Journal of Health and Nutrition Research
Vol. 5, No. 2, 2026, pg. 752-763, https://doi.org/10.56303/jhnresearch.v5i2.1524
Journal homepage: https://journalmpci.com/index.php/jhnr/index

e-ISSN: **2829-9760**

Nutritional and Sensory Evaluation of Dangke-Based Nuggets as a Nutrient-Dense Supplementary Food for Stunting Prevention in Indonesia

Mertien Sa'pang[1]*, Harna[2], Abdul Salam[3], Seprianto[4], Titis Retno Sawitri[1]

[1] Department of Dietitian Professional Education, Universitas Esa Unggul, DKI Jakarta, Indonesia
[2] Department of Nutrition Science, Universitas Esa Unggul, DKI Jakarta, Indonesia
[3] Department of Nutrition Science, Universitas Hasanuddin, Indonesia.
[4] Department of Biotechnology, Universitas Esa Unggul, DKI Jakarta, Indonesia

Corresponding Author Email: mertien.sapang@esaunggul.ac.id

ORIGINAL ARTICLES

Submitted: 07 May 2026

Accepted: 14 July 2026

Published: 01 August 2026

Keywords:
Amino Acid, Functional Food, Stunting Prevention, Supplementary Food, Traditional Food

ABSTRACT

Stunting remains a major nutrition challenge among children under five years in Indonesia. The development of nutrient-dense supplementary foods utilizing traditional food resources offers a sustainable strategy for stunting prevention. Dangke, a traditional Indonesian cheese from Enrekang, South Sulawesi, is rich in protein and calcium and has potential as a functional ingredient in supplementary foods for toddlers. This study aimed to develop and evaluate dangke-based nuggets as an alternative supplementary food for toddlers. Four nugget formulations containing different proportions of dangke (0%, 18%, 35% and 52%) were developed and evaluated. Sensory acceptability (taste, color, aroma and texture) was assessed by 25 semi-trained panelists and 26 consumer panelists. Data were analyzed using One-Way ANOVA followed by Duncan's post-hoc test. Proximate analysis, calcium content, and amino acid profiling were performed. Sensory evaluation demonstrated that all formulations were generally acceptable, with F3 receiving the highest consumer preference scores for taste ($p = 0.011$) and texture ($p = 0.024$). Nutritional analysis revealed significant increases in energy, fat, protein, calcium, and several essential amino acids as the proportion of dangke increased ($p < 0.05$). The F3 formulation exhibited the highest nutritional value, containing 235.04 kcal energy, 11.95 g protein, 11.92 g fat, and 329.08 mg calcium per serving. Amino acid analysis showed enhanced levels of alanine, aspartic acid, cystine, methionine, and tryptophan in formulations with higher dangke content. The product shows potential as a locally sourced supplementary food to support toddler nutrition and promote the utilization of traditional Indonesian foods. However, further studies are needed to evaluate its effectiveness in improving dietary intake and nutritional outcomes among young children.

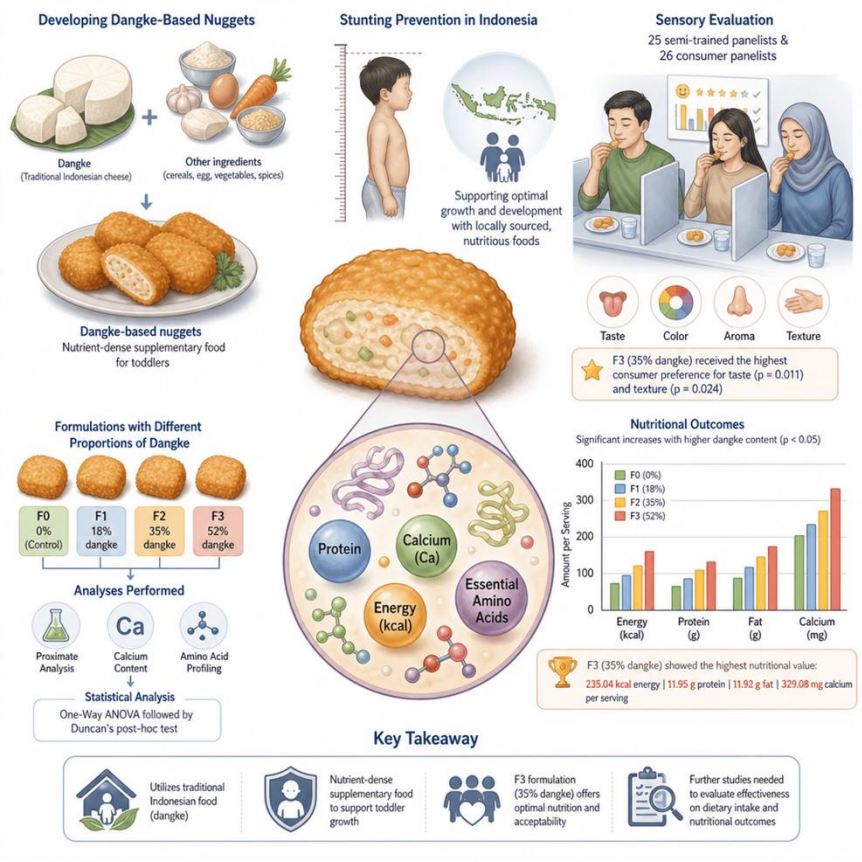
Key Messages:

- The dangke-based nuggets showed potential as a locally sourced supplementary food to support toddler nutrition and contribute to stunting prevention programs while promoting the utilization of traditional Indonesian foods.

Access this article online

Quick Response Code

GRAPHICAL ABSTRACT



INTRODUCTION

Stunting remains one of the most significant public health challenges affecting 23,2 % children under five years of age worldwide in 2024(1). Defined as impaired linear growth resulting in a height-for-age Z-score below −2 standard deviations from the World Health Organization (WHO) growth standard, stunting reflects chronic undernutrition during critical periods of growth and development. Despite considerable progress in reducing malnutrition, the prevalence of stunting remains high in many low- and middle-income countries, including Indonesia. The etiology of stunting is complex and multifactorial. According to the WHO conceptual framework, stunting results from the interaction of immediate, underlying, and basic determinants that influence child growth during the first 1,000 days of life. Immediate causes include inadequate dietary intake and recurrent infectious diseases, while underlying causes encompass food insecurity, inappropriate infant and young child feeding practices, inadequate maternal and childcare, poor sanitation, and limited access to healthcare services. At a broader level, socioeconomic conditions, educational attainment, cultural practices, and environmental factors further contribute to the risk of chronic undernutrition(2–7).

Maternal factors play a particularly important role in determining child growth outcomes. Poor maternal nutritional status during pregnancy, chronic energy deficiency, inadequate antenatal care, low maternal education, and insufficient nutrition knowledge have been consistently associated with an increased risk of stunting. Children born with low birth weight (LBW) are more likely to experience growth faltering and stunting during early childhood. Furthermore, inadequate breastfeeding practices, delayed or inappropriate complementary feeding, insufficient dietary diversity, and low intake of high-quality protein and micronutrients contribute substantially to impaired linear growth. Recurrent infections, often exacerbated by poor sanitation and hygiene conditions, further compromise nutrient absorption and utilization, perpetuating the cycle of malnutrition(4,6,8–10).

Dangke is a traditional cheese originating from Enrekang Regency, South Sulawesi, Indonesia. Produced through the coagulation of fresh cow's milk using papaya latex, dangke has been consumed by

https://doi.org/10.56303/jhnresearch.v5i2.1524

local communities for generations and represents an important component of regional food heritage. Previous studies have reported that dangke is characterized by a high protein content, considerable calcium concentration, and favorable sensory characteristics, making it a promising ingredient for the development of functional food products(11,12). In addition to its nutritional advantages, the utilization of dangke contributes to the preservation of local food culture while supporting regional food systems.

Several studies have investigated the physicochemical characteristics, nutritional composition, and potential health benefits of dangke as a traditional high-protein food(13). Research has also explored the incorporation of dangke into various food products, including biscuits and other processed foods(14). Nevertheless, limited evidence is available regarding the development of dangke-based supplementary foods specifically designed for toddlers and aimed at supporting stunting prevention. This lack of evidence represents an important research gap that must be addressed before such products can be recommended as practical interventions for improving child nutrition.

The development of supplementary foods for young children in an initial evaluation of nutritional composition and sensory acceptability. These findings may provide preliminary evidence to guide the selection of formulations for further research. Nuggets are commonly consumed across different age groups because of their convenient form, acceptable sensory characteristics, and ease of consumption. The development of a nutrient-dense nugget incorporating dangke may offer a potential approach to providing protein, calcium, and essential amino acids for young children. The combination of dangke and oyster mushrooms may also contribute to a favorable nutritional profile while maintaining acceptable sensory characteristics.

Therefore, this study aimed to develop nuggets based on traditional dangke cheese as a locally sourced supplementary food for young children. Specifically, the study evaluated the sensory characteristics, nutritional composition, calcium content, and amino acid profile of several dangke nugget formulations as an initial laboratory-based evaluation to explore formulations with potential for future efficacy studies.

METHODS

This study employed an experimental research design using a Completely Randomized Design (CRD) with four treatment levels. The study was conducted in several stages, including product development, sensory evaluation, and nutritional analysis. Product formulation, sensory testing, and selected laboratory analyses were conducted at the Integrated Laboratory of the Faculty of Health Sciences, Universitas Esa Unggul, Indonesia.

Product development and formulation

The product development stage involved a series of trial-and-error experiments to obtain a dangke-based nugget formulation that met both sensory acceptability and nutritional quality criteria. Several modifications were made to the initial formulation proposed in the research protocol.

Table 1 Formulation of dangke-based nuggets (g)

Ingredients	F0	F1	F2	F3
Dangke (g)	0	18	35	52
Oyster mushroom (g)	70	52	35	18
Egg (g)	15	15	15	15
Corn starch (g)	7,5	7,5	7,5	7,5
Wheat flour (g)	7,5	7,5	7,5	7,5
Bread crumbs (g)	5	5	5	5

Sensory Evaluation

Sensory evaluation was performed to assess both the sensory quality and consumer acceptability of the developed nugget formulations. The sensory attributes evaluated included color, aroma, taste, and texture. The hedonic quality test was conducted by 25 semi-trained panelists. The hedonic quality test was conducted by 25 semi-trained panelists using a 10-point Visual Analogue Scale (VAS), where higher scores

https://doi.org/10.56303/jhnresearch.v5i2.1524

indicated greater intensity or quality of the evaluated sensory attribute. The number of semi-trained panelists was selected based on sensory evaluation recommendations, indicating that 15–25 semi-trained panelists may be used for sensory quality assessment (15). The sensory quality attributes assessed included color, aroma, taste, and texture. The hedonic acceptance test was conducted by 26 consumer panelists recruited from Posyandu cadres in Parung Panjang, the community research partner. The hedonic acceptance test was conducted by 26 untrained panelists using a 4-point hedonic scale (1 = dislike, 2 = slightly dislike, 3 = like, and 4 = highly like) to determine consumer preference toward the nugget formulations. The number of untrained panelists was selected with reference to sensory evaluation guidelines suggesting that more than 25 untrained panelists may be involved in hedonic testing to assess product preference and acceptability (15,16).

General eligibility criteria for all panelists included: (1) willingness to participate in the sensory evaluation; (2) absence of illness and not being in a state of hunger or excessive fullness during testing; and (3) no known allergies or aversions to the ingredients used in the study. Drinking water was provided as a palate cleanser between sample evaluations to minimize carry-over effects and maintain sensory sensitivity.

Nutritional Analysis

Nutritional analysis were conducted in two replications for each measurement. Nutritional analysis were performed at PT Saraswanti Indo Genetech Laboratory, Indonesia. Moisture content was determined according to SNI 6683:2014, ash content according to SNI 01-2891-1992, total fat content using the gravimetric method, and protein content using the titrimetric method. The results were used to determine the nutritional composition of each nugget formulation.

Calcium content was determined using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). This method provides accurate quantification of mineral concentrations in food products and was used to evaluate the contribution of dangke to the calcium content of the nugget formulations.

Amino acid profiling was conducted to determine the content of essential and non-essential amino acids in the selected formulations. Analyses were performed by an accredited laboratory (PT Saraswanti Indo Genetech, Bogor, Indonesia). For the determination of L-alanine, L-arginine, L-aspartic acid, glycine, L-glutamic acid, L-histidine, L-isoleucine, L-leucine, L-lysine, L-valine, L-phenylalanine, L-proline, L-serine, L-threonine, and L-tyrosine, samples were hydrolyzed with HCl, filtered through a 0.2 μm syringe filter, mixed with an internal standard, derivatized, and analyzed using Ultra Performance Liquid Chromatography coupled with Photodiode Array Detection (UPLC-PDA). The analysis followed the Waters Acquity UPLC H-Class Amino Acid Analysis System Guide (17). L-cystine and L-methionine were determined using Liquid Chromatography–Tandem Mass Spectrometry (LC-MS/MS). Samples were subjected to oxidation, followed by acid hydrolysis at 110°C for 21 h, pH adjustment to 2.20, centrifugation, filtration through a 0.2 μm membrane filter, and LC-MS/MS analysis. The method followed Commission Regulation (EC) No. 152/2009 for amino acid determination. L-tryptophan was analyzed separately using High Performance Liquid Chromatography coupled with Photodiode Array Detection (HPLC-PDA). Samples were hydrolyzed with 4.2 M NaOH at 110°C for 20 h, adjusted to pH 4.25 using citrate buffer, centrifuged, filtered through a 0.45 μm syringe filter, and injected into the HPLC system. The analysis was performed according to AOAC Method 988.15.

Statistical Analysis

Data from sensory evaluation were analyzed using One-Way Analysis of Variance (One-Way ANOVA) to determine differences among the four nugget formulations. When significant differences were identified ($p < 0.05$), Duncan's Multiple Range Test (DMRT) was applied as a post-hoc analysis to identify specific differences between treatment groups. Results are presented as mean ± standard deviation (SD). Statistical analyses were performed using SPPS version 29.0.

https://doi.org/10.56303/jhnresearch.v5i2.1524

CODE OF HEALTH ETHICS

This research procedure has passed ethical review by the Esa Unggul University Research Ethics Commission with number 0923-10.063/DPKE-KEP/FINAL-EA/UEU/X/2023.

RESULTS

Sensory Evaluation

Hedonic Quality Test

The hedonic quality test results are presented in Table 2. Significant differences among formulations were observed only for color (p = 0.011), whereas taste (p = 0.383), aroma (p = 0.129), and texture (p = 0.941) did not differ significantly. The highest color score was observed in F3 (6.96 ± 2.05), indicating that increasing the proportion of dangke contributed to a more desirable color characteristic. No significant differences were found for taste, aroma, and texture, suggesting that the substitution of oyster mushroom with dangke did not negatively affect the overall sensory quality of the nuggets.

Table 2 Hedonic Quality Scores of Dangke-Based Nugget Formulation

Variable	Mean ± SD				p-value*
	F0	F1	F2	F3	
Taste	6.52±1.85 [a]	7.16±1.49 [a]	7.20±1.71 [a]	6.56±2.18 [a]	0.383
Color	5.00±2.06 [a]	5.52±2.00 [a]	5.92±2.24 [ab]	6.96±2.05 [b]	0.011*
Aroma	6.36±1.75	6.12±1.94	6.88±1.72	7.28±2.05	0.129
Texture	6.32±1.87	6.44±1.58	6.24±1.86	6.12±2.09	0.941

*Different superscript letters within a row indicate significant differences according to Duncan's Multiple Range Test (p < 0.05).

Hedonic Acceptance Test

The hedonic acceptance test results are shown in Table 3. Significant differences among formulations were observed for taste (p = 0.011) and texture (p = 0.024), whereas color (p = 0.849) and aroma (p = 0.157) did not differ significantly. F3 obtained the highest score for taste (3.11 ± 0.51) and was significantly preferred compared with the other formulations. In terms of texture, F0 showed the lowest score (2.52 ± 0.51), while F1, F2, and F3 received significantly higher scores. These findings indicate that increasing the proportion of dangke improved consumer acceptance, particularly with respect to taste and texture.

Table 3 Hedonic Acceptance Score of Dangke-Based Nugget Formulation

Variable	Mean ± SD				*p-value**
	F0	F1	F2	F3	
Taste	2.67±0.56 [a]	2.70±0.61 [a]	2.70±0.54 [a]	3.11±0.506 [b]	0.011*
Color	2.85±0.46	2.89±0.32	2.93±0.47	2.81±0.62	0.849
Aroma	2.78±0.42	2.78±0.51	2.96±0.44	3.00±0.48	0.157
Texture	2.52±0.51[a]	2.81±0.40 [b]	2.89±0.58 [b]	2.93±0.62 [b]	0.024*

* Different superscript letters within a row indicate significant differences according to Duncan's Multiple Range Test (p < 0.05).

Overall, formulations containing higher proportions of dangke tended to achieve higher scores across all sensory attributes. Among the tested formulations, F3 consistently demonstrated the highest consumer acceptance and was therefore selected as the most preferred formulation.

Nutritional Analysis

Nutritional Composition

The nutritional composition of the dangke-based nugget formulations is presented in Table 4. Significant differences were observed among formulations for energy (p = 0.001), fat (p = 0.001), protein (p < 0.001), moisture content (p = 0.003), ash content (p = 0.030), and calcium (p < 0.001). In contrast, carbohydrate content did not differ significantly among formulations (p = 0.430). Increasing the proportion of dangke resulted in a progressive increase in energy, fat, protein, and calcium contents. F3 exhibited the

https://doi.org/10.56303/jhnresearch.v5i2.1524

highest energy content (235.04 ± 3.68 kcal), protein content (11.95 ± 0.12 g), fat content (11.92 ± 0.96 g), and calcium content (329.08 ± 27.06 mg), whereas F0 showed the lowest values for these parameters. Conversely, moisture content decreased significantly with increasing dangke concentration, from 67.06 ± 1.47% in F0 to 53.41 ± 0.08% in F3.

Table 4 Nutritional Composition of Dangke-Based Nugget Formulations

Nutritional Analysis	Mean ± SD				p-value*
	F0	F1	F2	F3	
Energy (kcal/100 g)	138.40 ± 7.04^{a}	170.90 ± 14.46^{b}	201.27± 1.81^{c}	235.04 ± 3.68^{d}	0.001*
Carbohydrate (g/100g)	34.97 ± 18.31^{a}	21.58 ± 1.43^{a}	21.26 ± 0.26^{a}	20.23 ± 1.49^{a}	0.430
Fat (g/100g)	2.82 ± 0.02^{a}	5.95 ± 0.79^{b}	8.49 ± 0.11^{c}	11.92 ± 0.96^{d}	0.001*
Protein (g/100g)	5.27 ± 0.33^{a}	7.77 ± 0.39^{b}	9.96 ± 0.07^{c}	11.95 ± 0.12^{d}	0.000*
Moisture (%)	67.06 ± 1.47^{a}	62.27 ± 2.63^{b}	57.84 ± 0.39^{c}	53.41 ± 0.08^{d}	0.003*
Ash (%)	1.86 ± 0.26^{a}	2.44 ± 0.00^{b}	2.45 ± 0.09^{b}	2.73 ± 0.20^{b}	0.030*
Calcium (mg/100g)	26.23 ± 3.27^{a}	126.64 ± 22.05^{b}	218.39 ± 13.43^{c}	329.08 ± 27.06^{d}	0.000*

* Different superscript letters within a row indicate significant differences according to Duncan's Multiple Range Test ($p < 0.05$).

The amino acid analysis (Table 5) revealed significant differences in L-alanine ($p = 0.036$), L-aspartic acid ($p = 0.021$), L-cystine ($p = 0.049$), L-methionine ($p = 0.004$), and L-tryptophan ($p = 0.043$). In general, higher levels of dangke incorporation were associated with increased concentrations of these amino acids. L-alanine increased from 1990.39 ± 4.82 mg in F0 to 2782.57 ± 258.54 mg in F3, while L-aspartic acid increased from 2959.83 ± 101.34 mg to 4870.29 ± 347.64 mg. Likewise, L-cystine increased from 1006.01 ± 86.69 mg in F0 to 3324.54 ± 612.06 mg in F3. Significant increases were also observed for L-methionine and L-tryptophan, which reached 193.14 ± 18.90 mg and 1576.60 ± 241.32 mg, respectively, in F3. No significant differences were found for L-arginine, glycine, L-histidine, L-isoleucine, L-leucine, L-lysine, L-valine, L-phenylalanine, L-proline, L-serine, L-threonine, or L-tyrosine ($p > 0.05$), although most amino acids showed an increasing trend with higher proportions of dangke.

Table 5 Amino acid composition of the dangke-based nugget formulation

Amino Acid	Mean ± SD				p-value*
	F0	F1	F2	F3	
L-Alanine (mg/kg)	1990.39 ± 4.82^{a}	2484.02 ± 253.33^{ab}	2795.43 ± 100.25^{b}	2782.57 ± 258.54^{b}	0.036*
L-Arginine (mg/kg)	2613.15 ± 122.26^{a}	3227.36 ± 858.71^{a}	3040.93 ± 39.42^{a}	3104.93 ± 598.13^{a}	0.695
L-Aspartic Acid (mg) /kg	2959.83 ±101.34^{a}	3971.24 ± 612.41^{b}	4589.95 ± 82.63^{b}	4870.29 ± 347.64^{b}	0.021*
Glycine (mg/g)	2036.47 ± 175.73^{a}	2570.36 ±63.70^{ab}	3125.77 ± 420.76^{b}	2918.81 ± 277.22^{b}	0.054*
L-Histidine (mg/kg)	1016.29 ± 61.46^{a}	1578.85 ± 359.36^{a}	1885.26 ± 335.07^{a}	1814.82 ± 410.75^{a}	0.158
L-Isoleucine (mg/kg)	1223.19 ± 330.81^{a}	1724.45 ± 960.57^{a}	1661.05 ± 120.59^{a}	1614.91 ± 460.94^{a}	0.808
L-Cystine (mg/kg)	1006.01 ± 86.69^{a}	1636.99 ± 441.02^{ab}	2688.61 ± 851.71^{bc}	3324.54 ± 612.06^{c}	0.049*
L-Leucine (mg/kg)	2729.60 ± 277.24^{a}	4336.13 ± 1551.50^{a}	4906.29 ± 275.04^{a}	5280.88 ± 993.30^{a}	0.168
L-Lysine (mg/kg)	1913.28 ± 279.68^{a}	2700.52 ± 917.02^{a}	2817.88 ± 294.13^{a}	3330.66 ± 198.27^{a}	0.187
L-Methionine (mg/kg)	69.18 ± 13.15^{a}	123.89 ± 12.30^{b}	138.53 ± 5.84^{b}	193.14 ± 18.90^{c}	0.004*
L-Tryptophan (mg/kg)	737.29 ± 51.09^{a}	879.49 ± 81.79^{ab}	1480.05 ± 357.73^{bc}	1576.60 ± 241.32^{c}	0.043*

https://doi.org/10.56303/jhnresearch.v5i2.1524

Amino Acid	Mean ± SD				p-value*
	F0	F1	F2	F3	
L-Valine (mg/kg)	1632.76 ± 322.40[a]	2404.21 ± 981.39[a]	2577.27 ± 129.12[a]	2672.72 ± 483.81[a]	0.376
L-Phenylalanine (mg/kg)	1920.29 ± 50.06[a]	3168.91 ± 1017.57[a]	3565.18 ± 104.02[a]	3047.43 ± 2322.85[a]	0.639
L-Proline (mg/kg)	2869.37 ± 164.28[a]	4650.86 ± 1504.68[ab]	5737.60 ± 383.93[b]	6333.06 ± 1238.35[b]	0.086
L-Serine (mg/kg)	2945.63 ± 192.63[a]	4089.79 ± 175.31[ab]	5097.52 ± 873.03[b]	4566.88 ± 571.67[b]	0.061
L-Threonine (mg/kg)	1512.32 ± 162.71[a]	2043.14 ±735.01[a]	2049.81 ± 102.20[a]	1627.17 ± 804.19[a]	0.697
L-Tyrosine (mg/kg)	1420.69 ± 45.60[a]	2693.72 ± 675.99[ab]	2896.40 ± 419.30[ab]	3721.13 ± 770.58[b]	0.060

* Different superscript letters within a row indicate significant differences according to Duncan's Multiple Range Test ($p < 0.05$).

Overall, the incorporation of dangke substantially improved the nutritional profile of the nugget formulations by increasing protein, fat, calcium, and several amino acids. Among the tested formulations, F3 demonstrated the highest nutritional value and was therefore selected as the optimal formulation for further analyses.

DISCUSSION

Sensory Evaluation

Sensory acceptability is a critical factor in the development of supplementary foods for children under five years old because nutritional benefits can only be realized when the product is accepted and consumed. In the present study, the incorporation of dangke significantly influenced several sensory attributes of the nugget formulations. The hedonic quality test demonstrated significant differences only in color, whereas taste, aroma, and texture quality remained comparable among formulations. The higher color score observed in F3 may be attributed to the increased proportion of dangke, which produced a more yellowish appearance. Similar findings have been reported in previous studies showing that dairy-based ingredients can influence the visual characteristics of food products through their protein and fat composition(11).

Although differences in sensory quality were limited, consumer acceptance testing revealed significant improvements in taste and texture as the proportion of dangke increased. The F3 formulation achieved the highest taste acceptance score and was significantly preferred over the other formulations. These findings suggest that dangke contributed positively to the overall palatability of the product. According to a recent review, fresh dangke is characterized by a creamy taste, mild milky aroma, and a smooth, moist consistency with a semi-elastic and slightly chewy texture. Furthermore, dangke is described as being firmer than mozzarella cheese but softer than paneer, providing a distinctive mouthfeel that may enhance consumer preference(12). These sensory characteristics likely contributed to the higher taste and texture acceptance observed in formulations containing larger proportions of dangke.

Texture was another attribute significantly affected by formulation differences. The lower acceptance score observed in the control formulation (F0) suggests that replacing a portion of the oyster mushroom with dangke improved product texture. The protein and fat fractions present in dangke may have contributed to a softer and more cohesive matrix, resulting in a texture more like commercially available nuggets. Previous studies have also reported that the relatively high fat content of dangke contributes to its creamy taste, dense texture and smooth consistency, characteristics that are desirable in processed food products.

Interestingly, aroma acceptance did not differ significantly among formulations, despite a tendency for higher scores in formulations with greater dangke content. This finding may be related to the naturally mild aroma of dangke. Unlike many fermented dairy products, dangke lacks the pronounced sour notes associated with yogurt or kefir and does not possess the strong salty or umami characteristics of aged cheeses. As a result, increasing the proportion of dangke may enhance flavor and texture without

https://doi.org/10.56303/jhnresearch.v5i2.1524

substantially altering aroma perception. Despite the positive sensory outcomes, several limitations should be considered. The sensory evaluation involved a relatively small number of panelists and was conducted within a single geographical area. Consumer preferences may vary across populations with different cultural backgrounds and dietary habits. In addition, dangke is a traditional food that is more familiar to communities in South Sulawesi than to consumers from other regions(18). Therefore, further studies involving larger and more diverse populations are necessary to confirm the acceptability of dangke-based nuggets among broader consumer groups.

The sensory characteristics observed in this study may also be influenced by the inclusion of oyster mushroom in the nugget formulation. White oyster mushroom (Pleurotus ostreatus) possesses a fibrous, meat-like texture and a mild flavor that allows it to blend well with other food ingredients while contributing natural umami notes. These characteristics can enhance the overall palatability of processed food products when used at appropriate levels. In addition, oyster mushroom contains structural polysaccharides, particularly chitin-glucan complexes, which increase water-holding capacity and contribute to a softer, juicier texture (19,20). Such properties may have complemented the creamy and semi-elastic characteristics of dangke, resulting in improved texture acceptance among panelists. However, excessive incorporation of oyster mushroom has been reported to negatively affect sensory quality due to the development of a more dominant mushroom aroma, softer texture, and alterations in flavor perception. Previous studies showed that moderate levels of oyster mushroom substitution produced the highest sensory scores, whereas higher levels reduced consumer acceptance because the mushroom characteristics began to overpower the original product profile. Therefore, maintaining an appropriate balance between dangke and oyster mushroom is essential to achieve both nutritional improvement and desirable sensory properties.

Nutritional Analysis

The primary objective of this study was to develop a nutrient-dense supplementary food using dangke as a locally derived protein source. Dangke, a traditional cheese originating from Enrekang Regency, South Sulawesi, possesses considerable potential for the development of modern food products, including nuggets. Beyond its nutritional value, dangke represents an important element of local culinary heritage that has been consumed by communities for generations. The incorporation of dangke into innovative food products not only enhances nutritional quality but also supports the preservation and promotion of indigenous food resources. These findings support the hypothesis that dangke can improve the nutritional quality of processed food products intended for child nutrition interventions while maintaining cultural relevance(18,21,22) .

Protein content increased progressively with higher levels of dangke incorporation, reaching nearly 12 g per serving in the F3 formulation. This result is expected because dangke is produced from milk and is naturally rich in high-quality protein. Adequate protein intake is essential for tissue growth, muscle development, enzyme synthesis, and overall child growth. Previous studies have consistently demonstrated an association between inadequate protein intake and impaired linear growth among childre(23–25). Therefore, the higher protein content observed in the F3 formulation may contribute positively to dietary strategies aimed at improving child nutritional status. The substantial increase in protein content observed in the present study is consistent with previous reports describing dangke as a protein-rich traditional dairy product suitable for various population groups, including young children.

Similarly, calcium content increased substantially with increasing levels of dangke. The calcium concentration of the F3 formulation was more than twelve times higher than that of the control formulation. Calcium plays a critical role in bone mineralization and skeletal development during early childhood. Dairy products are recognized as important sources of bioavailable calcium, and the present findings indicate that dangke retains this nutritional advantage when incorporated into nugget products. This result is particularly relevant because inadequate calcium intake remains a concern among children in many low- and middle-income settings.

The amino acid analysis further demonstrated improvements in nutritional quality following dangke incorporation. Significant increases were observed in L-alanine, L-aspartic acid, L-cystine, L-

https://doi.org/10.56303/jhnresearch.v5i2.1524

methionine, and L-tryptophan. Among these, methionine and tryptophan are essential amino acids that must be obtained through dietary intake. The enhancement of amino acid content indicates that dangke not only increased total protein concentration but also improved protein quality. Previous research has highlighted the importance of essential amino acids in supporting growth, immune function, and protein synthesis, particularly during periods of rapid growth in early childhood.

The analysis revealed that not all amino acids show statistically significant differences among formulations. This finding may reflect the intrinsic amino acid composition of both dangke and oyster mushrooms, which contributed protein to all formulations. Nevertheless, formulations containing greater amounts of dangke generally exhibited higher amino acid concentrations, indicating enhanced amino acid content. Further studies are needed to evaluate protein digestibility and overall protein quality.

The combination of favorable sensory acceptance and enhanced nutritional composition suggests that the F3 formulation warrants further investigation as a locally sourced supplementary food product. The F3 formulation contained 235.04 kcal, 11.95 g protein and 11.92 g fat per 100 g product. According to the Indonesian Local Supplementary Feeding Program guidelines, supplementary foods for children aged 6–59 months should provide age-specific amounts of energy, protein, and fat, with a recommended protein-energy ratio (PER) of 10–16% (26). While its energy and fat contents are generally comparable with the recommended ranges for some age groups, the protein-energy ratio (20.3%) exceeded the recommended PMT range. Therefore, the F3 formulation may be more appropriately used as a protein-rich component of a supplementary feeding menu rather than as a the sole supplementary food. When combined with carbohydrate-rich foods, vegetables, and fruits in age-appropriate portions, the formulation may contribute to a more balanced nutrient intake while providing animal-source protein. Because sodium content was not determined in the present study, the suitability of the formulation, particularly for infants aged 6–11 months, should be interpreted with caution. Future studies should include sodium analysis, evaluate acceptability in broader populations, and assess age-specific nutritional suitability and dietary outcomes. Furthermore, the use of dangke as the primary ingredient may offer the additional benefit of preserving local food heritage while encouraging the utilization of culturally familiar foods in nutrition-related programs. However, further studies are needed to evaluate the product's acceptability in broader populations and its potential effects on dietary intake and nutritional outcomes.

However, several limitations should be acknowledged. The nutritional analyses focused primarily on macronutrients, calcium, and amino acid composition, whereas other micronutrients relevant to child growth, such as zinc, iron, and vitamin D, were not evaluated. In addition, the nutritional analyses were performed in duplicate rather than triplicate. Although duplicate analyses were conducted using validated analytical methods at an accredited laboratory and are commonly applied in the early stages of food product development, future studies should include triplicate analyses to further improve analytical precision and better estimate experimental variability. In addition, the study assessed nutritional composition rather than biological efficacy. Future studies should investigate nutrient bioavailability, growth outcomes, and long-term acceptability among target populations, particularly toddlers at risk of undernutrition and stunting. Overall, the findings suggest that dangke may be a valuable ingredient for the development of nutrient-dense supplementary foods. The incorporation of dangke increased protein, calcium, and selected amino acid contents while maintaining favorable sensory characteristics. These attributes may support the use of dangke-based nuggets as part of broader food-based nutrition strategies targeting young children, particularly in populations vulnerable to inadequate nutrient intake and growth faltering.

CONCLUSION

The findings of this study suggest that the incorporation of dangke improved both the sensory acceptability and nutritional quality of nugget formulations. Among the tested formulations, F3 demonstrated the most favorable characteristics, with the highest consumer acceptance as well as significantly greater energy, protein, fat, calcium, and selected amino acid contents. These results indicate that dangke may be a promising ingredient for the development of nutrient-dense supplementary foods for young children. In addition to its nutritional value, the use of dangke highlights the potential of traditional

https://doi.org/10.56303/jhnresearch.v5i2.1524

foods to contribute to innovative food products while preserving local culinary heritage. However, the present study evaluated sensory characteristics and nutritional composition rather than biological efficacy. Therefore, further research is needed to assess nutrient bioavailability, product stability, and the potential effects of dangke-based products on dietary intake and growth outcomes among toddlers.

DECLARATION OF THE USE OF AI

The authors used ChatGPT (OpenAI) and Google Gemini to support and enhance clarity, language editing, sentence restructuring, improvement of manuscript readability, and generates graphical abtract. All outputs generated by the AI tool were carefully reviewed, modified where necessary, and verified against the original data and relevant scientific literature. The authors maintained full control over the content, interpretation of findings, and conclusions presented in the manuscript and take full responsibility for its accuracy, integrity, and originality.

FUNDING

This research received funding from Ministry of Higher Education, Science, and Technology Indonesia.

ACKNOWLEDGMENTS

The authors would like to express their sincere appreciation to the Institute for Research and Community Service (LPPM) of Universitas Esa Unggul for its administrative and institutional support throughout this study. The authors also gratefully acknowledge the Posyandu cadres of Parung Panjang for their participation in the sensory evaluation and their valuable contribution to the research.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. UNICEF, WHO, The World Bank. Level and trends in child malnutrition: UNICEF / WHO / World Bank Group Joint Child Malnutrition Estimates. Geneva; 2025.
2. Azriani D, Masita, Qinthara NS, Yulita IN, Agustian D, Zuhairini Y, et al. Risk factors associated with stunting incidence in under five children in Southeast Asia: a scoping review. Journal of Health, Population and Nutrition. BioMed Central Ltd; 2024. doi:10.1186/s41043-024-00656-7 PubMed PMID: 39468694.
3. Gusnedi G, Nindrea RD, Purnakarya I, Umar HB, Andrafikar, Syafrawati, et al. Risk factors associated with childhood stunting in Indonesia: A systematic review and meta-analysis. Asia Pac J Clin Nutr. 2023;32(2):184–95. doi:10.6133/apjcn.202306_32(2).0001 PubMed PMID: 37382316.
4. Mulyani AT, Khairinisa MA, Khatib A, Chaerunisaa AY. Understanding Stunting: Impact, Causes, and Strategy to Accelerate Stunting Reduction—A Narrative Review. Nutrients . Multidisciplinary Digital Publishing Institute (MDPI); 2025. doi:10.3390/nu17091493 PubMed PMID: 40362802.
5. Muniroh L, Rifqi MA, Indriani Di, Abihail CT, Socadevia A. Nutrition Consumption and Impact on Stunting and Underweight among Children in the Tengger Community, East Java, Indonesia. Amerta Nutrition [Internet]. 2025 Mar [cited 2026 Jun 7];9(Issue1):128–36. Available from: https://e-journal.unair.ac.id/AMNT
6. Winarti E, Susmiati S, Alimansur M, Jayani I, Susilowati E. Analysis of Micro-Level Social Determinants on The Incidence of Stunting in Kediri City: A Qualitative Study. Journal of Health and Nutrition Research. 2025 Dec 1;4(3):969–83. doi:10.56303/jhnresearch.v4i3.455
7. Sulidah S, Damayanti A, Elmania E. Risk Factors for Stunting in Children Aged 6-36 Months Among Seaweed Farmers in Coastal Areas. Journal of Health and Nutrition Research. 2025 Aug 1;4(2):373–81. doi:10.56303/jhnresearch.v4i2.364

8. Harahap H, Darmawan A, Puspasari A, Ayudia EI, Adnyana IMDM, Yonera AF, et al. Multifactorial Predictors of Stunting Among Children Under Five Years: Evidence from Batanghari District, Jambi, Indonesia. Journal of Health and Nutrition Research. 2026 Apr 1;5(1):27–42. doi:10.56303/jhnresearch.v5i1.852
9. Santosa A, Arif EN, Ghoni DA. Effect of maternal and child factors on stunting: partial least squares structural equation modeling. Clin Exp Pediatr. 2022 Feb 1;65(2):90–7. doi:10.3345/cep.2021.00094 PubMed PMID: 33957035.
10. Qoyimah AU, Zahroh Shaluhiyah, Sri Winarni. Maternal Factors as Determinants of Stunting in Children under the Age of Five: Scoping Review. Jurnal Promkes. 2024 Sep 2;12(2):254–63. doi:10.20473/jpk.v12.i2.2024.254-263
11. Setiarto RHB, Nur N, Romulo A, Herlina VT. Dangke: unveiling Indonesian traditional fermented cheese from Enrekang, South Sulawesi. Journal of Ethnic Foods. BioMed Central Ltd; 2025. doi:10.1186/s42779-025-00279-1
12. Sa'pang M, Salam A, Harna H, Rahmayanti R A, Seprianto S, Nurmalasari M, et al. An Explorative Study of Indonesian Traditional Cheese "Dangke" as High Protein Food from Enrekang, South Sulawesi. Poltekita : Jurnal Ilmu Kesehatan. 2023 Nov 30;17(3):955–65. doi:10.33860/jik.v17i3.3345
13. Malaka R, Prahesti KI, Mahendradatta M, Astawan M, Putranto WS, Arief FA, et al. Physicochemical Properties of Dangke-cheese by Different Temperature Processing and Papaya-latex as Coagulant. Indian J Agric Res. 2024 Oct 1;58(5):911–6. doi:10.18805/IJARe.AF-882
14. Rahmat Riwayat Abadi, Andi Mustika Amin, Syahir Fadli, Ridfan Rifadly Abadi, Kartika Septiary Musa. Penguatan Branding Produk Dangke sebagai Produk Unggulan Kabupaten Enrekang. Kolaborasi : Jurnal Hasil Kegiatan Kolaborasi Pengabdian Masyarakat. 2025 Jun 5;3(2):18–25. doi:10.62383/kolaborasi.v3i2.550
15. Khairunnisa A, Arbi AS. Modul 01 Good Sensory Practices dan Bias Panelis Edisi 1 [Internet]. [cited 2026 Jun 18]. Available from: https://pustaka.ut.ac.id/lib/wp-content/uploads/pdfmk/PANG4430-M1.pdf
16. Ayustaningwarno F. Teknologi Pangan Teori Praktis dan Aplikasi. Yogyakarta: Graha Ilmu; 2016.
17. Waters. ACQUITY UPLC H-Class and H-Class Bio Amino Acid Analysis System Guide [Internet]. 2012. Available from: www.waters.com
18. Rahman S, Lasumange, Yunus A. Historical overview and contribution of Dangke as traditional food to income and public health. Food Research. Rynnye Lyan Resources; 2023. p. 245–50. doi:10.26656/fr.2017.7(5).964
19. If'all I, Nofrianto N, Spetriani S, Sabariyah S, Fathurahmi S, Indriasari Y, et al. Effect of Partial Substitution of Beef with White Oyster Mushroom (Pleurotus ostreatus) on Nutritional Profile and Sensory Quality of Meatball Products. Journal of Health and Nutrition Research. 2025 Aug 1;4(2):390–401. doi:10.56303/jhnresearch.v4i2.374
20. Tokarczyk G, Felisiak K, Adamska I, Przybylska S, Hrebień-Filisińska A, Biernacka P, et al. Effect of Oyster Mushroom Addition on Improving the Sensory Properties, Nutritional Value and Increasing the Antioxidant Potential of Carp Meat Burgers. Molecules. 2023 Oct 1;28(19). doi:10.3390/molecules28196975 PubMed PMID: 37836819.
21. Arifuddin H, Dwi Wahyuni R, Arifuddin H, Nur AF, Arifuddin A. Validity, reliability, and factor analysis of organoleptic tests of Dangke Deppamil as an alternative treatment of nutrition problems in pregnant women in Indonesia. J Educ Health Promot. 2024 Jan 1;13(1). doi:10.4103/jehp.jehp_156_23
22. Marwah, Hatta W, Nahariah N. Physicochemical quality of biscuits in various compositions of wheat flour, dangke flour and sago flour. In: IOP Conference Series: Earth and Environmental Science. IOP Publishing Ltd; 2020. doi:10.1088/1755-1315/492/1/012049
23. Xiong T, Wu Y, Hu J, Xu S, Li Y, Kong B, et al. Associations between High Protein Intake, Linear Growth, and Stunting in Children and Adolescents: A Cross-Sectional Study. Nutrients. 2023 Nov 1;15(22). doi:10.3390/nu15224821 PubMed PMID: 38004215.

https://doi.org/10.56303/jhnresearch.v5i2.1524

24. Ernalia Y, Dwi Utari L, . S, Restuastuti T. Different Intakes of Energy and Protein in Stunted and Non-stunted Elementary School Children in Indonesia. KnE Life Sciences. 2018;4(4):556. doi:10.18502/kls.v4i4.2318
25. Fikawati S, Syafiq A, Ririyanti RK, Gemily SC. Energy and protein intakes are associated with stunting among preschool children in Central Jakarta, Indonesia: a case-control study. Malays J Nutr. 2021;27(1):81–91. doi:10.31246/MJN-2020-0074
26. Ministry of Health Republic Indonesia. Petunjuk Teknis Pemberian Makanan Tambahan Berbahan Pangan Lokal bagi Ibu Hamil dan Balita Bermasalah Gizi. 2025.

https://doi.org/10.56303/jhnresearch.v5i2.1524