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Potential of Fermented Eggs for Stunting Prevention: Literature Review

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Abstract

Stunting is a condition of malnutrition that hampers children's physical growth due to inadequate nutritional intake. This condition impacts health, cognitive development, and increases the risk of diseases. The primary causes of stunting include insufficient nutrition, infections, food security, childcare practices, healthcare services, and sanitation. The prevalence of stunting in Indonesia reached 21.6% in 2022. The government has issued Presidential Regulation No. 72 of 2021 to accelerate stunting reduction. To explore the potential of fermented eggs as a nutritional intervention to prevent stunting, this study aims to identify the nutritional benefits of fermented eggs, assess the enhancement of nutrient bioavailability through fermentation, and evaluate the effectiveness of fermented eggs in improving children's nutritional status. This literature review gathers and analyses studies related to the nutritional impact of fermented eggs. Fermentation enhances the digestibility and bioavailability of proteins, fats, and micronutrients such as B vitamins, folate, and iron. This process breaks down complex proteins and fats into simpler, more absorbable forms. Fermented eggs present a potential solution for preventing stunting by improving digestibility and nutrient bioavailability while providing beneficial probiotics that support overall health. Given their nutritional profile, fermented eggs can serve as an effective and sustainable nutritional intervention.

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Introduction

Stunting is a nutritional condition that occurs when young children experience impaired physical growth, usually caused by a lack of balanced and adequate nutritional intake. Stunting can affect children's health and development, such as reducing physical, mental, and social abilities. Stunting can also increase the risk of disease and other health disorders. Inadequate nutritional intake and insufficient nutrient intake can be caused by various factors, such as a lack of balanced dietary consumption, lack of energy and protein intake, and lack of essential micronutrient intake. Infectious diseases can also contribute to stunting. Infectious diseases can lead to chronic malnutrition and prolonged growth disorders. Stunting can occur if a child has recurrent or chronic infectious diseases, such as diarrhea, pneumonia, and other diseases (Rohmania et al., 2024; Sumartini, 2022).

Stunting in children is a cumulative process, as demonstrated by several studies. This process begins in pregnancy, continues throughout childhood, and lasts throughout the life cycle. Stopping in children tends to develop, and the greatest chance of increased stunting occurs in the first two years of life.

The causes of stunting can be divided into two types, namely, direct and indirect. Direct causes include food consumed and infections that children may experience, while indirect causes include family food insecurity, child-care patterns, health care, and environmental sanitation. The factor that indirectly affects poor nutrition is knowledge. Ignorance of the vital role of food in the health of the body is one of the triggers of the lack of nutrient supply to the body. In addition, there are additional factors of direct cause, such as exclusive breastfeeding practices, breastfeeding, maternal nutrient intake, and feeding practice (Fitri, 2019). The prevalence of stunting in the 2022 Indonesian Nutrition Status Survey (SSGI) was 21.6%. According to UNICEF data from 2017, approximately 92 million (13.5%) children under five worldwide are underweight, 151 million (22%) are stunted, and 51 million (7.5%) are wasted. Most of them are from Africa and Asia. As part of Indonesia's commitment to accelerate the reduction of stunting, Presidential Regulation (Perpres) No. 72 of 2021 on the Acceleration of Stunting Reduction was issued. This regulation serves as a foundation to strengthen the intervention framework and institutions in efforts to reduce stunting. The government aims to reduce the stunting prevalence to 14 percent by 2024 and achieve sustainable development goals by 2030,

based on 2024 results (Kementerian Sekretariat Negara RI, 2023).

To achieve this target, specific and sensitive interventions are implemented. One specific intervention is providing complementary feeding to toddlers. Animal protein sources are crucial for nutritional intake during the critical development period, particularly in the first 1,000 days of life (Harrison et al., 2023). Consuming animal protein during this period can improve growth, cognitive function, and nutritional status in children. Long-term consumption of protein sources can enhance the nutritional status of toddlers. One relatively affordable and accessible protein source is eggs, which are also rich in nutrients. Eggs have great potential to improve maternal and child nutrition during the first 1,000 days of life. Despite their small size, eggs contain many micronutrients essential for a baby's growth and high-quality protein important as complementary food (Jin & Iannotti, 2014).

Stunting is a chronic malnutrition condition that results in impaired physical and cognitive development. The World Health Organization (WHO) identifies early childhood malnutrition as a major global health issue, with long-term consequences such as reduced academic performance and increased susceptibility to non-communicable diseases. Stunting often originates from inadequate nutrient intake during the first 1,000 days of life, exacerbated by infections and poor maternal nutrition (Soliman et al., 2021).

Recent research highlights the importance of animal protein in mitigating stunting, particularly through eggs, which provide essential nutrients such as high-quality proteins, choline, and selenium (Iannotti et al., 2020). However, traditional egg consumption may not always optimize nutrient absorption due to anti-nutritional factors. Fermentation, a process widely used to enhance food bioavailability, has been shown to improve protein digestibility and increase the bioavailability of key micronutrients. This review explores existing research on fermented eggs, differentiating itself from prior reviews by focusing specifically on their application in stunting prevention (Endrinikapoulos et al., 2023).

Complementary Foods

Complementary foods are foods and drinks given to children aged 6-24 months to meet their needs. The purpose of Complementary foods is to add nutrients necessary to the child's body (Fitri, 2019). Complementary foods are foods and drinks given to children aged 6-24 months to meet their needs. The purpose of Complementary foods is to add nutrients necessary to the child's body (Koes, 2014).

Children who experience stunting need a balanced and adequate nutritional intake to support optimal growth, as can be seen in Table 1.

Stunting in children is a cumulative process, as several studies have shown. This process begins during pregnancy, continues throughout childhood, and persists throughout the life cycle. Stunting tends to develop with the greatest likelihood of worsening occurring within the first two years of life (Kusumayanti & Herawati, 2021; Isnarti et al., 2019; Wati & Musnadi, n.d.).

Pathophysiology of Stunting

Nutritional deficiencies from food intake can cause the body to use its energy reserves, eventually leading to tissue degradation (Helmyati et al., 2022). This degradation is often marked by weight loss or impaired height growth. At this stage, chemical changes in the blood or urine begin to occur. Subsequently, the body starts experiencing a decline in function, and the characteristic signs of nutrient deficiency appear, resulting in anatomical changes in the body, which are specific indicators of the condition (Par'i, 2017).

Causes of Stunting

The causes of stunting are categorized into direct and indirect factors. Direct causes include the quality of food consumed and infections, while indirect causes involve household food security, child care practices, healthcare services, and environmental sanitation. A significant indirect factor is the lack of knowledge about proper nutrition, leading to insufficient nutrient intake (Bustami & Ampera, 2020; Purnamaningrum et al., 2021).

Exclusive breastfeeding for the first six months is crucial, providing all necessary nutrients and reducing the risk of malnutrition. After six months, complementary feeding (MPASI) is introduced to supplement the child's diet, gradually adjusting in texture and portion as the child develops (Fitri, 2019). Proper feeding practices, especially during the first 24 months, are essential to meet the child's nutritional needs. Initially, infants are exclusively breastfed, but as they grow, they are gradually introduced to solid foods. As children transition into the toddler stage, their nutrient requirements increase, necessitating more adult-like meals. However, toddlers may have reduced appetites, making it important for parents to create a positive and engaging eating environment to ensure adequate nutrition (Koes, 2014; Azwar, 2011).

Recommended Nutrient Intake

Recommended Nutrient Intake is a standard value indicating the average daily nutrient requirement that must be met by individuals based on characteristics such as age, gender, physical activity level, and physiological conditions to live healthily (Kementerian Kesehatan, 2019).

The need for energy and nutrients during early childhood is very high. Table 2 shows that as age increases, so does the need for energy and nutrients. This is because energy and nutrients are needed to support growth. A lack of energy and protein intake in early childhood can lead to Protein-Energy Malnutrition (PEM), which is a major cause of stunted growth (Sundari & Nuryanto, 2016).

Fermented Product For stunting

Achieving the stunting reduction target requires specific and sensitive interventions. One specific intervention is providing complementary feeding for toddlers. Animal protein sources are crucial for nutritional intake during critical development periods, such as the First 1000 Days of Life. Consuming animal protein sources during this period can improve growth, cognitive

Table 1. Content of nutrients

Nutrient	Function	Sources
Carbohydrates	Main energy source for children's bodies	Rice, wheat, potatoes
Fats	Brain growth and development, skin, and hair health	Meat, fish, eggs
Protein	Formation of new healthy cells, body functions	Chicken, eggs, fish, milk, legumes
Vitamins	Immune strength and bone growth	Vitamin D (sunlight), Vitamins B, A, C, E (milk, fish, vegetables)
Calcium	Optimal bone formation	Milk, fish, vegetables
Zinc	Body growth and development	Meat, fish, vegetables
Minerals	Bone growth, brain development, anemia prevention	Iron (meat, legumes), Phosphorus, Magnesium (fish, vegetables), Iodine (fish, vegetables)
Selenium	Antioxidant, immune system support, thyroid function	Brazil nuts, eggs, fish, chicken

function, and children's nutritional status. Long-term consumption of animal protein sources can enhance toddlers' nutritional status. One relatively affordable and accessible source of protein is eggs, which also contain many nutrients. Eggs have significant potential to improve maternal and child nutrition during the First 1000 Days of Life (HPK). Despite their small size, eggs contain many micronutrients needed by babies for growth, as well as high-quality protein, which is essential as complementary food (Jin & Iannotti, 2014).

A study in Malawi by Sight and Life found that essential amino acids, lipids, and choline levels were significantly lower in stunted children than in non-stunted children (Chikhungu & Madise, 2014). Eggs are an excellent nutrient source. Studies on the effects of egg consumption on women and children have shown significant growth improvements (Sartikah, 2023).

Eggs are versatile and nutrient-dense food that plays an essential role in human nutrition. Egg composition and quality can be influenced by various factors, including hen diet and processing methods used (Réhault-Godbert et al., 2019). One area of egg research that has garnered increasing attention is the impact of egg fermentation on micronutrient and macronutrient profiles for stunting prevention. Consuming animal protein sources during this period can improve children's growth, cognitive function, and nutritional status. Long-term consumption of animal protein sources can enhance toddlers' nutritional status. One relatively affordable and accessible protein source is eggs, which also contain many nutrients (Jin & Iannotti, 2014).

Egg Fermentation

Egg fermentation is a process that involves treating eggs with the help of certain microorganisms, such as bacteria or yeast, to enhance their nutrient content. Fermented cereal-based products, for example, have been shown to have better nutritional attributes, including increased levels of vitamins, minerals, and certain bioactive compounds. Similarly, egg fermentation may have the potential to alter its micronutrient and macronutrient content, potentially improving its overall nutritional value. Lactic acid bacteria commonly involved in food fermentation can produce various secondary metabolites with potential health benefits. Additionally, the introduction of live microorganisms through fermented eggs can contribute to gut microbiota modulation, which has been linked to various aspects of human health. Although existing literature on the impact of egg fermentation on micronutrient and macronutrient profiles is limited, some studies have provided insights into its potential effects (Rossi et al., 2013).

Eggs are a rich source of protein, fats, and micronutrients, making them an essential component of a balanced diet. The nutritional composition of eggs can be shown in Table 3.

Providing eggs significantly increases infants dietary diversity, especially in the consumption of meat and fish, according to previous research. In this study, the population was infants living in peri-urban Jouberton in the Matlosana Municipality area. Inclusion Criteria: Infants aged 6 to <9 months without allergies or intolerances to eggs, not experiencing severe acute malnutrition, severe anemia, or illnesses requiring hospitalization. The study design was a Randomized Controlled Trial with a parallel design. Infants were recruited at the household level and through clinics during 14-week vaccination.

Micronutrient Status Significant increases in copper and vitamin B6 levels were observed in the egg-fed group compared to the control group. This study shows that consuming one egg per day can increase dietary diversity and certain micronutrient statuses in infants, although it does not significantly increase growth after 6 months (Faber et al., 2022).

Eggs are rich in various micronutrients, including vitamins A, D, E, and B12, as well as minerals like iron and zinc. The fermentation process can increase the bioavailability of these micronutrients, making them more readily absorbable by the body. This is particularly important for populations at risk of micronutrient deficiencies. Fermented eggs have the potential to play a role in enhancing nutrient intake in vulnerable populations. Traditional food processing methods like

Table 1. Recommendation nutrition intake for a day

	Age (kg)	Height (cm)	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrates (g)	Selenium (mcg)
6-11 months	9	72	800	15	35	105	17
1-3 years	13	92	1350	20	45	215	17
4-6 years	19	113	1400	25	50	220	20

fermentation have been shown to improve nutrient bioavailability in other food sources. Given the importance of adequate micronutrient intake for children's growth and development, incorporating fermented eggs into the diet of stunted children may offer a practical and effective strategy for addressing nutritional deficiencies (Faber et al., 2022).

Table 2. Nutritional composition of 100 g of eggs

Nutrient	Composition
Energy (kkal)	162
Protein (g)	12.8
Fat (g)	11.5
Carbohydrate (g)	0.7
Calcium (mg)	54
Selenium (µg)	15-25
Iron (mg)	2.7
Phospor (g)	180
Vitamin A (IU)	900
Vitamin B1 (mg)	0.10

Source: Komala, 2008

Protein: Eggs are a significant source of protein, with about 6.3 grams per large egg, Fats: Eggs contain various types of fats, with the majority being unsaturated fats. Micronutrients: Eggs are a good source of several micronutrients, such as calcium, iron, and zinc (Miranda et al., 2015)

Fermented egg products, such as those produced through precision fermentation, offer a unique nutritional profile and benefits. The protein content in fermented egg products can be bio-identical to traditional eggs, maintaining the same nutritional profile and functional properties such as foaming, coagulation, and emulsification. The efficiency of the fermentation process can produce egg protein more efficiently and on a larger scale compared to traditional egg production methods (Zollman Thomas et al., 2023).

Fermented egg products are considered more sustainable and environmentally friendly due to the reduced resource requirements and lower pandemic risk. Egg fermentation involves the controlled breakdown of egg proteins and fats by beneficial microorganisms, such as lactic acid bacteria, in a saline solution. This process enhances the nutritional value and digestibility of the eggs by maximizing the full potential of the macronutrients and micronutrients contained within them. Fermentation breaks down complex proteins by fermentation enzymes into simpler polypeptides and amino acids. This makes the protein easier to digest, which is particularly beneficial for individuals with digestive issues or sensitivities to eggs. Additionally, fermentation transforms fats into more easily digestible forms, increasing their bioavailability and nutritional value.

Fermentation also enhances the bioavailability of micronutrients such as B vitamins, folate, and iron. These nutrients become more easily absorbed by the body, providing greater nutritional benefits. Fermented eggs also contain probiotics, which are beneficial bacteria that help balance the gut microbiome. This contributes to various aspects of health, including immune function, mental well-being, and weight management (Mangieri et al., 2023).

Saccharomyces cerevisiae offers significant benefits in fermentation processes, including efficient sugar fermentation, production of aromatic compounds that enhance the sensory quality of beverages, increased antioxidant capacity in fermented products, and an extended shelf life of the fermented foods (Sharma et al., 2020) (Table 4).

The effect of fermentation with *S. cerevisiae* has been studied in relation to the biochemical characteristics of tapioca (Kustyawati et al., 2013). Using the inoculum *S. cerevisiae*, 1 gram of Fermipan powder was aseptically weighed and dissolved in 9 ml of distilled water. The fermentation process began by preparing a tapioca suspension from 1000 grams of wet cassava, resulting in approximately 1000 ml of starch suspension. This suspension was inoculated with 1 ml of Saccharomyces cerevisiae culture at a concentration of 10^10 cells/mL and stirred until homogeneous. The suspension was then incubated at 30°C for 12, 24, 36, and 48 hours. After fermentation, the starch precipitate was dried and ground. The addition of Saccharomyces cerevisiae in tapioca production can modify the starch properties, including increasing the levels of protein and certain minerals, although the growth of *S. cerevisiae* was not yet. Fermenting *S. cerevisiae* enhances selenium content in the biomass in the form of organic selenium, which is more bioavailable and less toxic. Optimizing fermentation conditions can also increase protein production in the biomass. Selenium-enriched *S. cerevisiae* improves meat quality by enhancing antioxidant capacity, particularly benefiting broiler chickens. Maintaining sterile fermentation conditions is essential to prevent contamination and preserve the yeast's beneficial properties (Hendawy et al., 2021; Jach et al., 2022; Knez et al., 2023).

The study titled "Effects of Selenium-Enriched Yeast on Performance, Egg Quality, Antioxidant Balance, and Egg Selenium Content in Laying Ducks (2020)" involved 32-week-old female Longyan ducks during their mid-late laying period. The ducks were fed a basal diet containing corn and soybean sprouts. Three groups received selenium (Se) supplements through Se yeast at three different concentration levels (0.05 mg/kg, 0.15 mg/kg, and 0.25 mg/kg). Supplementation with Se yeast did not significantly affect laying performance and egg quality. However, antioxidant enzyme activity increased, and plasma malondialdehyde levels decreased, indicating improved antioxidant balance. Selenium content in the eggs increased with higher Se concentrations in the diet (Zhang et al., 2020).

In addition to these benefits, fermentation can reduce the allergenicity of eggs. The fermentation process can break down proteins that cause allergies, making fermented eggs a suitable option for individuals with egg sensitivities. Furthermore, fermentation is a natural preservation method that extends the shelf life of fermented eggs compared to fresh eggs, thereby reducing food waste. Overall, egg fermentation enhances nutritional value and digestibility by breaking down macronutrients and increasing the bioavailability of micronutrients. Additionally, fermented eggs contain probiotics and may have lower allergenicity, making them a nutritious and versatile food choice (Pi et al., 2022).

Fermented eggs have a different nutritional profile compared to traditional eggs, with improved

Table 4. The role of microbial during fermentation

Study	Fermentation	Key findings
(Rossi et al., 2013)	Lactic acid bacteria	Improved protein digestibility and micronutrient availability
(Zhang He et al., 2023)	Selenium-enriched yeast	Increased antioxidant activity and enhanced selenium bioavailability
(Sharma et al., 2020)	*Saccharomyces cerevisiae*	Enhanced shelf life and probiotic content

digestibility and bioavailability of macronutrients and micronutrients. The fermentation process alters the nutritional composition of eggs, providing additional benefits that can help prevent stunting. Fermentation significantly impacts macronutrients; fermentation enzymes break down complex proteins into simpler polypeptides and amino acids, making them easier to digest. This process is particularly beneficial for individuals with digestive issues or sensitivities to eggs. Furthermore, fermentation transforms fats into more digestible forms, increasing their bioavailability and nutritional value (Ajayi & Awe, 2022; Lyu et al., 2022).

In terms of micronutrients, fermentation enhances the bioavailability of B vitamins, folate, and iron. These micronutrients become more easily absorbed by the body, thereby enhancing their overall nutritional impact. Fermented eggs also contain probiotics, which are beneficial bacteria that help balance the gut microbiome. A balanced gut microbiome is associated with various health aspects, including immune function, mental well-being, and weight management (Ertop & Bektaş, 2018; Pineda-Vadillo et al., 2020).

Beyond these primary benefits, fermented eggs offer significant additional effects. The fermentation process can break down proteins that cause egg allergies, making fermented eggs a potential choice for those with egg allergies or sensitivities. Moreover, fermentation is a natural preservation method that extends the shelf life of fermented eggs compared to fresh eggs, reducing food waste (Tugiyanti & Iriyanti, n.d.;Siregar et al., 2016).

Despite extensive research on stunting interventions, fermented eggs remain an underexplored yet promising solution. Fermentation modifies egg proteins and lipids, breaking them into more bioavailable forms while simultaneously enriching them with probiotics. Unlike fresh eggs, fermented eggs may also have longer shelf life, making them a more sustainable nutritional option for food-insecure populations (Faber et al., 2022).

Several studies have reviewed fermented foods such as yogurt and tempeh in addressing malnutrition, but few have examined fermented eggs in this context. This review synthesizes existing literature on the benefits of fermented eggs, identifies gaps in research, and presents their potential role in stunting reduction strategies.

Conclusion

Fermentation of eggs can enhance the bioavailability and digestibility of macronutrients and micronutrients, such as proteins, B vitamins, folate, and iron. Fermented eggs also contain probiotics that help balance the gut microbiome, supporting digestive health and immunity. Fermentation can reduce egg allergenicity, making it safer for individuals sensitive to egg proteins. With an improved nutritional profile, fermented eggs can be an effective source of nutrition in preventing stunting in children.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Ajayi, O. A., & Awe, O. T. (2022). Nutritional And Anti-Nutritional Composition Of Fermented/Pickled Garden Egg (Solanum Aethiopicum L.). *Food Scientech Journal*, *4*(1), 8. https://doi.org/10.33512/Fsj.V4i1.14004

Azwar, S. (2011). *Sikap dan Perilaku Dalam: Sikap Manusia Teori dan Pengukurannya*. Pustaka Pelajar.

Bustami, B., & Ampera, M. (2020). The Identification Of Modeling Causes Of Stunting Children Aged 2–5 Years In Aceh Province, Indonesia (Data Analysis Of Nutritional Status Monitoring 2015). *Open Access Macedonian Journal Of Medical Sciences*, *8*(E), 657–663. https://doi.org/10.3889/Oamjms.2020.4659

Chikhungu, L. C., & Madise, N. J. (2014). Seasonal Variation Of Child Under Nutrition In Malawi: Is Seasonal Food Availability An Important Factor? Findings From A National Level Cross-Sectional Study. *Bmc Public Health*, *14*(1), 1146. https://doi.org/10.1186/1471-2458-14-1146

Endrinikapoulos, A., Afifah, D. N., Mexitalia, M., Andoyo, R., 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*, *11*. https://doi.org/10.1177/20503121231165562

Faber, M., Malan, L., Kruger, H. S., Asare, H., Visser, M., Mukwevho, T., Ricci, C., & Smuts, C. M. (2022). Potential Of Egg As Complementary Food To Improve Nutrient Intake And Dietary Diversity. *Nutrients*, *14*(16), 3396. https://doi.org/10.3390/Nu14163396

Fazriyati Siregar, R., Ni'matullah Al–Baarri, A., Hintono, A., Budi Pramono, Y., & Budi Muhammad Abduh, S. (2016). Purifikasi Dan Profil Protein Ovotransferrin Dari Eggshell Membrane Telur Ayam Ras Dan Buras. *Jurnal Teknologi Dan Industri Pangan*, *27*(1), 87–94. https://doi.org/10.6066/Jtip.2016.27.1.87

Fitri, I. & W. R. N. (2019). *Gizi Reproduksi Dan Bukti*. Gosyen.

Harrison, L., Padhani, Z., Salam, R., Oh, C., Rahim, K., Maqsood, M., Ali, A., Charbonneau, K., Keats, E. C., Lassi, Z. S., Imdad, A., Owais, A., Das, J., & Bhutta, Z. A. (2023). Dietary Strategies For Complementary Feeding Between 6 And 24 Months Of Age: The Evidence. *Nutrients*, *15*(13), 3041. https://doi.org/10.3390/Nu15133041

He, P., Zhang, M., Zhang, Y., Wu, H., & Zhang, X. (2023). Effects Of Selenium Enrichment On Dough Fermentation Characteristics Of Baker's Yeast. *Foods*, *12*(12). https://doi.org/10.3390/Foods12122343

Helmyati, S., Wisnusanti, S. U., Wigati, M., Aryanti, L., Suseno, S., & Suwignyo, B. (2022). The Given Of Fermented Drink Fortified With Fe-Zn (Intake) For Under-5-Year-Old Children As Integration Of Research Products And Stunting Prevention Program: An Action Research. *Open Access Macedonian Journal Of Medical Sciences*, *10*(B), 812–815. https://doi.org/10.3889/Oamjms.2022.8346

Hendawy, A. O., Sugimura, S., Sato, K., Mansour, M. M., Abd El-Aziz, A. H., Samir, H., Islam, Md. A., Bostami, A. B. M. R., Mandour, A. S., Elfadadny, A., Ragab, R. F., Abdelmageed, H. A., & Ali, A. M. (2021). Effects Of Selenium Supplementation On Rumen Microbiota, Rumen Fermentation, And Apparent Nutrient Digestibility Of Ruminant Animals: A Review. *Fermentation*, *8*(1), 4. https://doi.org/10.3390/Fermentation8010004

Hendek Ertop, M., & Bektaş, M. (2018). Enhancement Of Bioavailable Micronutrients And Reduction Of Antinutrients In Foods With Some Processes. *Food And Health*, 159–165. https://doi.org/10.3153/Fh18016

Iannotti, L. L., Chapnick, M., Nicholas, J., Gallegos-Riofrio, C. A., Moreno, P., Douglas, K., Habif, D., Cui, Y., Stewart, C., Lutter, C. K., & Waters, W. F. (2020). Egg Intervention Effect On Linear Growth No Longer Present After Two Years. *Maternal & Child Nutrition*, *16*(2). https://doi.org/10.1111/Mcn.12925

Isnarti, A. P., Nurhayati, A., & Patriasih, R. (2019). *Pengetahuan Gizi Ibu Yang Memiliki Anak Usia Bawah Dua Tahun Stunting Di Kelurahan Cimahi (Mother's Nutrition Knowledge For Toddlers Stunting In Cimahi Village)* (Vol. 8, Issue 2).

Jach, M. E., Serefko, A., Ziaja, M., & Kieliszek, M. (2022). Yeast Protein As An Easily Accessible Food Source. *Metabolites*, *12*(1), 63. https://doi.org/10.3390/Metabo12010063

Jin, M., & Iannotti, L. L. (2014). Livestock Production, Animal Source Food Intake, And Young Child Growth: The Role Of Gender For Ensuring Nutrition Impacts. *Social Science And Medicine*, *105*, 16–21. Https://doi.org/10.1016/J.Socscimed.2014.01.001

Kementerian Sekretariat Negara RI. (2023). *Gov't Sets Target to Reduce Stunting Rate to 14 Percent by 2024.* https://setkab.go.id/en/govt-sets-target-to-reduce-stunting-rate-to-14-percent-by-2024/

Kementerian Kesehatan. (2019). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 28* .

Knez, E., Kadac-Czapska, K., & Grembecka, M. (2023). Effect Of Fermentation On The Nutritional Quality Of The Selected Vegetables And Legumes And Their Health Effects. *Life*, *13*(3), 655. Https://Doi.org/10.3390/Life13030655

Koes, Irianto. (2014). *Gizi Seimbang Dalam Kesehatan Reproduksi (Balanced Nutrition In Reproductive Health)*. Alfabeta.

Komala I. (2008). *Kandungan Gizi Produk Peternakan*. Student Master Animal Science, Faculty of Agriculture-UPM. Lampung, Bandar Lampung.

Kustyawati, M. E., Sari, M., & Haryati, T. (2013). Efek Fermentasi Dengan Saccharomyces Cerevisiae Terhadap Karakteristik Biokimia Tapioka Effect Of Fermentation Using Saccharomyces Cerevisiae On The Biochemical Properties Tapioca. In *Agritech* (Vol. 33, Issue 3).

Kusumayanti, D. & Herawati, D. M. D. (2021). Asupan Gizi dan Pola Makan Anak Stunting Usia 12-23 Bulan Di Desa Lokasi Khusus (Lokus) Kabupaten Cirebon. *Gizi Indonesia*, *44*(2), 167–176. https://doi.org/10.36457/Gizindo.V44i2.446

Lyu, S., Yang, Q., Duan, X., Liu, X., Du, Z., Shang, X., Xu, M., Liu, J., Pan, F., & Zhang, T. (2022). Protective Effects And Potential Mechanisms Of Fermented Egg-Milk Peptides On The Damaged Intestinal Barrier. *Frontiers In Nutrition*, *9*. Https://Doi.org/10.3389/Fnut.2022.1068877

Mangieri, N., Rosciano, G., Porcellato, D., Winther, A. R., De Noni, I., Fracassetti, D., Foschino, R., & Vigentini, I. (2023). Sustainability Of Food Side Streams: A Case Study Of Fermented Blends Made With Sour Whey And Sunflower Press Cake Powder Using The Back-Slopping Technique. *Frontiers In Sustainable Food Systems*, *7*. Https://Doi.org/10.3389/Fsufs.2023.1166002

Miranda, J., Anton, X., Redondo-Valbuena, C., Roca-Saavedra, P., Rodriguez, J., Lamas, A., Franco, C., & Cepeda, A. (2015). Egg And Egg-Derived Foods: Effects On Human Health And Use As Functional Foods. *Nutrients*, *7*(1), 706–729. Https://Doi.org/10.3390/Nu7010706

Par'i, H. M. , W. S. , H. T. P. (2017). *Bahan Ajar Gizi Penilaian Status Gizi. Cetakan Pertama. Pusat Pendidikan Sumber Daya Manusia Kesehatan.* Kementerian Kesehatan Republik Indonesia: Badan Pengembangan Dan Pemberdayaan Sumber Daya Manusia Kesehatan.

Pi, X., Yang, Y., Sun, Y., Cui, Q., Wan, Y., Fu, G., Chen, H., & Cheng, J. (2022). Recent Advances In Alleviating Food Allergenicity Through Fermentation. *Critical Reviews In Food Science And Nutrition*, *62*(26), 7255–7268. Https://Doi.org/10.1080/10408398.2021.1913093

Pineda-Vadillo, C., Nau, F., Guérin-Dubiard, C., Bourlieu, C., Capozzi, F., Bordoni, A., & Dupont, D. (2020). In Vivo Digestion Of Egg Products Enriched With Dha: Effect Of The Food Matrix On Dha Bioavailability. *Foods*, *10*(1), 6. Https://Doi.org/10.3390/Foods10010006

Purnamaningrum, Y. E., Dewi Pertiwi, K., Margono, M., & Iswara, D. (2021). *Analysis Of Factors Related To Stunting Prevention In Children Aged 2-5 Years*. *10*(2). Https://Doi.org/10.37341/Interest.V9i2.404

Réhault-Godbert, S., Guyot, N., & Nys, Y. (2019). The Golden Egg: Nutritional Value, Bioactivities, And Emerging Benefits For Human Health. *Nutrients*, *11*(3), 684. Https://Doi.org/10.3390/Nu11030684

Rohmania, D., Lina, N., Novianti, S., & Studi Kesehatan Masyarakat Fakultas Ilmu Kesehatan, P. (2024). Hubungan Asupan Energi Dan Protein, Riwayat Penyakit Infeksi Dan Picky Eating Dengan Kejadian Stunting Di Kecamatan Cisayong Kabupaten Tasikmalaya. *Jurnal Kesehatan Komunitas Indonesia*, *20*.

Rossi, M., Nys, Y., Anton, M., Bain, M., De Ketelaere, B., De Reu, K., Dunn, I., Gautron, J., Hammershøj, M., Hidalgo, A., Meluzzi, A., Mertens, K., Nau, F., & Sirri, F. (2013). Developments In Understanding And Assessment Of Egg And Egg Product Quality Over The Last Century. *World's Poultry Science Journal*, *69*(2), 414–429. Https://Doi.org/10.1017/S0043933913000408

Sartikah. (2023). The Effectiveness of Providing Saluri (One Egg A Day) Against Height in Stunted Toddlers at The Pakuhaji Health Center. *Dohara Publisher Open Access Journal*, *2*(10), 910-918. Http://Dohara.Or.Id/Index.Php/Isjnm|

Sharma, R., Garg, P., Kumar, P., Bhatia, S. K., & Kulshrestha, S. (2020). Microbial Fermentation And Its Role In Quality Improvement Of Fermented Foods. *Fermentation*, *6*(4), 106. Https://Doi.org/10.3390/Fermentation6040106

Soliman, A., De Sanctis, V., Alaaraj, N., Ahmed, S., Alyafei, F., Hamed, N., & Soliman, N. (2021). Early And Long-Term Consequences Of Nutritional Stunting: From Childhood To Adulthood. *Acta Biomedica*, *92*(1). Https://Doi.org/10.23750/Abm.V92i1.11346

Sumartini, E. (2022). Studi Literatur : Riwayat Penyakit Infeksi Dan Stunting Pada Balita. *Jurnal Kesehatan Mahardika*, *9*(1), 55–62. Https://Doi.org/10.54867/Jkm.V9i1.101

Sundari, E. & Nuryanto. (2016). *Hubungan Asupan Protein, Seng, Zat Besi dan Riwayat Penyakit Infeksi Dengan Z-Score Tb/U Pada Balita*. *5*(4), 520–529.

Tugiyanti, E. & Iriyanti.N. (N.D.). *Kualitas Eksternal Telur Ayam Petelur Yang Mendapat Ransum dengan Penambahan Tepung Ikan Fermentasi Menggunakan Isolat Produser Antihistamin*.

Wati, L., & Musnadi, J. (N.D.). Hubungan Asupan Gizi Dengan Kejadian Stunting Pada Anak di Desa Padang Kecamatan Manggeng Kabupaten Aceh Barat Daya. In *Jurnal Biology Education*.

Zhang, X., Tian, L., Zhai, S., Lin, Z., Yang, H., Chen, J., Ye, H., Wang, W., Yang, L., & Zhu, Y. (2020). Effects Of Selenium-Enriched Yeast On Performance, Egg Quality, Antioxidant Balance, And Egg Selenium Content In Laying Ducks. *Frontiers In Veterinary Science*, *7*. Https://Doi.org/10.3389/Fvets.2020.00591

Zollman Thomas, O., Chong, M., Leung, A., Fernandez, T. M., & Ng, S. T. (2023). Not Getting Laid: Consumer Acceptance Of Precision Fermentation Made Egg. *Frontiers In Sustainable Food Systems*, *7*. Https://Doi.org/10.3389/Fsufs.2023.1209533