carbohydrate levels tended to decrease as the amount of pumpkin increased. Organoleptic test results indicated that all formulations fell into the "liked" category. F0 achieved the highest average scores for color and taste, while F1 achieved the highest scores for aroma and texture. Statistical analysis showed no significant differences ($p > 0.05$) among the formulations regarding the acceptance of color, aroma, taste, and texture.

Descriptively, F1 could be considered the most balanced formulation, as it possessed higher protein content alongside good acceptance of aroma and texture. Meanwhile, F2 showed a descriptively higher vitamin A content but tended to have lower organoleptic acceptance scores. Therefore, future product development needs to consider the balance between increasing vitamin A content and maintaining organoleptic acceptance. The dangke and pumpkin combination chips have the potential to be developed as a snack for school-aged children and could be considered for use in school-based feeding programs or nutrition education initiatives. However, the product's effectiveness in improving children's vitamin A intake or status could not be determined from this study. Consequently, further research is required, specifically intervention trials involving children and evaluations of the product's implementation within school nutrition programs.

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Recommendations

Future research should aim to optimize the formulation specifically by varying the amount of pumpkin puree and analyze the product's physical characteristics, such as color, crispness, and shelf life. Formulation F1 could serve as a starting point for product development, as it demonstrates a balance between nutritional content and organoleptic acceptability. Nutritional education regarding the benefits of pumpkin as a source of vitamin A should also be provided to school-aged children. Furthermore, direct intervention studies involving school-aged children are needed to determine the impact of consuming the product on vitamin A intake and status, as well as to assess its potential utility in school nutrition programs.

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