Journal of Applied Food and Nutrition

Journal homepage:
https://ejournal.upi.edu/index.php/JAFN/index

Development of Churros Substituted with Soy Flour and Chickpeas as a Source of Protein Snack for Adolescents

*Cintana Luthfia Azzahra, Vieta Annisa Nurhidayati**

IPB University, Indonesia

*Correspondence: E-mail: vietanisa@apps.ipb.ac.id

ABSTRACT

Background: Adolescents require adequate protein intake to support growth. Soy flour and chickpeas are high-protein ingredients that can be substituted for wheat flour in churros production. This study aimed to develop protein-enriched churros using soy flour and chickpea substitution.
Research Methods: An experimental study with a completely randomized design (one factor, three treatments) was conducted. The study involved formulation development, organoleptic testing, and proximate analysis.
Research Result: Significant differences were found in color and texture ($p<0.05$), but not in aroma and taste. The selected formula contained per 100 g: 451 kcal energy, 12 g protein, 27.84 g fat, 37.98 g carbohydrate, 20.46 g moisture, and 1.71 g ash. A 50 g serving provides 6 g protein, contributing 9% of the Recommended Dietary Allowance (RDA) for adolescents aged 13–15 years.
Conclusion: The developed churros qualify as a protein source snack, contributing 20% of protein RDA per 100 g serving, and is suitable for adolescents with high protein requirements.

ARTICLE INFO

Article History:
Submitted/Received August 2025
First Revised February 2026
Accepted June 2026
First Available online June 2026
Publication Date June 2026

Keyword:
Chickpeas; Churros; Protein; Soy Flour; Adolescent

1. INTRODUCTION

Statistical data from the United Nations Children's Fund (UNICEF) in 2021 shows that adolescents aged 10–19 years constitute 17% of Indonesia's total population (UNICEF, 2021). Nutritional status plays a vital role in producing a quality generation (Parewasi et al., 2021). Adolescence is a critical period requiring higher nutrient intake due to rapid physical growth and development. Adolescents are among the groups most susceptible to nutritional problems because they undergo growth and physical changes that require adequate and balanced nutrient intake to meet their nutritional needs, thus preventing both undernutrition and overnutrition (Rahmayani et al., 2025). However, unhealthy eating habits often develop as adolescents frequently consume snacks outside the home, affecting their nutritional status (Hafiza et al., 2020). The 2023 Indonesian Health Survey (SKI) reveals that among adolescents aged 13–15 years in West Java, 11.8% experience overnutrition and 6.1% experience undernutrition, indicating the need for balanced and nutritious food options.

Protein is particularly essential during adolescence for tissue growth and development. Protein deficiency can lead to stunted growth, reduced immunity, and decreased cognitive function (Utami et al., 2020). Unfortunately, snacks commonly sold around schools are often nutritionally poor and may contain harmful additives such as rhodamine B and borax (Chikmah & Maulida, 2019). The high consumption of unhealthy snacks among students is a global concern (Al Rahmad et al., 2023), highlighting the urgent need for nutritious snack alternatives.

Legumes such as soybeans and chickpeas offer promising solutions as protein-rich ingredients. Soy flour contains 40–50% protein (34.9 g per 100 g), the highest among legumes (Nidia, 2020; Khoerunnisa & Handayani, 2018). Similarly, chickpeas (*Cicer arietinum* L.) are recognized for their high plant-based protein content and multifunctional properties due to their ideal polysaccharide composition (Pujianti, 2023). These characteristics make both ingredients suitable for fortifying snack foods.

Previous studies have explored protein fortification in various snack products. For instance, protein enrichment has been applied to cookies, crackers, and bread using soy flour and other legume-based ingredients, demonstrating improved nutritional profiles and acceptable sensory properties. However, research on protein fortification in churros as a popular snack among adolescents remains limited. Most existing churros are made primarily from wheat flour with minimal nutritional value beyond energy and carbohydrates.

Despite the potential of soy flour and chickpea flour as protein sources, their application in churros as a protein-enriched snack for adolescents has not been explored. No studies have specifically investigated the substitution of wheat flour with soy flour and chickpea flour in churros production to enhance protein content while maintaining organoleptic acceptability. This study addresses this gap by developing a churros formulation incorporating soy flour and chickpea substitution. This study aimed to develop protein-enriched churros using soy flour and chickpea substitution, evaluate their organoleptic acceptability and nutritional composition, and assess their contribution to adolescents' protein requirements.

2. METHODS

This study used an experimental design, aiming to determine the effect of specific treatments in producing churros with soy flour substitution. The experiment involved substituting wheat flour with soy flour to meet adolescents' protein intake needs, using a completely randomized design (CRD) with 1 factor and 3 levels of treatment. The process included several stages: formulation development, organoleptic testing, and proximate analysis. Each treatment was replicated three times, with each formula produced in three

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

different batches to ensure consistency and reliability of results. Randomization was performed using a random number generator to assign treatment orders during production and testing, minimizing systematic bias.

The experiment included several stages: formulation development, organoleptic tasting, and proximate analysis. Product trials were conducted in Kp. Binuang RT 01 RW 11, Kersamanah, Garut, West Java, from October 2024 to March 2025. Organoleptic testing was carried out at SMPN 1 Kersamanah, Garut, and proximate analysis was performed by PT. Saraswanti Indo Genetech.

Formulation was the initial stage in developing churros substituted with soy flour and chickpea to achieve the optimal balance of taste, texture, color, aroma, and nutritional content. In this study, chickpeas were substituted at 20% in all formulas, while soy flour substitution levels varied at 10% (F1), 20% (F2), and 30% (F3). Each formula was produced in three separate batches on different days to account for batch-to-batch variation. The ingredients for producing churros were listed in Table 1.

Table 1. Formulation of Churros with Soy Flour and Chickpea

Ingredients	F1 (10%)	F2 (20%)	F3 (30%)
Wheat flour	108	96	84
Soy flour	12	24	36
Chickpeas (20%)	30	30	30
Low fat milk	230	230	230
Margarine	60	60	60
Sugar	20	20	20
Salt	1	1	1
Eggs	110	110	110
Vanilla extract	1	1	1
Cooking oil	28	28	28

The production process began by preparing production equipment and ingredients. The equipment included a calibrated digital scale, stainless steel bowls, sieve, pot, stove, spoon, piping bag, star-shaped nozzle, and spatula. The process involved weighing all ingredients using a calibrated digital scale (accuracy ±0.1 g), grinding and sieving the chickpeas through a 60-mesh sieve to ensure uniform particle size, boiling milk, margarine, sugar, salt, and vanilla until boiling, then mixing in wheat flour, soy flour, and chickpeas until well combined. The dough was left to cool to lukewarm temperature (approximately 40–45°C) before adding eggs. The mixture was piped into 10 cm lengths using a star nozzle and fried over medium heat at 180°C for about 3–4 minutes, turning occasionally to ensure even cooking (see Figure 1 for process flow).

Quality control measures were implemented throughout the study to ensure product consistency and data reliability. During production, all raw materials were sourced from the same supplier and checked for quality (appearance, odor, and expiration date) before use. Mixing times (5 minutes for dough preparation) and frying temperatures (180°C ± 5°C, monitored using a calibrated cooking thermometer) were strictly controlled. Each batch was prepared under standardized conditions to maintain consistency across batches. Visual inspection was conducted to ensure uniform size (10 cm ± 0.5 cm length) and color (golden brown) across batches. Any churros showing uneven frying or deviation from standard size were excluded from testing.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

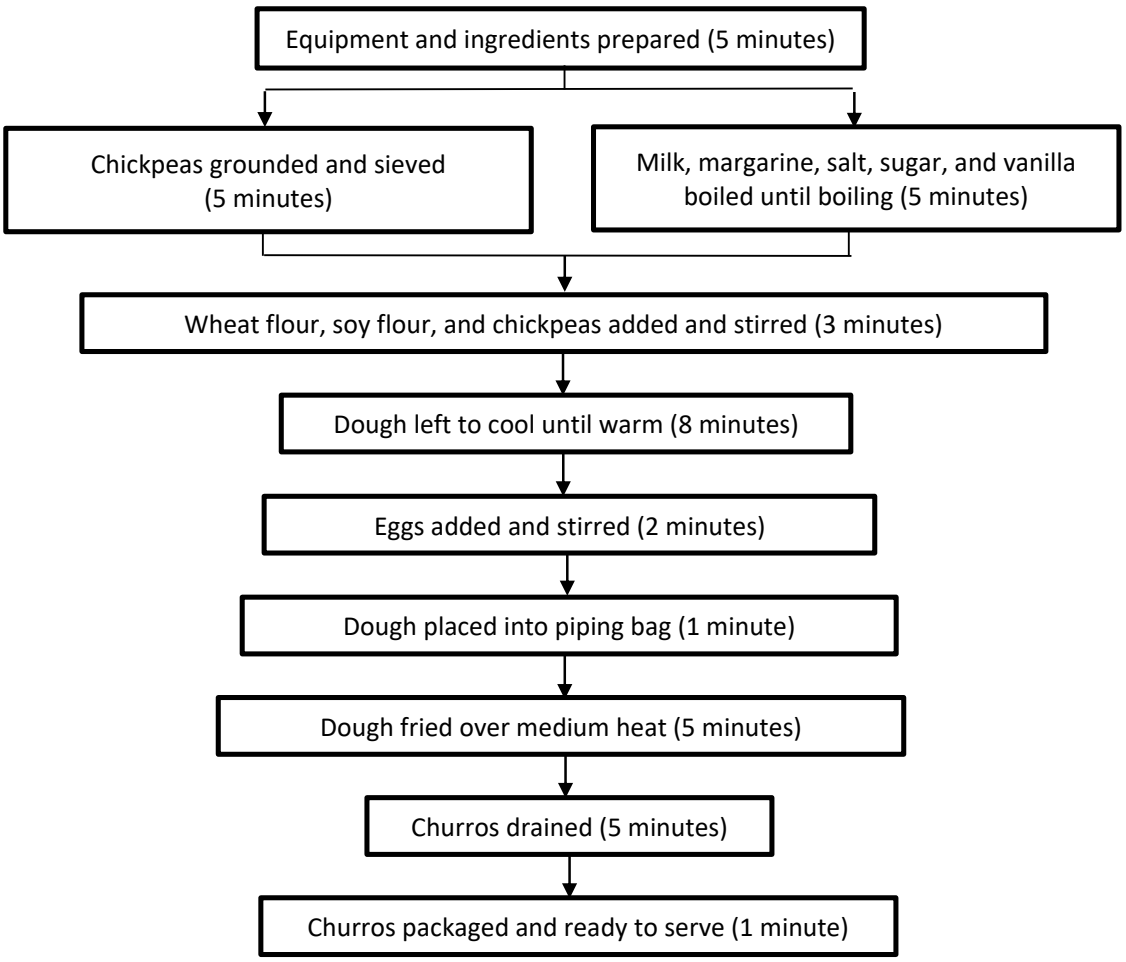

Figure 1. Production Flow of Churros with Soy Flour and Chickpea Substitution

For organoleptic testing, samples from each formula were coded with three-digit random numbers and served at the same temperature (room temperature, 25–27°C) to minimize bias. Each panelist received samples from all three formulas in randomized order. All proximate analyses were conducted in duplicate to verify accuracy.

The panelists for organoleptic testing were students from SMPN 1 Kersamanah, Garut, with a total of 43 individuals. The number of panelists was determined according to SNI 01-2346-2006, which stated that the minimum number of untrained panelists is 30 people. Panelists consisted of 22 females (51.2%) and 21 males (48.8%), aged 13–15 years old, representing the target consumer group for this product. The inclusion criteria for panelists were: (1) students enrolled at SMPN 1 Kersamanah, (2) aged 13–15 years, (3) willing to participate voluntarily as indicated by signed informed consent forms (approved by parents/guardians), (4) having no food allergies, particularly to wheat, soy, chickpeas, eggs, or dairy products, (5) in good health condition on the day of testing, and (6) willing to taste and evaluate all samples provided. Exclusion criteria included students with a history of allergic reactions to any churros ingredients or those unwilling to complete the entire testing session.

All panelists were untrained consumers with no prior experience in formal sensory evaluation. Prior to testing, panelists received a brief orientation explaining the evaluation procedure, the use of the hedonic scale (1 = dislike extremely to 5 = like extremely), and the attributes to be assessed (color, aroma, taste, and texture). However, no specific training on sensory descriptors or intensity scaling was provided, maintaining their status as untrained panelists to reflect genuine consumer preferences.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

The selection of the best churros formula was determined using the Exponential Comparison Method (ECM), a multi-criteria decision-making technique that systematically compares alternatives based on weighted criteria. The ECM calculation involved five steps: (1) determining criterion weights (W) ranging from 0 to 1 with ΣW = 1, (2) normalizing performance scores (S) using the formula S = (X - Xmin)/(Xmax - Xmin), (3) calculating weighted scores (W × S), (4) computing total ECM scores (Σ(W × S)), and (5) ranking formulas based on total scores. The weighting system prioritized protein content at 30% as the primary research objective to support adolescent growth and development, allocated 40% equally among organoleptic attributes (color, aroma, taste, and texture at 10% each) to ensure consumer acceptance, and assigned 30% to other nutritional parameters (energy, fat, and carbohydrate at 10% each) as secondary considerations. This weighting approach ensured that the selected formula would meet nutritional targets while maintaining organoleptic acceptability for adolescent consumers.

Statistical analysis was performed using IBM SPSS Statistics version 26 with a significance level of $\alpha = 0.05$. Prior to analysis, the Shapiro-Wilk test was conducted to assess normality of variance. Since the did not meet parametric test assumptions, the Kruskal-Wallis H test was used to determine significant differences among the three churros formulas (F1, F2, F3) for each organoleptic parameter (color, aroma, taste, texture). When the Kruskal-Wallis test indicated significant differences ($p < 0.05$), pairwise comparisons were conducted using the Mann-Whitney U test as a post-hoc procedure to identify which specific formulas differed from each other.

3. RESULTS AND DISCUSSION

The churros produced from each formula are shown in Figure 1. In this study, chickpeas were substituted at 20% in all formulas, while soy flour substitution levels varied at 10% (F1), 20% (F2), and 30% (F3). Each formula was produced in three separate batches to ensure consistency and reliability of results. The three formulas exhibited visual differences in color, ranging from yellowish (F1) to golden-yellow (F2) and brownish (F3), attributable to the increasing levels of soy flour substitution and the associated natural pigments and Maillard reactions during frying.

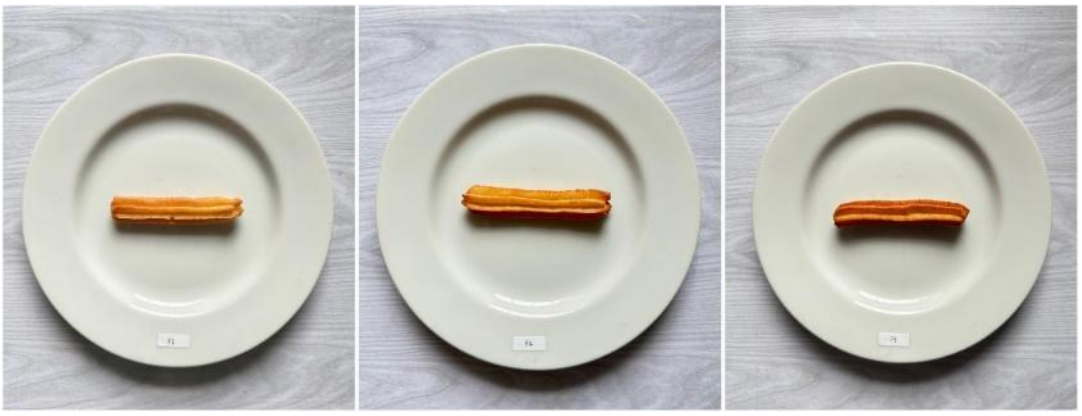

Figure 2. Churros Substituted with Soy Flour and Chickpeas F1, F2, and F3, Respectively

Organoleptic testing used a 5-point hedonic scale to evaluate color, texture, aroma, and taste, with scores ranging from 1 (strongly dislike) to 5 (strongly like). The average hedonic scores for all three formulas are presented in Table 2. Statistical analysis using the Kruskal-Wallis test revealed significant differences in color and texture parameters among formulas, while no significant differences were observed in aroma and taste.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

Table 2. Organoleptic Test Results of Churros with Soy Flour and Chickpea Substitution

Parameter	Formula			*p value*
	F1	F2	F3	
Color	4,19 ± 0,588[a]	4,28 ± 0,630[a]	3,44 ± 0,881[b]	<0,001
Texture	4,23 ± 0,649[a]	4,37 ± 0,757[a]	3,74 ± 0,790[b]	<0,001
Aroma	4,07 ± 0,985[a]	4,19 ± 0,824[a]	3,95 ± 0,872[a]	0,459
Taste	4,09 ± 0,750[a]	4,23 ± 0,782[a]	3,91 ± 0,895[a]	0,240

Note: [a] and [b] indicate significant results of the Mann-Whitney test (p<0.05), identical letters within the same row indicate no significant difference

For color parameter, significant differences were found among F1, F2, and F3 ($p < 0.001$). Mann-Whitney post-hoc tests showed no significant difference between F1 and F2, but significant differences were observed between F1 and F3, and between F2 and F3. F2 was preferred for its golden-yellow color, while F1 appeared more yellow and F3 more brownish. This aligns with research on soy flour–substituted bread, which attributes yellow-brown coloring to natural pigments in soy flour and Maillard reactions during cooking (Taghdir et al., 2017; Harleni & Nidia, 2017). The Maillard reaction, occurring between reducing sugars and amino acids at high temperatures, intensifies with higher soy flour content, resulting in darker coloration in F3.

Texture preference was also significantly affected by soy flour substitution ($p < 0.001$). F2 was preferred for its crispy exterior and soft interior, characteristic of ideal churros texture. F1 was perceived as crispier, while F3 was softer and denser. Similar results have been reported in soy flour–substituted bread (Khoirunnisa et al., 2021) and brownies (Nidia, 2020), where higher substitution levels result in softer, denser textures. This textural change is attributed to the higher protein and lower gluten content in soy flour compared to wheat flour. Wheat gluten forms an elastic network that provides structure and chewiness, whereas soy protein does not form the same type of network, leading to a denser, less crispy texture at higher substitution levels (F3).

For aroma, no significant differences were observed among the three formulas ($p = 0.459$). However, F2 was most preferred in aroma, with a mild soy scent complementing margarine and vanilla notes. Higher soy flour levels, as in F3, tended to produce stronger, less preferred beany aromas (Bahlawan et al., 2025). The beany aroma in soy products is primarily caused by lipoxygenase enzymes that generate volatile compounds such as hexanal and other aldehydes. While the beany aroma was detectable in F3, it did not reach a level that significantly affected overall acceptability, likely due to the masking effect of vanilla and the sweetness of the churros.

Similarly, no significant differences were observed in taste among the three formulas ($p = 0.240$). F2 was again preferred, offering a mild soy flavor that balanced sweetness and savoriness. F3's stronger soy taste was less favored by panelists. The sweet, slightly savory profile of the soy flour and chickpea churros is enhanced by glutamic acid in soybeans, which imparts umami notes (Harleni & Nidia, 2017). The lack of significant statistical differences suggests that all formulas were acceptable to adolescent consumers, though preference trends favored F2's more balanced flavor profile.

The best formula was selected using the Exponential Comparison Method (ECM), which systematically compared the three formulas based on weighted criteria including organoleptic attributes (color, aroma, taste, texture) and nutritional composition (protein, energy, fat, carbohydrate). The nutritional composition of churros substituted with soy flour and chickpea for the three formulas (F1, F2, and F3), calculated using the 2020 Indonesian Food Composition Table, is presented in Table 3.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

Table 3. Nutritional Content of Churros with Soy Flour and Chickpea Substitution

Nutrient Content	F1	F2	F3
Energy	251 kcal	251 kcal	252 kcal
Protein	7.0 g	7.5 g	8.0 g
Fat	13.1 g	13.4 g	13.7 g
Carbohydrate	22.9 g	21.9 g	21.0 g

The ECM weighting system prioritized protein content (30%) as the primary research objective, allocated 40% equally among organoleptic attributes (10% each for color, aroma, taste, and texture) to ensure consumer acceptance, and assigned 30% to other nutritional parameters (10% each for energy, fat, and carbohydrate). Based on the ECM calculation, F2 ranked highest with a total score of 1.6, followed by F3 and F1. Formula F2 was therefore selected as the optimal formulation, as it achieved the best balance between high protein content (7.5 g per 50 g serving), superior organoleptic acceptability (highest scores in all sensory attributes), and adequate nutritional composition.

Laboratory proximate analysis of the selected formula (F2) was conducted by PT. Saraswanti Indo Genetech to verify its nutritional composition. The results are presented in Table 4.

Table 4. Nutritional Content of the Selected Churros Formula

Parameter	Unit	Content	Method
Energy	kkal/100 g	451	18-8-9/MU/SMM-SIG (calculation)
Protein	%	12.01	Titrimetry
Fat	%	27.84	Gravimetry
Carbohydrate	%	37.98	18-8-9/MU (calculation)
Moisture	%	20.46	SNI 01-2891-1992 point 5.1
Ash	%	1.71	SNI 01-2891-1992 point 6.1

Source: Proximate laboratory analysis, PT. Saraswanti Indo Genetech

The laboratory analysis confirmed that F2 contains 451 kcal energy, 12.01% protein, 27.84% fat, 37.98% carbohydrates, 20.46% moisture, and 1.71% ash per 100 g. The protein content (12.01 g per 100 g or 6.0 g per 50 g serving) was largely contributed by soy flour, chickpeas, milk, and eggs. Soy flour, as the primary protein source, contains approximately 40–50% protein, while chickpeas contribute approximately 20–22% protein. The combination of these plant-based proteins, along with animal proteins from milk and eggs, provides a complementary amino acid profile that enhances the overall protein quality of the churros.

The high fat content (27.84 g per 100 g or 13.92 g per 50 g serving) was mainly due to margarine, eggs, and cooking oil absorbed during the deep-frying process. Deep-frying is known to significantly increase the fat content of foods, as oil penetrates the food matrix during cooking. The fat content warrants careful consideration in the context of adolescent nutrition, as discussed in detail in section 3.5.

Carbohydrate content (37.98 g per 100 g) was primarily derived from wheat flour and sugar. The moisture content (20.46%) falls within the acceptable range for fried products, indicating proper cooking and suitable shelf stability. The ash content (1.71%) reflects the mineral content of the product, contributed by ingredients such as soy flour, chickpeas, milk, and salt.

One serving size of churros compared to the Recommended Dietary Allowance for adolescents aged 13–15 years is shown in Table 5. The data in Table 5 indicate that churros substituted with soy flour and chickpea can fulfill energy requirement of snack for female adolescents because they contribute more than 10% of energy requirement.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

Table 5. Contribution of Churros with Soy Flour and Chickpea Substitution to Adolescents' RDA

Component	Content per serving size (50 g)	RDA for adolescent (13-15 years)		RDA contribution (%)	
		Male	Female	Male	Female
Energy (kcal)	226	2400	2050	9	11
Protein (g)	6	70	65	9	9
Fat (g)	13,9	80	70	17	20
Carbohydrate (g)	19	350	300	5	6

Note: One serving of churros with soy flour and chickpea substitution is 50 grams, equivalent to 5 pieces of churros measuring 10 cm each.

The Indonesian Food and Drug Authority (BPOM, 2022) Regulation No. 9 of 2022 states that a food product can be claimed as a source of protein if it contains not less than 20% of the general RDA (ALG) per 100 grams in solid form. The 20% RDA per 100 g is calculated for the general group as 60 g, meaning that 20% ALG per 100 g for the general group equals 12 g of protein. Based on the above calculation, adjusted to the BPOM (2022) requirements for a protein-source claim, soy flour and chickpea–substituted churros contribute 20% of the general RDA with a protein content of 12 g per 100 g of product, thus meeting the requirements for a protein-source claim.

Snacking is an integral part of adolescents' daily eating patterns in Indonesia, with studies showing that Indonesian adolescents typically consume snacks 1–3 times per day, contributing approximately 10–20% of their total daily energy intake (Hafiza et al., 2020; Al Rahmad et al., 2023). Snacks are commonly consumed during school breaks (mid-morning around 10:00 AM and afternoon around 3:00 PM) and after school activities. However, commercially available snacks around schools are often nutritionally poor, high in refined carbohydrates and unhealthy fats, while low in protein and micronutrients (Chikmah & Maulida, 2019). In the context of daily meal planning, this protein-enriched churros is positioned as a nutritious mid-meal snack that complements main meals rather than replacing them, designed to bridge nutritional gaps between meals while providing sustained energy for adolescents' active school and extracurricular activities. A serving size of 50 g was determined based on standard snack portion guidelines from the Indonesian Ministry of Health, which recommends that snacks contribute 10–15% of total daily energy intake. For adolescents with an average energy requirement of 2,100–2,475 kcal/day, one serving of 50 g churros provides 226 kcal (approximately 9–11% of daily energy needs), falling within the recommended range. This portion size (approximately 3–4 pieces of 10 cm churros) is practical, easy to package, and aligns with typical snack consumption quantities among adolescents. The recommended consumption frequency is 1–2 servings per day, ideally consumed as a mid-morning or afternoon snack, with one serving providing 6 g protein (9% of daily protein RDA) and two servings contributing 18% of protein RDA.

The churros, however, contain relatively high fat content (27.84 g per 100 g or 13.92 g per 50 g serving), influenced by the frying process and the composition of ingredients such as margarine, eggs, and cooking oil. The fat contribution in one serving accounts for 17% of the RDA for male adolescents aged 13–15 years (70 g/day) and 20% for female adolescents (62 g/day). According to the Indonesian Ministry of Health Regulation (Permenkes No. 28 Tahun 2019), the recommended fat intake for adolescents is 25–30% of total daily energy intake, translating to approximately 58–83 g of fat per day for a 2,100–2,475 kcal diet. Therefore, consuming one serving of churros (13.92 g fat) is still safe and well below the recommended daily limit, accounting for less than one-quarter of total fat allowance. However, two servings would provide 27.8 g fat, representing 34–45% of daily fat RDA, emphasizing the importance of limiting consumption to 1–2 servings per day and ensuring the churros is part

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

of a varied diet balanced with nutrient-dense, lower-fat foods during main meals such as vegetables, fruits, lean proteins, and whole grains. To minimize excessive fat content in the product, it is advisable to refrigerate the shaped churros dough before frying, as this technique has been shown to reduce oil absorption during deep-frying by firming the dough structure. Additional strategies to reduce fat content in future product development could include air-frying or oven-baking methods, using oil with higher smoke points, or incorporating fiber-rich ingredients that can form a barrier to oil penetration.

The churros contain relatively high fat content influenced by the frying process and the composition of ingredients such as margarine, eggs, and cooking oil. While consuming one serving of churros (13.9 g fat) is safe and well below the recommended daily limit, the high fat content warrants critical consideration given that excessive fat intake from deep-fried snacks is associated with increased risk of overweight, obesity, and metabolic disorders in adolescents. It is particularly concerning as the 2023 Indonesian Health Survey (SKI) reported that 11.8% of adolescents aged 13–15 years in West Java already experience overnutrition. When compared to international recommendations, the fat content of the developed churros exceeds WHO/FAO guidelines for healthy snacks, as fat contributes approximately 55% of total energy per serving recommendation that snack foods should ideally contain less than 20% of energy from fat to be classified as "low-fat" snacks.

As a strategy to reduce fat content, refrigeration prior to frying is recommended; Rochmah et al., (2019) demonstrated that storing dough in the refrigerator before frying significantly reduces oil absorption, as low temperatures firm the dough structure, creating a tighter surface that resists oil penetration during frying, with longer storage at low temperatures resulting in greater fat reduction. Additional strategies for future product development could include alternative cooking methods such as air-frying or oven-baking, ingredient modifications (e.g., replacing margarine with lower-fat alternatives or incorporating hydrocolloids to create a protective barrier), and optimizing frying parameters (temperature, oil type, and post-frying drainage) to develop a lower-fat churros formulation that maintains protein content and organoleptic qualities while better aligning with international healthy snack standards. Despite the high fat content, churros remain safe to consume for up to 12 hours after frying if stored in a closed or airtight container to maintain their crisp texture.

4. CONCLUSION

The study developed protein-enriched churros by partially substituting wheat flour with soy and chickpea flours to create a more nutritious snack for adolescents, finding that a moderate level of soy substitution produced the best balance of protein content and sensory acceptability, with appealing color, texture, and acceptable taste and aroma; the optimal formula met Indonesian standards for a protein-source snack and illustrates how legume-based flours can improve the nutritional value of familiar foods without reducing consumer appeal. However, generalizability is limited by the use of untrained panelists from one school, deep-frying led to high fat content, shelf-life and protein quality were not fully assessed, and issues such as micronutrients, antinutritional factors, allergenicity, scalability, and real-world dietary impact were not evaluated. Practically, the product offers a feasible protein-rich option for nutrition programs, school canteens, and entrepreneurs using affordable legume flours, and could support policies to improve school snack quality, while future research should focus on lower-fat cooking methods, fuller nutritional and sensory analyses, shelf-life and safety, clinical and economic evaluations, and adaptation of similar fortification strategies to other snacks.

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

5. REFERENCES

Al Rahmad AH, Ichsan I, Imran H, Miko A. 2023. Mendorong pilihan jajanan sehat pada anak-anak sekolah: Pengalaman pengabdian kepada masyarakat di Desa Panteriek, Banda Aceh. *Jurnal PADE: Pengabdian & Edukasi*, *5*(1), 5-10. doi: http://dx.doi.org/10.30867/pade.v5i1.1330

Bahlawan ZAS, Megawati M, Damayanti A, Abdurrafi F, Hutomo GA. 2025. Peningkatan kandungan nutrisi dan mutu biskuit berbasis tepung sorgum melalui modifikasi perendaman dan fortifikasi tepung kedelai. *REACTOR: Journal of Research on Chemistry and Engineering*. 6(1), 24-32. https://doi.org/10.52759/reactor.v6i1.19

[BPOM] Badan Pengawas Obat dan Makanan. 2016. *Acuan Label Gizi*. Jakarta: Badan Pengawas Obat dan Makanan Republik Indonesia.

[BPOM] Badan Pengawas Obat dan Makanan. 2022. *Pengawasan Klaim pada Label dan Iklan Panga Olahan*. Jakarta: Badan Pengawas Obat dan Makanan Republik Indonesia.

Chikmah AM, Maulida I. 2019. Identifikasi bahan tambahan pangan yang berbahaya (Rhodamin B dan Borak) pada jajanan di lingkungan Jl. Kartini Kecamatan Tegal Timur Kota Tegal. *Parapemikir: Jurnal Ilmiah Farmasi*. 8(2): 1-4.

Hafiza D, Utami A, Niriyah S. 2020. Hubungan kebiasaan makan dengan status gizi pada remaja SMP YLPI Pekanbaru. *Jurnal Medika Hutama*. *2*(1): 332-342.

Harleni H, Nidia G. 2017. Pengaruh substitusi tepung kedelai (Glycine max (l.) merill) terhadap mutu organoleptik dan kadar zat gizi makro brownies kukus sebagai alternatif snack bagi anak penderita KEP. *Jurnal Kesehatan Perintis.* 4(2), 69-79. doi: https://doi.org/10.33653/jkp.v4i2.231

[KEMENKES] Kementrian Kesehatan Republik Indonesia. 2019. *Angka Kecukupan Gizi yang Dianjurkan Bagi Bangsa Indonesia*. Jakarta: Kementrian Kesehatan RI.

[KEMENKES] Kementerian Kesehatan Republik Indonesia. 2020. *Tabel Komposisi Pangan Indonesia 2020*. Jakarta: Kementerian Kesehatan RI.

Khoerunnisa R, Handayani THW. 2018. Mini tart kedelai sebagai pengembangan produk patiseri berbahan substitusi tepung kedelai lokal (prosiding). *Pendidikan Teknik Boga Busana*. 13(1):1-2

Khoirunnisa W, Nasrullah N. 2021. Penambahan tepung kedelai pada roti tawar tepung sorgum dan pati garut bebas gluten dengan zat besi dan serat pangan. *Ghidza: Jurnal Gizi Dan Kesehatan*. 5(1): 82. doi: https://doi.org/10.22487/ghidza.v5i1.217

Nidia G. 2020. Pengaruh substitusi tepung kedelai (*Glycine Max(L.) Merril*) terhadap mutu organoleptik dan kadar zat gizi makro brownies sebagai alternatif snack bagi anak penderita kurang energi protein. *Jurnal Ilmu Gizi Indonesia*. 1(1):10. doi: https://doi.org/10.57084/jigzi.v1i1.297

Parewasi DFR, Indriasari R, Hidayanty H, Hadju V, Battung SM. 2021. Hubungan asupan energi dan zat gizi makro dengan status gizi remaja putri Pesantren Darul Aman Gombara. *The Journal of Indonesian Community Nutrition.* 10(1):1

Pujianti R. 2023. Pembuatan snack bar tepung kacang arab (*Cicer arietinum*) dan tepung chia seed (*Salvia hispanica*) sebagai alternatif camilan untuk diabetes melitus tipe 2 [Skripsi]. Bekasi: Sekolah Tinggi Ilmu Kesehatan Mitra Keluarga

Rahmayani, Rosita S, Yunita, Yani ED, Indiraswari T. *Pendidikan Gizi Untuk Remaja Putri (Perubahan Pola Makan).* Jakarta: Nuansa Fajar Cemerlang, 2025.

Rochmah MM, Sofa AD, Oktaviys EE, Muflihati I, Affandi AR. 2019. Karakteristik sifat kimia dan organoleptik *churros* tersubtitusi tepung beras dengan tepung ubi. *Jurnal Pangan Dan Gizi*. 9(1):54-55. doi: https://doi.org/10.26714/jpg.9.1.2019.74-82

Taghdir M, Mazloomi SM, HonarN, Sepandi M, Ashourpour M, Salehi M. 2017. Effect of soy flour on nutritional, physicochemical, and sensory characteristics of gluten-free bread. *Food science & nutrition*. 5(3): 442. doi: https://doi.org/10.1002/fsn3.411

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698

[UNICEF] United Nations Children's Fund. (2021). *Profil Kesehatan Remaja Indonesia 2021*. Retrivied online: https://www.unicef.org/indonesia/id/kesehatan/laporan/profil-kesehatan-remaja

Utami HD, Kamsiah SA. 2020. Hubungan Pola Makan, Tingkat Kecukupan Energi, dan Protein dengan Status Gizi pada Remaja. Jurnal Kesehatan. 11(2):280. doi: 10.26630/jk.v11i2.2051

DOI: https://doi.org/10.17509/jafn.v7i1.89145
p- ISSN 2797-068X e- ISSN 2797-0698