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# The Influence of Tilapia on the Growth and Development of Stunted Toddlers

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***Abstract***

*Stunting, stemming from chronic malnutrition in young children, presents a significant public health challenge in Indonesia, impairing physical, mental, cognitive, and intellectual growth. Protein deficiency notably contributes to this condition. Tilapia, a readily available and cost-effective animal protein source, contains essential complete proteins. This study investigates how tilapia consumption impacts stunted toddlers' growth and development. Employing systematic review methods following PRISMA guidelines, searches on Scopus and Google Scholar using specific keywords yielded 17 relevant articles from the last decade. Findings suggest that supplementing food and fortifying diets positively affect stunted toddlers' height and weight, while nutrition education enhances maternal knowledge and practices. Combined interventions are more effective than singular ones. Tilapia's nutritional richness in protein, omega-3, vitamin B12, iron, phosphorus, and selenium supports stunted toddlers' growth and development, potentially preventing stunting and improving their nutritional status. Regular tilapia consumption fosters bone, muscle, and brain development, positively influencing weight, height, and overall health. Widening tilapia accessibility can aid in mitigating stunting and enhancing toddler nutrition. Incorporating tilapia into diets alongside proper education and stimulation represents a promising strategy against stunting in Indonesia. Strengthening promotion efforts and parental education regarding tilapia's benefits is crucial for combating stunting effectively.*

***Keywords:*** *Tilapia, Nile Tilapia, Oreochromis Niloticus, Stunting.*

## INTRODUCTION

Stunting remains a significant public health problem in Indonesia. The Basic Health Research (Riskesdas) in 2018 indicated that the prevalence of stunting among children under five in Indonesia is still 30.8% (Ministry of Health of the Republic of Indonesia, 2018). Stunting refers to the condition of failure to thrive in toddlers due to chronic malnutrition that occurs during the First 1000 Days of Life (HPK). It involves impaired growth and development attributed to factors such as malnutrition, recurrent infections, and inadequate psychosocial stimulation (Kusumaningrum et al., 2020). This condition results from chronic malnutrition caused by inadequate nutritional intake over a prolonged period, leading to growth failure and children being shorter than their age (Simarmata & Suryanegara, 2021). Stunting not only disrupts physical growth but also renders children vulnerable to disease, impacting brain development and intelligence (Hasan et al., 2023). It is characterized by impaired growth and development in children due to chronic malnutrition and inadequate nutritional intake over time (Damayanti et al., 2017). Stunted babies and toddlers typically have lower energy intake compared to their non-stunted counterparts (Hautvast et al., 1999).

Several factors contribute to stunting, including inadequate nutritional intake, repeated infections, and insufficient psychosocial stimulation (Hasnawati et al., 2022). This condition can lead to health problems, susceptibility to disease, and reduced productivity levels in children (Erda, 2023). Furthermore, stunting not only affects physical growth but also impacts mental, cognitive, and intellectual development. It is associated with cognitive impairment and an increased risk of chronic disease later in life. Stunting causes delays in the physical growth and brain development of toddlers, resulting in a lower quality of human resources in the future. Various other factors contributing to stunting include low maternal body mass index, low socio-economic status, child birth weight, gender, and age (Mtongwa et al., 2021).

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The primary factor causing stunting is protein deficiency. Protein, a crucial macronutrient, is essential for the growth and development of body tissue, including the brain. Adequate protein intake is necessary to support the development of lean body mass and overall physical growth in children (Shin et al., 2021). Additionally, protein plays a vital role in immune function, aiding the body in fighting infection and disease. For toddlers with stunting, who may be more susceptible to disease due to malnutrition, adequate protein intake can strengthen their immune system (Cai et al., 2021). Moreover, proteins are involved in various metabolic processes in the body, including enzyme production, hormone regulation, and energy metabolism. Protein-rich foods can provide the nutrients necessary to support these metabolic functions, ensuring that toddlers with stunting have the energy and resources needed for optimal growth and development (Santos Mendes & Costa-Filho, 2022). Additionally, protein is essential for cognitive development and brain function. Adequate protein intake supports neurological growth and cognitive abilities in children, critical for their overall well-being (Taoufiq et al., 2020).

Protein deficiency can lead to delays in height, weight, and cognitive development in toddlers. It can exacerbate the effects of stunting. Inadequate protein intake further hinders the growth and development of toddlers with stunting, compounding the effects of chronic malnutrition (Dewi & Mahmudiono, 2021; Elisanti, 2023; Gowele et al., 2021). One of the main consequences of protein deficiency for toddlers with stunting is impaired growth and development. Inadequate protein intake inhibits the body's ability to build and repair tissue, leading to stunted growth in children (Endrinikapoulos et al., 2023; Nyoman Supariasa et al., 2023). This results in children being shorter than their peers and experiencing delays in reaching developmental milestones. Furthermore, protein deficiency weakens the immune system of toddlers with stunting, making them more susceptible to infection and disease (Kusumawardani & Ashar, 2022; Rizkika, 2023). Protein plays a crucial role in immune function, and inadequate protein intake compromises the body's ability to fight infections. This further impacts the overall health and well-being of children with stunting, leading to frequent illnesses and slower recovery times. To meet the protein needs of toddlers, tilapia serves as a good source of animal protein for those suffering from stunting.

Tilapia fish (Oreochromis niloticus) is a freshwater fish known for its popularity due to its taste and rich nutritional content (Elyana et al., 2018). It is an easily obtainable and relatively cheap source of animal protein. Tilapia contains complete protein consisting of all the essential amino acids needed by the body. Tilapia has a protein content of $75.14 \pm 0.53$ mg/g, indicating moderate to high protein levels compared to other fish species (Mandal et al., 2021). Chromatological composition analysis shows that tilapia is a good source of protein because 100 grams of tilapia contains 16 grams of protein (Delgado et al., 2021). Other studies report that the protein content of tilapia is 50% to 55% higher than other fish species (Full et al., 2020). Additionally, tilapia also contains various other important nutrients such as omega-3, vitamin B12, and iron, which are crucial for the growth and development of toddlers.

Based on the above description, this research aims to determine the effect of tilapia on the growth and development of stunted toddlers. The objective of this research is to investigate the effect of consuming tilapia on the growth and development of stunted toddlers.

## METHOD

The method used in this research is systematic literature review. This method was employed to collect relevant research results regarding the influence of tilapia on the growth and development of stunted toddlers. The search instruments used were the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) (Page et al., 2021) or the process of searching and assessing the suitability of articles. Researchers conducted a comprehensive literature search using databases such as Scopus and Google Scholar, using keywords namely "Nile Tilapia", "Oreochromis niloticus", and "stunting", and obtained 73 documents. The inclusion and exclusion criteria in this study can be seen in Table 1.

**Table 1 Research Inclusion and Exclusion Criteria**

| Inclusion | Exclusion |
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| Articles discussing the benefits of tilapia on the growth and development of stunted toddlers. | Articles not related to the benefits of tilapia on the growth and development of stunted toddlers. |
| Scholarly and research articles<br>English-language documents<br>Indonesian-language documents<br>Publication years 2014-2024<br>Available full-text articles<br>Open access articles | Non-scholarly and non-research articles<br>Documents not in English or Indonesian.<br>Publications outside the years 2014-2024<br>Articles not available in full-text and are non-open access. |
| Articles utilizing quantitative, qualitative, or experimental research methods | Articles employing systematic review method, literature review, or those not presenting research results |

The researcher then filtered the articles based on the title, abstract, and assessed the full text of the potentially relevant articles, resulting in 17 articles suitable for use in this research. Furthermore, these 17 articles will undergo data extraction, where relevant information such as research location, research subjects and samples, research instruments, research design, and research results will be extracted and synthesized. Finally, a narrative synthesis will be conducted to summarize the findings and identify patterns and themes across the research. Systematic review is a research method that can be used to answer these questions. It combines the results of several studies and provides stronger evidence about the influence of tilapia on the growth and development of stunted toddlers.

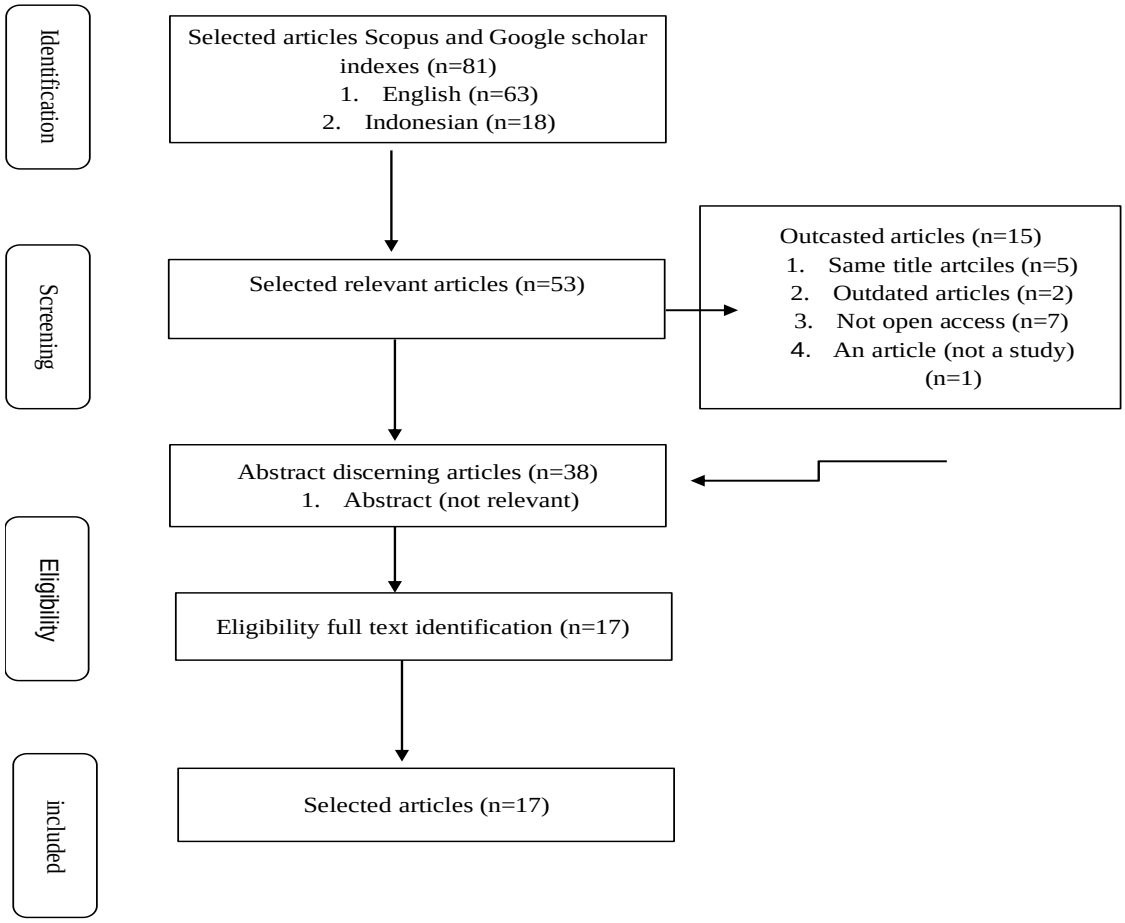


**Figure 1**. Flow diagram of the article extraction process

## RESULTS

| No. | Title, Author, and Year | Sample and Research Design | Research result |
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| 1. | Low-field NMR Studies the Changes in Cellular Water in Tilapia Fillet Tissue During Different Drying Conditions (Luo et al., 2021) | Tilapia fillet samples were obtained from local markets in China. These fillets were then cut into specific sizes and treated with polydextrose using ultrasonic assistance before undergoing drying through heat pump drying and vacuum freeze-drying methods. The research design involved investigating the water distribution in tilapia fillet tissue at various levels during the drying process. Low-field NMR technology was utilized to understand the migration mechanisms of bound and free water in tilapia fillet tissue. The aim of this research is to enhance the energy efficiency and quality of processed foods by examining different water migration mechanisms in tilapia ingredients during drying. | This study provides significant insights that can inform further investigations into the dynamic mechanisms underlying drying processes and the advancement of drying technologies for tilapia fillets and similar aquatic products. Additionally, it underscores the importance of comprehending cell membrane rupture during the drying process, which can expedite the drying rate and enhance the quality of dried products. |
| 2 | Nutritional Profile and Chemical Stability of Pasta Fortified with Tilapia (Oreochromis Niloticus) Flour (Guerra Monteiro et al., 2016) | This study investigated five pasta formulations with varying concentrations of tilapia flour as a partial substitute for wheat flour. Fortification with tilapia flour led to significant increases ($p < 0.05$) in protein, fat, ash, total essential amino acids, and total polyunsaturated fatty acids content. | The fortification of pasta with tilapia flour resulted in notable improvements in protein, fat, ash, total essential amino acid, and polyunsaturated fatty acid levels. Additionally, the inclusion of tilapia flour led to reductions in moisture and carbohydrate content in the pasta. Although there was an observed increase in fat and protein oxidation in select pasta formulations with certain concentrations of tilapia flour, all formulations exhibited chemical stability over 21 days of storage at 25°C. Pasta containing 6% tilapia flour is deemed to hold potential as a technological alternative for enhancing the nutritional value of traditional pasta without significant adverse effects on the chemical stability of the final product. |
| 3 | Fresh Pasta Enriched with Tilapia Protein Concentrate: Nutritional and Sensory Characteristics (Goes et al., 2016) | This research involved developing fresh pasta enriched with tilapia protein concentrate derived from leftover tilapia fillets. The research design included chemical analysis, mineral content assessment, as well as sensory and microbiological analysis of the resulting pasta. For sensory analysis, pasta samples were cooked with water and salt for 20 minutes, followed by the addition of tomato sauce. Sensory evaluation was conducted by 40 non-trained academic assessors from UEM. The sensory analysis method was approved by the Comitê Permanente de Ética em Pesquisa com Seres Humanos (CDPEP) from Universidade Estadual de Maringá, Brazil. Assessments were made using a 9-point hedonic scale for appearance, aroma, taste, texture, and overall impression. | The results indicated that adding 20% tilapia protein concentrate to fresh pasta was ideal for improving nutritional quality without compromising sensory properties. Pasta with 0%, 10%, and 20% tilapia protein concentrate additions showed high acceptance levels (75.56%, 71.00%, and 77.6% respectively), while pasta with 30% protein concentrate addition had an acceptance rate below 70%.<br><br>Previous research has also demonstrated that dry pasta with 10% tilapia protein concentrate and fresh pasta with 30.6% cured pacu fillet produce products with higher protein content and good sensory qualities. Therefore, fresh pasta enriched with tilapia protein concentrate presents a promising alternative for enhancing the nutritional value and quality of pasta products. |
| 4 | Nutritional Evaluation of Clarias Gariepinus and Tilapia Guineensis Fish from River Doma in Nasarawa State, Nigeria (Aremu et al., 2021) | The research involved sampling fish species Clarias gariepinus and Tilapia guineensis from the Doma River in Nasarawa State, Nigeria, for nutritional analysis to determine their nutritional composition.<br><br>This study followed an experimental research design with a focus on fish species. Samples were collected using standard procedures, and nutritional analysis was conducted using specific laboratory methods. | Key findings from the research include:<br><br>1. Protein content: Both fish species exhibited high protein content, serving as significant sources of amino acids for the human body.<br>2. Fat content: The fat content in Clarias gariepinus and Tilapia guineensis fish was analyzed, providing insights into the types of fats present in the fish.<br>3. Mineral content: The research also analyzed the mineral content in fish, including calcium, phosphorus, and iron, which are crucial for bone health and body metabolism.<br>4. Vitamin content: Information on the vitamin content in fish was presented, offering insights into the contribution of fish to dietary vitamin intake. |

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| 5 | Energy and Protein Intakes Associated with Stunting Among Preschool Children in Central Jakarta, Indonesia: A Case-Control Study<br>(Fikawati et al., 2021) | In this study, the sample comprised 121 children aged 25-30 months, divided into two groups: 36 children in the case group (stunting) and 85 children in the control group (non-stunting). The minimum sample size was calculated using the two-proportion formula, which determined that the largest sample size required was 35 children. The case-control ratio was set at 1:2, resulting in 35 cases and 70 controls. However, during data collection, 36 children were included in the case group and 85 in the control group, encompassing all available subjects for research.<br><br>The research design employed a case-control study with a total sample of 121 children aged 25-30 months, conducted in Gambir and Sawah Besar Districts, Central Jakarta, where stunting prevalence is high. All children were exclusively breastfed for a minimum of four months and shared similar socioeconomic backgrounds. Data collection involved height measurements, questionnaire-based interviews, and 24-hour food recalls. Statistical analyses included the t-test and chi-square test to identify differences between the two groups, along with logistic regression for multivariate analysis. | The study results revealed that energy intake (AOR=6.0; 95% CI=1.0-35.0) and protein intake (AOR=4.0; 95% CI=1.1-15.5) were associated with stunting after controlling for fat, carbohydrate, vitamin C, iron, and zinc intake. The proportion of children with energy intake below the recommendation was significantly higher in stunted children (86.1%) compared to non-stunted children (43.5%). Similarly, the proportion of children with protein intake below the recommendation was notably higher among stunted children (30.6%) compared to non-stunted children (8.2%). |
| 6 | Determinants of Stunting in 24–59-Month-Old Children in Kulon Progo District 2019<br>(Hendraswari et al., 2021) | This study adopts a cross-sectional research design involving a sample of 150 children aged 24-59 months. Children are randomly selected based on a proportional distribution determined by each village to ensure balanced representation. Data collection takes place at the Temon II Community Health Center in Kulon Progo Regency, with respondents selected using predefined inclusion and exclusion criteria. The study entails interviews with respondents utilizing questionnaires to gather information on various factors such as gender, maternal employment status, energy intake, feeding practices, immunization status, infectious diseases, and access to clean water.<br><br>The data collection process encompasses obtaining information about the history of exclusive breastfeeding, energy intake, protein intake, immunization status, incidence of acute respiratory infections (ARI) and diarrhea, as well as access to clean water. Direct interviews are conducted by the nutrition team to record 24-hour food recall data, which is subsequently analyzed using NutriSurvey 2007 software to evaluate energy and protein intake. Additionally, the study utilizes the Maternal and Child Health (KIA) book for secondary data on immunization status.<br><br>Data analysis comprises univariate, bivariate, and multivariate analysis. Univariate analysis involves a frequency distribution test, while bivariate analysis employs a chi-square test with a significance level of p-value = 0.05 and a confidence interval of 95%. Interpretation of odds ratio (OR) values is utilized to determine risk factors, and multivariate logistic regression analysis is conducted to identify the most dominant factors. | The study results reveal a significant relationship between energy intake factors and stunting in children aged 24-59 months (p-value = 0.030; $\alpha$ = 0.05; CI = 95%). Identified risk factors include low energy intake, low protein intake, acute respiratory infections, and diarrhea. Conversely, immunization status is identified as a non-risk factor, while protective factors include access to clean water and a history of exclusive breastfeeding. Energy intake emerges as the most influential factor in stunting among children aged 24-59 months.<br><br>Moreover, the research findings indicate that boys are more susceptible to stunting compared to girls, while maternal employment contributes to stunting relative to non-working mothers with secondary education. However, other factors such as history of exclusive breastfeeding, protein intake, immunization status, infectious diseases (diarrhea and ARI), and toileting show no association with stunting in children aged 24-59 months.<br><br>Thus, the study provides crucial insights into the factors influencing stunting in children in Kulon Progo Regency, along with recommendations for enhancing family nutrition awareness, disseminating information about stunting, implementing policies to improve the nutritional status of pregnant women and children under five years, and providing education for practitioners and mothers with children under five years to prevent stunting. |

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| 7 | Usual Nutrient and Food Intake of Filipino Stunted Children: Does It Matter? (Angeles-Agdeppa & Toledo, 2020) | Data for the analysis is sourced from the 2013 National Nutrition Survey in the Philippines, a cross-sectoral population survey describing the health and nutritional status of the Filipino population. The survey design involves selecting Primary Sample Units (PSUs), Enumeration Areas (EAs), and households as the final sample units, with samples collected from urban and rural areas separately. Individual dietary intake data from 8,881 preschool children (aged 3-5 years), young school children (aged 6-9 years), and older school children (aged 10-12 years) from surveyed households were utilized in this study. | The research findings reveal that stunted children exhibit a lower average energy intake compared to non-stunted children. Additionally, stunted children tend to experience higher rates of nutritional deficiencies, particularly in energy, carbohydrate, and protein intake, highlighting the significant role of diet and nutritional intake in children's growth.<br><br>Furthermore, the research identifies that stunted children typically consume lower amounts of certain food groups in comparison to non-stunted children, indicating a correlation between eating patterns and children's growth status. |
| 8 | Education and Workshop on Healthy Food Preparation from Tilapia Fish to Prevent Stunting in Biru-Biru District, Deli Serdang (Wahyuni et al., 2024) | This action research design involves direct intervention through education, training, and provision of food products to local communities. | The community service activity was successfully conducted and received a positive response from the community. Evaluation of community interest and understanding of the activity revealed a significant increase post-activity, with community understanding levels rising from 70% to 94% before the activity to 81% to 100% after the activity.<br><br>Furthermore, educational and training sessions focused on emphasizing the importance of providing healthy food and adequate nutrition to children. Additionally, processing tilapia fish into biscuits and floss as a healthy food alternative for preventing stunting was highlighted. These initiatives are expected to yield benefits by enhancing public awareness regarding nutrition and children's health. Moreover, they aim to stimulate the entrepreneurial spirit within local communities. |
| 9 | Food Intake and Stunting Incidents in Fisherman's Families in Bengkulu City (Yuliantini et al., 2022) | This research employs an analytical survey design with a cross-sectional method and a quantitative approach. The study population comprises all toddlers from fishing families in Bengkulu City, with purposive sampling techniques utilizing inclusion and exclusion criteria. A total of 74 respondents were randomly selected from the population.<br><br>The research was conducted from August to November 2020, utilizing interviews, measurements, and observations for data collection. Toddler food intake data were gathered using the Food Frequency Questionnaire-Semi Quantitative (FFQ-SQ) to facilitate food consumption surveys, while toddler height was measured using Microtoise.<br><br>Univariate analysis was conducted to provide an overview of maternal characteristics (level of education, age, and occupation). Additionally, the relationship between nutritional intake (energy, protein, fat, carbohydrates, zinc, and iron) and the incidence of stunting was analyzed using the Chi-square test with a significance level of 5% ($\alpha$=0.05). | The results indicate a relationship between energy, protein, fat, carbohydrate, and zinc intake and the incidence of stunting in toddlers from fishing families in Bengkulu City. Adequate food intake was found to be associated with the incidence of stunting in fishing families, while no relationship was observed between iron intake and stunting incidents.<br><br>Moreover, the study reveals that many toddlers have sufficient levels of both macro and micronutrients. There is a correlation between the intake of macronutrients (energy, fat, and protein) and the intake of micronutrients such as zinc and the incidence of stunting among toddlers in fishing families in Bengkulu City. However, no association was found between iron intake and stunting incidents in toddlers from fishing families in Bengkulu City. |

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| 10 | Overview of Children's Eating Patterns: Challenges in Pasongsongan Village (Coastal Area of Sumenep Regency) (Soesanti, 2019) | This study adopts a qualitative approach, selecting informants purposively. The chosen informants include grandmothers or mothers with grandchildren or children experiencing stunting aged 9 to 22 months, shamans/herbal medicine makers, Posyandu cadres, and community leaders. Data collection involved in-depth interviews using interview guides and participant observation. Observations were conducted within 3 families with stunted children, focusing on food preparation and feeding methods. | The research findings reveal that children's eating patterns in Pasongsongan Village are characterized by the predominant consumption of porridge, lontong, and soup without side dishes and vegetables until the age of one year. These foods are preferred as they are deemed suitable for delicate infant intestines. After 12 months, children are gradually introduced to protein-rich foods such as eggs, chicken, tofu, and tempeh, albeit in limited quantities. Fish, a significant source of protein in the village, is typically introduced after the child reaches the age of one or two years, or when they begin walking. However, the prevailing belief within the community that fish is taboo for children under the age of one or two years may impede optimal growth.<br><br>The insufficient availability of protein sources such as eggs, sea fish, and chicken, both in terms of quality and quantity, may contribute to stunting among children. Moreover, local cultural beliefs influence children's eating patterns, reinforcing certain assumptions that require reconsideration to promote healthier dietary habits for stunted children. |
| 11 | Potential of Nile Tilapia (Oreochromis Niloticus) as an Alternative Complementary Food Ingredient for Stunted Children (Nuryanto et al., 2022) | This study conducted laboratory research using tilapia fish samples from Grobogan. The research analyzed the proximate content, fatty acids, amino acids, and heavy metal lead in tilapia fish, employing descriptive statistical methods.<br><br>The research design aimed to analyze the nutritional and heavy metal content in tilapia, providing a better understanding of its potential as an additional food ingredient for stunted children. Thus, this research offers valuable insights into the contribution of tilapia fish to meeting the nutritional needs of children experiencing stunting. | The results revealed that tilapia has high nutritional content, particularly in terms of protein, calcium, and monounsaturated fatty acids. Every 100 grams of tilapia contains 18.46 grams of protein and 74.38 grams of calcium. Additionally, the total fatty acids in tilapia constitute 30.39%, comprising palmitic, stearic, oleic, and linoleic acids. The total amino acids in tilapia amount to 21.56%, including various essential amino acids such as arginine, leucine, lysine, aspartic acid, and glutamic acid.<br><br>These findings demonstrate that tilapia has the potential to serve as a valuable source of nutrition, especially for meeting the nutritional needs of stunted children. With its rich nutritional content, consumption of tilapia fish can aid in improving the nutritional status and growth of stunted children. |
| 12 | Tilapia Fish Production Using Tarpaulin Ponds in Villageskramajaya, West Lombok, to Prevent Stunting (Azhar et al., 2023) | This research was conducted in Villageskramajaya, Narmada District, West Lombok Regency, West Nusa Tenggara. The target group for the counseling and training program was Karang Taruna Mandiri Jaya. Thus, the research sample comprised members of the Karang Taruna Mandiri Jaya group in Kramajaya Village.<br><br>The method employed in the counseling and training program was Focus Group Discussion (FGD). FGDs were utilized to provide information and insights to cultivators, emphasizing two-way communication, exchange of experiences, group discussions, and demonstrations. This research design adopted a participatory and interactive approach in delivering information and training to the target group. | 1. Community Empowerment: The tilapia fish production program using tarpaulin ponds not only provides fish as a source of nutrition but also empowers the community with new knowledge and skills in tilapia cultivation. This fosters independence in meeting food and nutritional needs.<br><br>2. Collaboration and Support: Support and collaboration from local communities, village governments, or non-governmental organizations are highly beneficial in achieving the success of this program. Strong collaboration can enhance the implementation and positive impact of the tilapia production program using tarpaulin ponds.<br><br>3. Stunting Prevention: Tilapia fish production using tarpaulin ponds in Kramajaya Village was identified as an effective solution in efforts to prevent stunting in children. Stunting, a condition of growth failure caused by chronic malnutrition in children, can be alleviated by increasing community access to animal protein sources such as fish.<br><br>4. Program Enthusiasm and Success: Farmers exhibit high enthusiasm for this program as they witness the tangible benefits of utilizing tarpaulin pond technology in tilapia cultivation. The success of this program can make a positive contribution to preventing stunting in children, improving |

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| | | | community nutrition, and increasing farmers' income. |
| 13 | Oreochromis Niloticus and Fish Processing Training: Creating Healthy and Nutritious Snacks to Combat Stunting in Sawit Permai Village<br>(Sayuti et al., 2023) | The subject research focuses on the people of Kampung Sawit Permai, particularly parents of babies and toddlers. The research design comprises a survey aimed at assessing the prevalence of stunting rates in Sawit Permai Village, identifying factors contributing to stunting in children, and analyzing food ingredients rich in protein and easily obtainable for use as basic ingredients in fish processing. | Factors causing stunting in children in Sawit Permai Village, Dayun District, Siak Regency. The research also emphasizes the significance of collaboration among communities, government entities, and other stakeholders in establishing an environment conducive to children's optimal growth and development. Through education, training, and regular monitoring, the aim is to ensure every child could grow into a healthy and robust generation, ready to embrace a promising future.<br>It is anticipated that these efforts will serve as an inspiring model for other regions striving to combat stunting and enhance the well-being of children across Indonesia. |
| 14 | Meeting the Nutritional Needs of Children: The Role of Fish Products from the Emerging Aquaculture of Nepal<br>(Sapkota et al., 2020) | The study utilized a sample of 100 randomly selected children aged 5 to 13 years, along with their caregivers who provided opinions regarding fish dish preferences. The study design involved trend analysis and individual questionnaires to explore the contribution of fish diets to children's daily lifestyles, ensuring their nutritional security. | The results revealed that the most favored fish dishes among respondents included fried fish, fish balls, and dried fish dishes. Based on proximate analysis, several fish dishes such as tilapia tacos, trout curry, and pangasius fillets were found to contain significant protein and calcium content. Additionally, this study underscores the importance of increasing public awareness and interest in the significant health benefits of fish consumption. |
| 15 | Oreochromis Niloticus [Linnaeus, 1758]: Its Biomedical Benefits for Children<br>(Shillewar, 2023) | This study was conducted by collecting Nile Tilapia fish (Oreochromis niloticus) from Wadi Ponds, Shekhachi wadi ponds, Nanded Maharashtra, India, with the assistance of fishermen in the morning. Subsequently, the fish were transferred to the College Laboratory, Institute of Pathology for further experiments in Maharashtra, India. The methods employed in this research included lipid profile analysis, analytical methods, chromatographic methods, and enzyme methods to explore the biochemical properties of Nile Tilapia fish.<br>The research design entailed the collection of fish samples from their natural habitat, followed by rigorous laboratory analysis utilizing a variety of analytical methods. | The research results indicate that Nile Tilapia fish (Oreochromis niloticus) possesses significant pharmaceutical potential in preventing unsaturated fatty acids, Vitamin B12, and Vitamin D deficiencies. Furthermore, this fish is rich in important nutrients such as protein, calcium, unsaturated fatty acids, and other minerals, supporting brain development and blood health.<br>Lipid profile analysis reveals that Nile Tilapia fish contains arachidonic acid (AA) and DHA, which play roles in prostaglandin metabolism and skin health. Additionally, this fish contains Vitamin B12, Vitamin D, and other minerals crucial for children's body functions, including the nervous system, red blood cell production, and the immune system.<br>Therefore, the research results suggest that consumption of Nile Tilapia fish can offer significant health benefits for children, particularly in supporting brain development, skin health, and overall bodily functions. This fish is recommended as a nutritious addition to the diet and is beneficial for children's health. |

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| 16 | Development, Preservation, and Chemical and Fatty Acid Profiles of Nile Tilapia Carcass Meal for Human Feeding (Godoy et al., 2012) | The research design involved the use of 100 tilapia fish remains from farms in municipalities in Maringá, Paraná State, Brazil. After washing and drying, the fish remains were soaked in a seasoned salt solution for 15 minutes, then warmed to reduce the surface water content. Next, the fish remains were processed by smoking using a manually made stainless steel smoke stove at a certain temperature and time. After the smoking process was complete, the fish remains were weighed to calculate the results and ground into flour. The samples were then vacuum packed, labeled, and stored frozen until analysis.<br>The research sample consisted of the remains of tilapia fish that were processed into flour, which was then analyzed to determine its proximate composition, fatty acid content, and microbiological quality. Chemical analysis was carried out to determine water, protein, fat, and ash content, while fatty acid analysis identified certain fatty acids important for human health. Additionally, the microbiological quality of the prepared food was evaluated to ensure safety for human consumption. [-T3]. | The results showed that the flavorful food prepared from the remains of tilapia fish had an average content of water, protein, total fat, and ash of 17.41%, 32.51%, 19.72%, and 26.22%, respectively. Twenty-three fatty acids were identified, including alpha-linolenic acid, eicosapentaenoic acid, and docosahexaenoic acid, which have high physiological and nutritional importance. The resulting food can be used to enrich and prepare various products for human consumption.<br>Furthermore, the research results also showed that the tilapia fish used for food preparation had an average weight of 670 ± 75 g. The weight of the fish remains before and after smoking showed a yield of 45.33%, with the fish remains losing 54.67% of their mass during the smoking process. Chemical analysis was also conducted to determine the proximate composition of fish remains processed into flour, including analysis of water, protein, fat, and ash content.<br>[-T4]. |
| 17 | Quality Improvement of Tilapia Fish Nuggets by Addition of Legume Flour as Extenders (Jayasinghe et al., 2013) | The research design used was experimental, employing samples of Tilapia fish nuggets made with the addition of various types of bean flour as extenders. Tilapia fish nugget samples were prepared with variations in composition among Tilapia fish meat, nut flour, and a mixture of spices. This research also entailed physical, chemical, and sensory evaluations of fish nuggets stored frozen for 3 months. The research was conducted at the Department of Food Science and Technology, Faculty of Animal Husbandry, Fisheries, and Nutrition, Wayamba University in Sri Lanka. | The research results indicated that the addition of bean flour as an extended to Tilapia fish nuggets could increase the protein content of the nuggets. Tilapia fish nuggets with the addition of peanut flour also exhibited good sensory quality and were deemed acceptable by the sensory test panelists. Furthermore, nuggets with the addition of nut flour demonstrated high moisture retention capabilities and maintained good quality during storage under frozen conditions for 3 months. Therefore, this research demonstrates that the addition of legume flour as an extender can enhance the nutritional, physical, and sensory quality of Tilapia fish nuggets. |

## DISCUSSION

### Benefits of Tilapia for Fulfilling Nutrition for Toddlers

Tilapia offers various benefits for fulfilling toddler nutrition. One of them is its high protein content, crucial for children's growth and development. Based on research results (Sapkota et al., 2020; Shillewar, 2023), tilapia also contains omega-3 fatty acids, beneficial for heart and brain health. The calcium content in tilapia supports the growth of healthy bones and teeth in toddlers. By consuming tilapia regularly, toddlers can acquire essential nutrients necessary for their growth and development. Tilapia is rich in protein, a vital nutrient for toddlers' growth and development. Protein aids in building and repairing body tissue, as well as in the formation of enzymes and hormones. Tilapia holds high nutritional value, comprising high biological value protein, vitamins, unsaturated fatty acids, and low cholesterol, making it a valuable source of essential nutrients for children (Luo et al., 2021). Research results indicate that food fortification with tilapia fish meal can enhance the protein, lipid, essential amino acid, and polyunsaturated fatty acid content of food products, thereby increasing their nutritional value (Guerra Monteiro et al., 2016). Tilapia is also rich in omega-3, omega-6, and lysine fatty acids, important for brain and eye development (Sarker et al., 2020; Stoneham et al., 2018). Omega-3 improves learning ability and memory, while omega-6 enhances visual development and nerve function. Tilapia also contains various important vitamins and minerals, such as vitamin B12, iron, phosphorus, and selenium (Shillewar, 2023). Vitamin B12 aids in the formation of red blood cells, iron helps prevent anemia, phosphorus supports bone and teeth development, and selenium enhances the immune system. Regular consumption of tilapia can help prevent stunting in toddlers. Tilapia serves as a valuable protein source for children, meeting their dietary needs and contributing to overall nutritional adequacy (Moyo & Rapatsa-Malatji, 2023). Enriching food products with tilapia protein concentrate can enhance their nutritional value, providing essential nutrients

for children's health (Goes et al., 2016). Tilapia meat, rich in protein with high biological value, vitamins, and unsaturated fatty acids, meets children's nutritional requirements (Aremu et al., 2021).

### The Effect of Tilapia on the Growth and Development of Stunted Toddlers

Consuming tilapia can positively contribute to the growth and development of toddlers, particularly in preventing stunting. The protein, omega-3 fatty acids, and calcium content in tilapia support bone growth, muscle, and brain development, crucial for toddlers (Shillewar, 2023). The nutrients in tilapia can also help reduce the risk of stunting, a condition of chronic malnutrition affecting children's physical growth and cognitive development (Sapkota et al., 2020). By regularly incorporating tilapia into toddlers' diets, their nutritional needs can be met, supporting optimal growth and preventing stunting. Tilapia fish meat contains high protein, crucial for children's growth and development (Godoy et al., 2012). Protein is essential for repairing body tissue, including muscles and bones, thus consuming tilapia can aid in increasing the growth of stunted toddlers. Protein in tilapia has been identified as a vital nutrient for growth, with limited efficacy of micronutrient supplementation in addressing stunting (Fikawati et al., 2021), as energy and protein intake are pivotal factors in preventing stunting among children, especially during the first thousand days of life (Kapantow et al., 2023). Adequate energy intake has been identified as a significant factor in preventing stunting in children aged 24-59 months (Hendraswari et al., 2021). Additionally, the fat and calcium content in tilapia also play an essential role in supporting healthy bone growth. Processing tilapia into healthy food products such as biscuits and floss can provide additional nutrition needed to accelerate growth recovery for stunted toddlers (Wahyuni et al., 2024). This aligns with other research (Angeles-Agdeppa & Toledo, 2020), stating that higher protein intake significantly reduces the risk of stunting among children. This is also consistent with research by (Yuliantini et al., 2022), revealing a positive relationship between protein consumption and stunting prevention in fishing families. Furthermore, (Soesanti, 2019) highlighted that a lack of protein sources such as fish can contribute to stunting in children under two years old. Research results (Nuryanto et al., 2022) demonstrate that tilapia's use as an additional food ingredient has the potential to increase the growth of stunted toddlers. Tilapia, rich in protein, calcium, and monounsaturated fatty acids, is crucial for children's growth and development. Consuming tilapia fish can provide good nutritional intake for stunted toddlers, aiding in increasing body weight, height, and overall nutritional status. Additionally, tilapia can provide essential nutrients such as essential fatty acids necessary for children's development. This aligns with other research indicating that the intake of fish and fish derivative products has been associated with increased linear growth in children, indicating that including fish in the diet can help overcome height growth disorders in stunted children (Adjepong et al., 2018). A research result (Azhar et al., 2023) in the village Kramajaya, West Lombok, stated that consumption of tilapia fish has a positive influence on the growth of stunted toddlers. Tilapia is a source of high-quality animal protein. Consuming sufficient animal protein is important for the growth and development of children, including toddlers. By increasing community access to animal protein sources through consuming tilapia, this program can help reduce stunting and improve community nutrition as a whole. Additionally, tilapia fish production can also help improve the economic welfare of families through increasing income from selling tilapia fish. Thus, tilapia fish production in Kramajaya Village can make a positive contribution to efforts to prevent stunting in toddlers and improve the nutritional status of the community as a whole. By increasing access to quality animal protein sources, such as tilapia, it is hoped that the growth of stunted toddlers can be properly stimulated, thereby helping to overcome conditions of growth failure caused by chronic malnutrition.

## CONCLUSION

Based on the research results, the intervention of giving tilapia to stunted toddlers showed a positive effect. Providing sources of animal protein, such as tilapia fish, can reduce stunting and improve nutritional status in toddlers. This indicates that consumption of tilapia can support the physical growth of stunted toddlers. Tilapia's nutritional content is rich in high-quality animal protein, an important component for building and repairing body tissue, including muscles and bones. Protein also plays a role in the synthesis of growth hormone, thus supporting the physical growth of toddlers. Apart from protein, tilapia also contains omega-3 fatty acids, which play an important role in brain development. Omega-3 helps improve the function of nerve synapses and the formation of brain cells, thus impacting toddlers' learning and memory abilities.

This research provides promising initial evidence about the potential of tilapia to overcome stunting. Regular consumption of tilapia, combined with a healthy diet and adequate psychosocial stimulation, has the potential to be an effective strategy in improving the growth and development of stunted toddlers.

Based on this conclusion, it is recommended to promote tilapia consumption in nutritional intervention programs to overcome stunting. Education to parents about the importance of tilapia for toddlers and interesting processing methods for children needs to be improved. With joint efforts from various parties, it is hoped that the problem of stunting in Indonesia can be overcome so that future generations can grow and develop optimally.

## REFERENCES


Adjepong, M., Yakah, W., Harris, W. S., Colecraft, E. K., Marquis, G. S., & Fenton, J. I. (2018). Association of Whole Blood Fatty Acids and Growth in Southern Ghanaian Children 2–6 Years of Age. Nutrients. https://doi.org/10.3390/nu10080954

Angeles-Agdeppa, I., & Toledo, M. B. (2020). Usual Nutrient and Food Intake of Filipino Stunted Children: Does It Matter? Journal of Food and Nutrition Research. https://doi.org/10.12691/jfnr-8-9-8

Aremu, M. O., Ibrahim, H., Gwadabe, A. S., Audu, S. S., Mohammed, M. A., Omosebi, M. O., & Aremu, E. D. (2021). Nutritional Evaluation of Clarias Gariepinus and Tilapia Quineesis Fishes From River Doma in Nasarawa State, Nigeria. European Journal of Nutrition & Food Safety. https://doi.org/10.9734/ejnfs/2021/v13i1130464

Azhar, F., Marzuki, M., Scabra, A. R., Muahiddah, N., Affandi, R. I., & Sumsanto, M. (2023). Produksi Ikan Nila Dengan Kolam Terpal di Desa Kramajaya, Lombok Barat Untuk Mencegah Stunting. Jurnal Gema Ngabdi, 5(3), 308–318. https://doi.org/10.29303/jgn.v5i3.374

Cai, Y., Wang, J., Jin, D.-Q., Li, Q., Chen, X., Pan, L., Yang, L., Wang, X., Qian, F., Wang, J., Zhong, T., & Wang, S. (2021). <i>Dhx15</I> Regulates Zebrafish Definitive Hematopoiesis Through the Unfolded Protein Response Pathway. Cancer Science. https://doi.org/10.1111/cas.15002

Damayanti, R. A., Muniroh, L., & Farapti, F. (2017). Perbedaan Tingkat Kecukupan Zat Gizi Dan Riwayat Pemberian Asi Eksklusif Pada Balita Stunting Dan Non Stunting. Media Gizi Indonesia. https://doi.org/10.20473/mgi.v11i1.61-69

Delgado, D. L. C., Rubio, C. A., & Cueva-Quiroz, V. A. (2021). Proximal and Sensory Analysis of Red Tilapia (Oreochromis Sp.) Fed With Fish Tanks Sediments From a Biofloc Culture. In Food Science and Technology. https://doi.org/10.1590/fst.24520

Dewi, N. U., & Mahmudiono, T. (2021). Effectiveness of Food Fortification in Improving Nutritional Status of Mothers and Children in Indonesia. International Journal of Environmental Research and Public Health. https://doi.org/10.3390/ijerph18042133

Elisanti, A. D. (2023). Macronutrient Intake in Stunted and Non-Stunted Toddlers in Jember, Indonesia. Journal of Public Health Research. https://doi.org/10.1177/22799036231197178

Elyana, P., Pangastuti, A., & Nugraheni, E. R. (2018). The Effect of Adding Coconut Pulp Resulting From Aspergillus Oryzae Fermentation in Commercial Feed on the Growth of Nile Tilapia (Oreochromis Niloticus). In Cell Biology and Development. https://doi.org/10.13057/cellbioldev/v020105

Endrinikapoulos, A., Afifah, D. N., Mexitalia, M., Djali, M., Hatimah, I., & Nuryanto, N. (2023). Study of the Importance of Protein Needs for Catch-Up Growth in Indonesian Stunted Children: A Narrative Review. Sage Open Medicine. https://doi.org/10.1177/20503121231165562

Erda, G. (2023). Counseling on Early Stunting Prevention Efforts With Riau University KKN Students in Munsalo Kopah Village. Jurnal Ilmiah Pengabdian Masyarakat Bidang Kesehatan (Abdigermas). https://doi.org/10.58723/abdigermas.v1i3.91

Fikawati, S., Syafiq, A., Ririyanti, R. K., & Gemily, S. C. (2021). Energy and Protein Intakes Are Associated With Stunting Among Preschool Children in Central Jakarta, Indonesia: A Case-Control Study. Malaysian Journal of Nutrition. https://doi.org/10.31246/mjn-2020-0074

Godoy, L., Franco, M. L. R. de S., Souza, N. E. de, Stevanato, F. B., & Visentainer, J. V. (2012). Development, Preservation, and Chemical and Fatty Acid Profiles of Nile Tilapia Carcass Meal for Human Feeding*. In Journal of Food Processing and Preservation. https://doi.org/10.1111/j.1745-4549.2011.00624.x

Goes, E. S. dos R., Souza, M. L. R. de, Michka, J. M. G., Kimura, K. S., Lara, J. A. F. de, Delbem, A. C. B., & Gasparino, E. (2016). Fresh Pasta Enrichment With Protein Concentrate of Tilapia: Nutritional and Sensory Characteristics. In Food Science and Technology. https://doi.org/10.1590/1678-457x.0020

Gowele, V. F., Kinabo, J., Jumbe, T., Rybak, C., & Stuetz, W. (2021). High Prevalence of Stunting and Anaemia Is Associated With Multiple Micronutrient Deficiencies in School Children of Small-Scale Farmers From Chamwino and Kilosa Districts, Tanzania. Nutrients. https://doi.org/10.3390/nu13051576

Guerra Monteiro, M. L., Mársico, E. T., Soares, M. S., Magalhães, A. O., Canto, A. C. V. C. S., Costa-Lima, B. R. C., Álvares, T. S., & Conte, C. A. (2016). Nutritional Profile and Chemical Stability of Pasta Fortified With Tilapia (Oreochromis Niloticus) Flour. Plos One. https://doi.org/10.1371/journal.pone.0168270

Hasan, I. K., Falaq, N., & Payu, M. R. F. (2023). Optimization Fuzzy Geographically Weighted Clustering With Gravitational Search Algorithm for Factors Analysis Associated With Stunting. Jurnal RESTI (Rekayasa Sistem Dan Teknologi Informasi), 7(1), 120–128.

Hasnawati, Syamsuryana Sabar, S. S., & Sumang Sumang, A. S. (2022). Profiling the Total Number of Bacteria in the Digestive Tract of Children With Stunting Conditions. Journal of Islamic Nursing. https://doi.org/10.24252/join.v7i2.32922

Hautvast, J., der Heijden, L. J. M. van, Luneta, A. K., Staveren, W. A. van, Tolboom, J. J. M., & van Gastel, S. M. (1999). Food Consumption of Young Stunted and Non-Stunted Children in Rural Zambia. European Journal of Clinical Nutrition. https://doi.org/10.1038/sj.ejcn.1600676

Hendraswari, C. A., Purnamaningrum, Y. E., Maryani, T., Widyastuti, Y., & Harith, S. (2021). The Determinants of Stunting in 24-59 Month-Old Children in Kulon Progo District 2019. Kesmas National Public Health Journal. https://doi.org/10.21109/kesmas.v16i2.3305

Hye, Q. M. A., Wizarat, S., & Lau, W. Y. (2016). The impact of trade openness on economic growth in China: An empirical analysis. The Journal of Asian Finance, Economics and Business, 3(3), 27-37.

Jayasinghe, C., Silva, S. S. G., & Jayasinghe, J. M. J. K. (2013). Quality Improvement of Tilapia Fish Nuggets by Addition of Legume Flour as Extenders. In Journal of Food and Agriculture. https://doi.org/10.4038/jfa.v6i1-2.5186

Jam, F. A. (2019). CRYPTO CURRENCY–A NEW PHENOMENON IN MONETARY CIRCULATION. Central Asian Journal of Social Sciences and Humanities, 4(1), 39-46.

Kapantow, N. H., Sanggelorang, Y., & Adam, H. (2023). Non-Exclusive Breastfeeding as the Risk Factor of Stunting Among Indonesian Toddler in Coastal Areas. International Journal of Community Medicine and Public Health. https://doi.org/10.18203/2394-6040.ijcmph20230208

Kementerian Kesehatan RI. (2018). Riset Kesehatan Dasar Tahun 2018.

Kusumaningrum, R., Indihatmoko, T. A., Juwita, S. R., Hanifah, A. F., Khadijah, K., & Surarso, B. (2020). Benchmarking of Multi-Class Algorithms for Classifying Documents Related to Stunting. Applied Sciences, 10(23). https://doi.org/10.3390/app10238621

Kusumawardani, H. D., & Ashar, H. (2022). Food Consumption Patterns for Children Under Two Years (Toddler) in Areas With High Stunting Prevalence. Iop Conference Series Earth and Environmental Science. https://doi.org/10.1088/1755-1315/1024/1/012071

Luo, J., Li, M., Zhang, Y., Zheng, M., & Ling, C. M. (2021). The Low-field NMR Studies the Change in Cellular Water in Tilapia Fillet Tissue During Different Drying Conditions. Food Science & Nutrition. https://doi.org/10.1002/fsn3.2221

Mandal, A. B., Biswas, T., Mondal, N. S., Dey, S., Patra, A., Das, S., Mondal, A. K., & Dey, A. (2021). Assessment of the Nutritional Quality of Fish Cultured in Samdihi, an Open Cast Coalpit at the Raniganj Coal Field Areas, West Bengal, India. Lakes & Reservoirs Research & Management. https://doi.org/10.1111/lre.12351

Moyo, N. A. G., & Rapatsa-Malatji, M. M. (2023). A Review and Meta-Analysis of Selected Plant Protein Sources as a Replacement of Fishmeal in the Diet of Tilapias. In Annals of Animal Science. https://doi.org/10.2478/aoas-2022-0084

Mtongwa, R. H., Festo, C., & Elisaria, E. (2021). A Comparative Analysis of Determinants of Low Birth Weight and Stunting Among Under Five Children of Adolescent and Non-Adolescent Mothers Using 2015/16 Tanzania Demographic and Health Survey (TDHS). BMC Nutrition. https://doi.org/10.1186/s40795-021-00468-6

Nuryanto, N., Afifah, D. N., Sulchan, M., Martosuyono, P., Ihsani, K., & Kurniastuti, P. L. (2022). Potential of Nile Tilapia (Oreochromis niloticus) as an Alternative Complementary Food Ingredient for Stunting Children. Open Access Macedonian Journal of Medical Sciences, 10(A), 1170–1177. https://doi.org/10.3889/oamjms.2022.9650

Nyoman Supariasa, I. D., Fajar, I., Khairuddin, K., & Adelina, R. (2023). Analyzing Nutritional Factors That Affect Toddler's Stunting in Malang Regency, Indonesia. Open Access Macedonian Journal of Medical Sciences. https://doi.org/10.3889/oamjms.2023.10199

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., & Brennan, S. E. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. International Journal of Surgery, 88, 105906.

Rizkika, M. (2023). Factors Related to Stunting Incidence in Toddlers in the Working Area of the Waborobo Health Center, Betoambari District, Baubau City in 2023. Journal of Social Research. https://doi.org/10.55324/josr.v2i9.1363

Santos Mendes, L. F., & Costa-Filho, A. J. (2022). A Gold Revision of the Golgi Dynamics (GOLD) Domain Structure and Associated Cell Functionalities. Febs Letters. https://doi.org/10.1002/1873-3468.14300

Sapkota, S., Laudari, S., & Sapkota, S. D. (2020). Meeting the Nutritional Needs for the Children: The Role of Fish Products From the Emerging Aquaculture of Nepal. In International Journal of Social Sciences and Management. https://doi.org/10.3126/ijssm.v7i4.32469

Sarker, P. K., Kapuscinski, A. R., McKuin, B., Fitzgerald, D. S., Nash, H., & Greenwood, C. (2020). Microalgae-Blend Tilapia Feed Eliminates Fishmeal and Fish Oil, Improves Growth, and Is Cost Viable. In Scientific Reports. https://doi.org/10.1038/s41598-020-75289-x

Sayuti, I., Yudha Pratama, F., Manuel Sihotang, L., Adlina Rifani, M., Dini Dameria, P., Annasya Varandra, K., Musdalifah, G., Gleri Lubis, S., & Ferdinandsyah, A. (2023). Pelatihan Pengolahan Ikan Oreochromis niloticus Dan Pangaside Menjadi Cemilan Sehat Dan Bergizi Dalam Upaya Pengentasan Stunting di Kampung Sawit Permai. Jurnal Hasil Kegiatan Pengabdian Masyarakat Indonesia, 1(4), 133–143. https://doi.org/10.59024/faedah.v1i4.352

Shillewar, K. S. (2023). Oreochromis Niloticus [ Linnaeus, 1758] Its Biomedical Benefits for Children's. In The American Journal of Interdisciplinary Innovations and Research. https://doi.org/10.37547/tajiir/volume05issue07-09

Shin, M.-K., Choi, J. Y., Kim, S. Y., Kim, E. Y., Lee, S. H., Chung, K. S., Jung, J. Y., Park, M. S., Kim, Y. S., & Kang, Y. A. (2021). Association of Protein Consumption and Energy Intake on Sarcopenia in Tuberculosis Survivors. Therapeutic Advances in Chronic Disease. https://doi.org/10.1177/20406223211056712

Simarmata, V. P. A., & Suryanegara, W. (2021). The Knowledge Relationship between Mothers who have Children Aged 2-5 years about Anemia toward Stunting Incidence. Journal of Drug Delivery and Therapeutics, 11(4), 170–179.

Soesanti, I. (2019). Gambaran Pola Makan Anak Baduta Pendek Di Desa Pasongsongan (Wilayah Pesisir Kabupaten Sumenep). In Gorontalo Journal of Public Health. https://doi.org/10.32662/gjph.v2i2.738

Stoneham, T. R. J., Kuhn, D. D., Taylor, D. B., Neilson, A. P., Smith, S. A., Gatlin, D. M., Chu, H. S. S., & O'Keefe, S. F. (2018). Production of Omega-3 Enriched Tilapia Through the Dietary Use of Algae Meal or Fish Oil: Improved Nutrient Value of Fillet and Offal. In Plos One. https://doi.org/10.1371/journal.pone.0194241

Taoufiq, Z., Ninov, M., Villar-Briones, A., Wang, H. Y., Sasaki, T., Roy, M. C., Beauchain, F., Mori, Y., Yoshida, T., Takamori, S., Jahn, R., & Takahashi, T. (2020). Hidden Proteome of Synaptic Vesicles in the Mammalian Brain. Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.2011870117

Tenyang, N., Zambou, G. T., Ponka, R., & Womeni, H. M. (2020). Antioxidant Effect of Plants Aqueous Extract on Lipid Stability of &Amp;lt;i>Oreochromis Niloticus</I> During Traditional Sun and Smoke Drying in Far-North Cameroon. Food and Nutrition Sciences. https://doi.org/10.4236/fns.2020.118060

Wahyuni, S., De Lux Putra, E., Prasetyo, B. E., & Laila, L. (2024). Education and Workshop of Healthy Food Prepared from Tilapia Fish to Prevent Stunting at Biru-Biru District, Deli Serdang. 8(Februari), 75–83. https://doi.org/10.31849/dinamisia.v8i1.16654

Yuliantini, E., Kamsiah, K., Maigoda, T. C., & Ahmad, A. (2022). Asupan Makanan Dengan Kejadian Stunting Pada Keluarga Nelayan Di Kota Bengkulu. In Action Aceh Nutrition Journal. https://doi.org/10.30867/action.v7i1.579