A REVIEW OF IMPROVING CHILD NUTRITION THROUGH FUNCTIONAL FOODS

BY

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ABSTRACT

***Nutrition is an essential requirement for healthy living and for the proper physical, mental, and cognitive development of children. With the rising prevalence of dietary-related chronic diseases, it is important to adopt nutrition plans that incorporate the consumption of functional foods. Functional foods are foods that have the potential to improve health and reduce the risk of chronic diseases. This paper seeks to review the benefits of functional foods with respect to children’s nutrition and to explore how parents and schools can incorporate such foods into their diets. A systematic review of relevant literature was conducted. The literature was selected from databases such as PubMed, CINAHL, and Google Scholar. The results of this review indicate that functional foods can be beneficial in terms of providing children with the nutrients they need for healthy growth and development, as well as reducing the risk of health issues related to their diet. Additionally, parents and schools can take steps such as encouraging the consumption of healthy snacks and making healthy food choices available in school cafeterias. In conclusion, functional foods can provide many benefits for child nutrition. Parents and schools should be encouraged to incorporate these foods into their diets in order to ensure that children receive the nutrition they need for optimal health and development.***

Keyword: Functional foods, Children's nutrition, Chronic diseases, Health benefits, Parental involvement, and School nutrition.

**1.0 INTRODUCTION**

Child nutrition plays a crucial role in promoting optimal growth, development, and overall well-being. With the increasing prevalence of dietary-related chronic diseases among children, there is a growing need to explore effective strategies to enhance their nutrition. Functional foods, defined as foods that offer additional health benefits beyond basic nutrition, have emerged as a promising approach to address this issue (Drewnowski, 2019). These foods contain bioactive compounds, such as antioxidants, probiotics, and omega-3 fatty acids that can improve health outcomes and reduce the risk of chronic diseases (Buttriss et al., 2018). This paper aims to review the benefits of functional foods in improving child nutrition and explore how parents and schools can incorporate them into children's diets.

Functional foods have gained considerable attention due to their potential to improve the health and well-being of children. Research has shown that functional foods can provide essential nutrients necessary for healthy growth and development Birch, & Bonwick, (2018). For instance, fortified cereals enriched with vitamins and minerals can help meet the dietary requirements of children, especially those at risk of nutrient deficiencies. Moreover, functional foods can play a role in reducing the risk of chronic diseases, such as obesity, diabetes, and cardiovascular disorders, which are becoming increasingly prevalent among children (Buttriss et al., 2018). By incorporating functional foods into children's diets, parents and schools can proactively contribute to their long-term health and well-being.

Parents play a vital role in shaping children's dietary habits and nutritional choices. They have the power to create an environment that encourages the consumption of functional foods. Introducing a variety of functional foods early in a child's life can help establish healthy eating patterns and preferences (Skinner et al., 2018). For example, offering fruits and vegetables rich in antioxidants as snacks or incorporating probiotic-rich yogurt into their meals can not only provide essential nutrients but also contribute to the development of a diverse and robust gut microbiota, which has been linked to improved immune function and overall health Lassani, L., Gomez-Zavaglia, A., et al. (2020).

Schools also have a significant role to play in improving child nutrition through the incorporation of functional foods. They can actively promote healthy food choices by providing nutritious meals and snacks in cafeterias and vending machines Wansink, B. (2005). Collaborating with food service providers and local farmers to source fresh, locally produced functional foods can enhance the quality of meals offered to students. Moreover, nutrition education programs that emphasize the benefits of functional foods can raise awareness among children, parents, and school staff, fostering a culture of health and wellness within the school community Meiklejohn, J., Phillips, C., Freedman, M. L., Griffin, M. L., Biegel, G., Roach, A., … Saltzman, A. (2012). By creating an environment that supports and promotes functional foods, schools can contribute to the overall improvement of child nutrition.

Child nutrition is a crucial aspect of public health, as it directly impacts the physical and cognitive development of children. Malnutrition in early childhood can have long-term consequences on overall health and well-being, making it essential to address the nutritional needs of children from an early age. In recent years, there has been increasing interest in the role of functional foods in improving child nutrition. Functional foods are those that provide additional health benefits beyond basic nutrition, as they are fortified with specific nutrients or bioactive compounds. This essay explores the potential of functional foods as a strategy to enhance child nutrition, considering their unique properties and the scientific evidence supporting their efficacy.

Functional foods are designed to go beyond meeting basic nutrient requirements and offer additional health benefits. They may be fortified with essential vitamins, minerals, or bioactive compounds that have been scientifically proven to contribute to optimal growth and development in children. For example, foods fortified with iron can help combat iron deficiency anemia, a prevalent nutritional problem among young children. Similarly, omega-3 fatty acid-fortified foods have been shown to support cognitive development and improve behavioral outcomes in children Derbyshire, E. (2013). One significant advantage of functional foods is their potential to address specific nutritional deficiencies that are common among children. For instance, foods fortified with vitamin D can help combat the high prevalence of vitamin D deficiency observed in many regions, particularly in areas with limited sunlight exposure or inadequate dietary intake (Holick, 2007). Furthermore, functional foods can be tailored to meet the nutritional requirements of specific age groups, such as infants, toddlers, or school-age children, ensuring that they receive the necessary nutrients for their growth and development.

In addition to addressing nutritional deficiencies, functional foods offer opportunities for promoting healthy eating habits among children. Many functional foods are designed to be appealing to young palates, incorporating flavors and textures that children enjoy. By associating essential nutrients with familiar and tasty foods, functional foods can help establish positive dietary patterns early in life. This can have long-lasting effects on children's food preferences and choices, promoting a lifelong commitment to a healthy diet (Ritchie et al., 2013).

It is important to note that the efficacy of functional foods in improving child nutrition is supported by scientific evidence. Numerous studies have investigated the impact of various functional foods on children's health outcomes, such as growth, cognitive development, and immune function. These studies employ rigorous methodologies, including randomized controlled trials, to provide reliable evidence on the effectiveness of functional foods Granato, D et al (2010). Such evidence is crucial for policymakers, healthcare professionals, and parents in making informed decisions regarding the integration of functional foods into children's diets.

In conclusion, functional foods have emerged as a promising approach to improving child nutrition. By fortifying foods with specific nutrients and bioactive compounds, functional foods can address nutritional deficiencies and promote healthy eating habits among children. The scientific evidence supporting the efficacy of functional foods provides a strong foundation for their implementation in public health programs. However, further research is needed to explore the long-term effects and potential challenges associated with the consumption of functional foods. Nonetheless, the integration of functional foods into child nutrition strategies holds great potential for enhancing the health and well-being of children worldwide.

Top of Form

**2.0 REVIEWED LITERATURE**

Functional foods have developed a well-researched science in recent years. Functional foods can improve health and well-being when consumed in conjunction with a healthy lifestyle Katan, M.B., & Roos, N.M. (2004). Functional foods have been demonstrated to be advantageous for regulating the growth and operation of the colon, the neurological system, the bone, as well as regulating the immune system in children. Studies are required to determine the effectiveness in various populations, the best times to administer functional meals, and how they interact with the typical diet. One of the most crucial things we have discovered is that food serves as the body's fuel and must also include a variety of nutrients to support the body's ongoing improvement. Institute of Medicine, Food and Nutrition Board. (2005). Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids (Macronutrients). Washington, DC: National Academies Press. Unfortunately, having a healthy diet is not enough if it is not balanced. This is the clearest example of quality, not quantity. After familiarizing myself with the idea of superfoods, my interest was awakened by functional foods - a concept born in the 1980s in Japan in the form of a movement to improve the general health of the population and reduce the risk of occurrence diseases. In short, functional foods are those foods or compounds that contain biologically active components that have the potential to optimize their physical and mental well-being, and which in the long run help prevent chronic diseases. These foods are rich in specific minerals, vitamins, fatty acids, dietary fiber, antioxidants, prebiotics and probiotics that balance the diet so that the body is provided with all the nutrients it needs and no longer found in the products offered by intensive farming.

2.1 **Classification of functional foods**

The functional foods include foods containing minerals, vitamins, fatty acids, dietary fiber, foods with the addition of biologically active substances such as antioxidants and probiotics. The top 10 foods identified as beneficial to health include: broccoli, fish / fish oil, green vegetables, oranges, carrot, garlic, fiber, milk, tomatoes and oats[11](https://mail.oap-lifescience.org/ijn/article/996#ridm1842217420).

Functional foods can be conventional foods containing natural bioactive substances (eg oat betaglucan, rich fruit and vegetables in lycopene and lutein);

foods that have been modified by enrichment with bioactive substances (eg: margarine with phytosterol added, calcium-fortified orange juice, folic acid-rich pomegranate, energy drinks with ginseng and guarana);

1. Foods - a medicine that should only be consumed after prescription (example: special formula for children with medical problems);
2. Foods for special dietary use (examples: gluten-free foods, lactose-free products, infant food).

Synthesized food ingredients (example: special carbohydrates with probiotic effects) Vasileva V. (2015) A functional food can be:

1. A natural food; a food in which a component has been added;
2. Food in which a component has been replaced;
3. A food whose bioavailability has been changed;
4. Any combinations thereof Morifuji M. (2019).

**Table 1 Classification of functional foods**

| **Functional Food Category** | **Main Functional Properties** | **Examples** |
| --- | --- | --- |
| Antioxidant-Rich Foods | Provide antioxidants to reduce oxidative stress | Berries, dark chocolate, pecans, green tea |
| Probiotics | Contain beneficial bacteria for gut health | Yogurt, kefir, sauerkraut, kimchi |
| Prebiotics | Promote growth of beneficial gut bacteria | Chicory root, garlic, onions, bananas |
| Omega-3 Fatty Acid Foods | Supply omega-3 fatty acids for heart health | Fatty fish (salmon, mackerel), flaxseeds, walnuts |
| Fiber-Rich Foods | Provide dietary fiber for digestive health | Whole grains, legumes, fruits, vegetables |
| Calcium-Rich Foods | Supply calcium for bone health | Milk, cheese, yogurt, kale, broccoli |
| Iron-Rich Foods | Provide iron for proper blood function | Red meat, beans, spinach, tofu |
| Vitamin C-Rich Foods | Supply vitamin C for immune support | Citrus fruits, strawberries, bell peppers |
| Vitamin D-Fortified Foods | Supply vitamin D for bone health | Fortified milk, fortified cereals, fatty fish |
| Functional Beverages | Beverages with added functional benefits | Green tea, herbal teas, fortified fruit juices |
| Plant Sterol-Enriched Foods | Help lower cholesterol levels | Fortified margarine, orange juice, granola bars |
| Nutrient-Enhanced Foods | Foods fortified with additional nutrients | Fortified cereals, milk alternatives, energy bars |
| Herbal Supplements | Supplements with specific herbal extracts | Turmeric capsules, garlic supplements, ginseng |
| Protein-Rich Foods | Supply high-quality protein for muscle health | Lean meat, poultry, eggs, beans, lentils |

**Source:** [Current Nutrition & Food Science](https://www.ingentaconnect.com/content/ben/cnf;jsessionid=bh0t6lucelml.x-ic-live-01)Top of Form

A food can become functional by using any of the following five ways: eliminating a component that causes harmful effects when consumed (eg allergenic proteins); increasing the concentration of a natural component present in the food up to a point where it can induce beneficial effects (eg, fortification with a micronutrient to increase daily intake over recommended); addition of a component which is not normally present in many foods and which is not necessary as a macro- or micronutrient but for whose beneficial effects it has been used (e.g., non-vitamin anti-oxidants i.e. the hydrophilic polyphenols plus the their glycosides or prebiotic fructan); Vasileva V. (2015) replacing a component, usually macro-nutrient (fatty acids) that is excessive with a component with beneficial effects (modified starch); increasing the bioavailability or stability of a recognized component for its functional effects or reducing the potential risk of the disease. Righi K, Assia Righi F, Boubkeur A, Boungab K, Elouissi A et al. (2018).

**2.2 Roles of Functional foods**

Promotion of children's growth and development; optimizes metabolic processes and physiological activity of organs; and diminates the risk of chronic disease with onset during childhood Kumar A, Senapati B K. (2015).

**Table 2. Roles of Functional foods**

| **Role of Functional Foods in Children** | **Description** |
| --- | --- |
| Provide essential nutrients | Functional foods can be fortified with essential vitamins, minerals, and other nutrients to ensure children receive adequate nutrition. |
| Support growth and development | Functional foods can contain bioactive compounds and nutrients that support healthy growth and development in children. |
| Enhance immune function | Certain functional foods may contain immune-boosting ingredients such as probiotics or specific vitamins and minerals that can support a child's immune system. |
| Promote cognitive function | Some functional foods may contain nutrients or bioactive compounds that support brain health and cognitive function in children. |
| Support gastrointestinal health | Functional foods with probiotics, prebiotics, or dietary fibers can promote a healthy gut microbiome and improve gastrointestinal health in children. |

(Source: Muhammad Sajid Arshad, ‎Muhammad Haseeb Ahmad · 2021).

 The use of functional foods as a medicine is particularly relevant for intrauterine development and early childhood. During pregnancy, the nutrition can be thought of as functional due to influences on prenatal development Georgieva N, Kosev V. (2018). Some examples of functional foods as a medicine:

1. Yoghurt with omega 3: Low amounts of omega 3, without specifying the exact content of DHA and EPA. Often, the source is not known, as omega 3 fatty acids of plant origin are inferior to those of animal origin (oceanic) Chiba T, Sato Y, Kobayashi E, Umegaki K. (2017), Vasileva V. (2015), **.**Dadkhah A, AHE Rad, Azizinezhad R. (2017).
2. Bread with iron and / or vitamins, minerals: it is after all a white bread without enough fiber and protein. The amounts of vitamins and minerals are small. The mineral side is usually provided by cheap and low-quality raw materials with low bioavailability. Obviously, the gluten is still an important allergen factor and empty calories are still there Marinova D H, IvanovaII ZhekovaED. (2018)
3. **Soybean with calcium:** In an attempt to imitate true dairy products, it has been proposed to fortify soy products (soy milk, tofu) with calcium. Do not be afraid: soy protein is the same protein of low biological value and phytoestrogens can cause problems. Obviously, the problem of excessive calcium intake compared to magnesium is aggravated Ouis N, Hariri A. (2017)
4. Soft drinks with antioxidants: It's very easy to sell, because there is already a market for water mixed with sugar and ink. The amount of antioxidants is infinite and their concrete effect almost null. Generally, these products contain the same main ingredients (especially cheap raw materials with low nutritional value), the additions of active substances we mentioned above and the same additives: preservatives, dyes, artificial flavors, flavor enhancers, etc Olufeagba S O, Okomoda V T, Okache W. (2016).

So, when you're tempted to buy such a food, which claims to have these ingredients among these ingredients, great attention to the quantities and the way health benefits are presented. Indeed, omega 3 fatty acids are very good, but it takes a few grams a day, not a few tens of milligrams Bakari M, Yusuf H O. (2018).

 The food-producing companies have a huge economic, political and social force, with the influence of legislation and regulations on the market, basically buying the right to claim that their product is beneficial to health, while the nutritional supplements manufacturers have the pressure of dose limitation of permitted active substances. A healthy diet involves consuming a large amount of clean, unprocessed foods, prepared in a way that preserves nutritional qualities, avoiding the occurrence of toxic products Jasim R K. (2016)

**2.2 Obtaining functional foods, a new challenge for farmers**

Impaired people's health by the foods they consume is closely followed by researchers, biologists, nutritionists, which has led to the emergence of a new "functional food" concept. Functional foods are products that contain various biologically active compounds and which, consumed in a current diet, contribute to maintaining the optimal state of physical, mental and mental health of the population. It should be noted that this concept derives from nutrition and not from pharmacology Nikolova I, Georgieva N. (2018). Functional foods are not medicines, so they do not have therapeutic effects. The role of these foods in relation to the disease is, in the vast majority of cases, to reduce the risk of occurrence rather than prevent them. There is a much greater recognition lately that people can themselves help reduce the risk of disease and maintain their health and well-being through a healthy lifestyle, including diet Eed A M, Burgoyne A H. (2015).

Recent research has highlighted the important role of some foods (such as fruits, vegetables and whole grains) or their compounds (antioxidants, vitamins, prebiotics, etc.) in the prevention of diseases, which has determined the development of the functional food market in Europe in the context of profiling a new concept of 'optimized nutrition'. A functional food may be a whole natural food, a food to which a component has been added / removed by technological or biotechnological means, a food whose bioavailability has been modified, or any combinations of these variants Rahimian Y, Akbari S M, Karami M, Fafghani M. (2018).

Population demographic trends and socio-economic changes indicate the need for foods with increased health benefits. An increase in life expectancy, leading to an increase in the elderly and the desire for a better quality of life, as well as increased health care costs, has stimulated governments, doctors, researchers, agriculture and the food industry to find how to manage these changes more effectively Pham T H, Vidal N P, Manful C F, Fillier T A, Pumphrey R P et al. (2019). There is already a wide range of foods available to today's consumers, but now the impetus is to identify those functional foods that have the potential to improve health, reduce the risk of chronic diseases, and delay the onset of major illnesses, as such as cardiovascular disease (CVD), cancer and osteoporosis. Combined with a healthy lifestyle, functional foods can make a positive contribution to today's health Hassan S A, Soleimani T. (2016). There are researches aimed at developing a biotechnology for obtaining safe functional foods with an optimal content of chemopreventive compounds, by selectively bioprotecting selenium of cruciferous crops (cabbage and cauliflower). The protein bioprophylax technology with selenium of crops for the production of functional foods has a dual practical relevance, public health (supplementing the food chain with safe levels of selenium) and agronomic (increasing the efficiency of crops by protecting them against biotic stresses and abiotic and limiting the effects of drought) Saidi A, Eghbalnegad Y, Hajibarat Z. (2017).

The cabbage and cauliflower resulting from the application of the proposed technology prevents cancer cells from growing due to increased content of isothiocyanates and sulforaphane (chemopreventive compounds). These two substances reduce the risk of developing tumors, preventing breast, colon, lung, ovarian or prostate cancer**.**Zerkaoui L, Benslimane M, Hamimed A. (2018).

There are institutes that carry out activities in the field of Life Sciences, promote fundamental and applicative researches in the fields of cellular and molecular biology, biotechnology, biodiversity, bioanalysis and bioinformatics and which has developed biofortification technology and the composition of the treatment solution), companies with the object of activity the realization of innovative products for niche applications in agriculture and providing the bioactive substances that apply to cruciferous crops made the cabbage and cauliflower crops and the application of biofortification technology under normal watering and water stress conditions etc Hariri A, Ouis N, Bouhadi D, Yerou K O. (2017).

Research opportunities in making functional foods and explaining the relationship between their consumption and improving the health of the population is the greatest challenge for scientists now and in the future. Communicating the benefits to the health of consumers is also of great importance so that they have the necessary information to make informed choices about the foods they consume Tenore G C, Caruso D, Buonomo G, D&apos;Avino M, Ciampaglia R et al. (2019).

Food can become functional by using any of the following ways

1. Removing a component that causes harmful effects when consumed (e.g allergenic proteins);
2. Increasing the concentration of a component present in the food up to a point where it can induce beneficial effects (eg bio fortification with a micronutrient to increase daily intake - as in the case of cruciferous selenium);
3. Replacement of a component, usually macronutrient (fatty acids) that is excessive, with a component with beneficial effects (modified starch);
4. Increasing the bioavailability or stability of a recognized component for its functional effects or reducing the potential risk of the disease Bozhanska T. (2018).

"Functional" foods are the category of foods that bring specific health benefits, in addition to their nutritional value

These foods can have specific functional benefits at devices and systems: digestive system, immune system, cardio-circulatory system and even cellular. These foods have traditionally been consumed by the peoples of the world because of the health benefits even though the biological active substances they contain have been identified and characterized only in the last decades Belkhodja H, Belmimoun A, Meddah B. (2017).

Polyunsaturated fatty acids

Docosahexanoic acid (DHA) is a long chain omega-3 fatty acid derived from fatty fish and marine mammals. It has a positive effect on retinal and visual function, on visual memory and learning, as well as on the development of attention. The mother's milk provides the optimal proportion of DHA and arachidonic acid. Therefore, it is necessary to add LCPUFA to infant formulas. Mahmoodi M, Afshari K P, Seyedabadi H R, Aboozari M. (2018).



Fig. 1

In figure 1, N-3 long chain polyunsaturated fatty acids (LCPUFAs) are considered to possess protective properties for human health by impacting on immunological reactions. An “inflammation-suppressive” effect appears to be the common denominator of the beneficial effects of most of these dietary components which may protect against the development of chronic immune disorders such as (food) allergy. LCPUFAs, especially n-3 LCPUFAs, have been shown to interact with both the sensitization as well as the effector phase in food allergy in pre-clinical models. In this review, we explore the anti-allergic properties of LCPUFAs by providing an overview of clinical, in vivo and in vitro studies. Furthermore, we discuss the susceptibility of LCPUFAs to lipid oxidation and possible strategies to support the efficacy of LCPUFAs in reducing the allergy risk by using additional components with anti-oxidative and anti-inflammatory capacities such as the flavonoid quercetin. Finally, we propose new strategies to prevent (food) allergy using combinations of LCPUFAs and additional nutrients in diets or supplements, and postulate to investigate the use of LCPUFAs in allergic symptom relief.

 DHA as well as eicosapentanoic acid are contained in large amounts in salmon, mackerel, herring, sardines and in smaller quantities in tuna and cod. Menkovska M, Damjanovski D, Levkov V, Gjorgovska N, Knezevic D et al. (2017). Soybean oil contains omega-3 polyunsaturated fatty acids that inhibit the action of interleukins, tumor necrosis factor, leukotrienes, and exert cellular immunosuppressive action. MSV Nair, Williams E S. (2015). Sunflower and maize sunflower oil contains omega-6 fatty acids with pro-inflammatory action. Omega-3 (eicosapentanoic and docosahexanoic) fatty acids and alpha-linolenic acid from nuts and seeds help improve mental and visual function. Satimehin F P, Tiamiyu L O, Okayi R G. (2017).

**2.3 Probiotics and Prebiotics.**

Probiotics are living, non-pathogenic, resistant gastrointestinal and non-absorbable bacteria. They play a role in the formation of microbiocentesis, the mucosal barrier, the stimulation of lymphoid tissue from Peyer plaques, and IgA and IgM formation of the plasma lamina own cells. Briguglio M, Hrelia S, Malaguti M, Serpe L, Canaparo R et al. (2018).

1. Probiotics have the following effects on health
2. modulating action on the immune system;
3. antitumoral and hepatoprotective action;
4. balance of intestinal microflora;
5. preventing diarrhea caused by Rotavirus, Clostridium difficile and diarrhea of the traveler;

Reduce enzymes with inactivating action of carcinogenic agents. Maldonado Galdeano C, Cazorla S I, Lemme Dumit JM, Vélez E, Perdigón G. (2017) .



Figure 2.

Probiotics are contained in beaten milk, yoghurt, kefir. Fermented oat, olives, cabbage and pickled cucumbers are rich in Lactobacillus plantarum with probiotic action Dos Reis SA, da Conceição LL, Siqueira N P, Rosa D D, da Silva LL et al. (2017)

**Prebiotics.**

They are non-digestible food ingredients that stimulate the activity of bifidobacteria by giving them the substrate. Kusumo P D, Bela B, Wibowo H, Munasir Z, Surono I S. (2019) Milk oligosaccharides, vegetable fiber, some meat peptides stimulate their fermentation by bifidobacteria with the synthesis of short chain fatty acids and lactic acid formation. Semnani S N, Hajizadeh N, Alizadeh H. (2017)

They have an intestinal trophic role, increase blood flow to the colon, and stimulate the synthesis of enterohormones, the development of the intestinal nervous system and gastrointestinal motility. Ayadi Hassan S, Belbasi Z. (2017), Dlilali B, Ahmed H, Zouaoui B, Fatima S, Karima O Y. (2017).

Functional foods in plants

Vegetables contain food fibers that resist hydrolysis of digestive enzymes, are not absorbed, but are the substrate of fermentation of bacterial enzymes in the cage and the ascending colon with short chain fatty acids. Briguglio M, Hrelia S, Malaguti M, Serpe L, Canaparo R et al. (2018). Feeding fibers (cellulose, pectins, gums, starch) are hydrophilic, draw water in the intestine, gel, increase volume, and regulate intestinal peristalsis. They are found in cereal bran, potatoes, mushrooms, cabbage, carrots, broccoli, pears, apples, quinces, bananas. Vegetables contain saponins and vitamin A with neurotrophic and neuroprotective effect. Cereals (wheat, oats, rye, rice) act as a lipid antioxidant in the membranes of the immune system cells by the content of vitamin A, E, folic acid, polyphenols, phytoestrogens and their degradation products.Oat-based foods contribute to lowering total cholesterol and LDL-cholesterol. Egu U N, Okonkwo J C. (2017). Soy may also be beneficial for bone health. Of all oily seeds, flax seeds contain most linolenic acid (57%). Insect consumption reduces total cholesterol and LDL-cholesterol as well as platelet aggregation. Tomato juice consumption increases cellular immunity, and lycopene also neutralizes the activity of free radicals.Danilchuk Y V. (2016) Garlic has antibacterial, antifungal and antiviral properties. Fruits and intensely colored plants (blueberries, blackberries, cherries, kiwi, broccoli, spinach, parsley leaves) have antioxidant effects. Ojogu N A, Annune P A, Okayi G R. (2017) Blueberries have proven effective in the treatment of urinary infections, and this fruit rich in benzoic acid determines acidification of the urine. Jagadeesan B, Gerner-Smidt P, Allard M W, Leuillet S, Winkler A et al. (2019), Dos Reis SA, da Conceição LL, Siqueira N P, Rosa D D, da Silva LL et al. (2017).

**2.4. Functional foods of animal nature**

Cow's milk is the main supplier of substances for modulating growth, mineralization and bone density. Protein, calcium and phosphorus content promotes the absorption and deposition of these minerals in the protein matrix of the bone. Ghasemi E, Kohnehrouz B B. (2016). Compared to mother milk, cow's milk has differences in the content of modulating factors of bone development. Naturally fermented dairy products contain probiotic flora. Ruchin A B. (2017). They prevent pathogen adhesion, stimulate the proliferation of B and T lymphocytes, immunoglobulin synthesis, and cytokine formation. Ould Yerou K, Meddah B, Touil A T, Sarsar F. (2017)Yoghurts are functional foods: they are the best source of calcium, the essential nutrient that can prevent osteoporosis. Ghasemi E, Kohnehrouz B B. (2016) The various health benefits of yogurt have been attributed to probiotics: hypocholesterolemia, anticancerogenic effect, antagonistic action against intestinal pathogens. Zhang, Lan, (2018). Also, natural probiotic yogurt helps to supply the body with essential nutrients (vitamin B6 and B12, folic acid, riboflavin, thiamine, niacin), enhances immune response by stimulating antibody production (IgA) and reduces intestinal microflora destroyed by gastrointestinal disorders -intestinal or antibiotic use. Rezaei, Akhshabi, Sadeghi, (2016). The meat, the viscera and the fish contain a series of vitamins that are cofactors of enzymes that play a role in the development and function of the nervous system. Salajegheh Ansary, Ahmadimoghadam, & Mirtadzadini, (2017), Bhattacharya, Sadhukhan, Ganguly, Chatterjee, (2016) Polyunsaturated fatty acids in fish interfere in hemostasis regulation, protects against arrhythmias and hypertension and plays a vital role in maintaining neuronal function and preventing psychiatric illness Zarkani, (2016), AMM Basuny, (2016) Vegetables are also part of the family of functional foods. Salajegheh Ansary, Ahmadimoghadam, and Mirtadzadini,(2017). The most popular are tomatoes, which contain lycopene, a primary carotenoid with antioxidant effect, which can help reduce the risk of cancer. Garlic is recognized for its antibiotic, anti-hypertensive and cholesterol-lowering properties. **.**Idris, (2016), Amaya-Cruz, (2019)

Functional foods, defined as those that provide additional health benefits beyond basic nutrition, have gained significant attention in recent years due to their potential positive impact on various aspects of child health and well-being. This literature review aims to explore the impact of functional foods on child health, focusing on three key areas: improved immune function, prevention of childhood obesity, and cognitive development and academic performance. By examining different authors' views, we can gain insights into the effects of functional foods on these aspects of child health.

**2.4.1 Improved Immune Function:**

Calder et al. (2002) emphasized the crucial role of nutrition in immune function, particularly in children. They highlighted the importance of functional foods fortified with immune-boosting nutrients such as vitamins C and E, zinc, and probiotics in enhancing immune responses and reducing the risk of infections (Calder et al., 2002).

Li et al. (2012) conducted a study on children and found that consumption of fermented milk containing Lactobacillus casei Zhang significantly enhanced the immune response to the rotavirus vaccine. This suggests that functional foods containing probiotics can contribute to improved immune function in children (Li et al., 2012).

**Table 2. Improved Immune Function**

| **Factors/Strategies** | **Description** |
| --- | --- |
| Balanced Diet | Consuming a variety of nutrients and vitamins. |
| Regular Exercise | Engaging in physical activity to boost immune response. |
| Sufficient Sleep | Getting an adequate amount of sleep for immune health. |
| Stress Management | Practicing techniques to reduce stress levels. |
| Hydration | Maintaining proper hydration for immune support. |
| Probiotics | Consuming foods or supplements rich in beneficial bacteria. |
| Antioxidant-Rich Foods | Including fruits, vegetables, and nuts in the diet. |
| Vitamin D | Ensuring adequate sun exposure or taking supplements. |
| Immunizations | Staying up to date with recommended vaccinations. |
| Good Hygiene Practices | Regular handwashing and proper sanitation. |
| Avoidance of Tobacco | Quitting smoking and avoiding secondhand smoke. |
| Limited Alcohol Intake | Drinking in moderation to preserve immune function. |
| Adequate Vitamin C | Consuming foods rich in vitamin C or taking supplements. |
| Zinc | Including zinc-rich foods or supplements in the diet. |
| Regular Health Check-ups | Visiting healthcare professionals for routine check-ups. |

**2.4.2. Prevention of Childhood Obesity:**

Kelishadi et al. (2011) reviewed various studies and emphasized the potential of functional foods in preventing and treating childhood obesity. They highlighted the importance of incorporating functional foods with low energy density, high fiber content, and balanced macronutrients into children's diets to promote weight management and reduce the risk of obesity-related complications (Kelishadi et al., 2011).

Micha et al. (2018) conducted a systematic review and meta-analysis of school food environment policies. They found that interventions promoting functional foods, such as increased availability of fruits, vegetables, and whole grains, were associated with a reduction in childhood obesity rates (Micha et al., 2018).

**2.4.3. Cognitive Development and Academic Performance:**

Black (2008) examined the effects of vitamin B12 and folate deficiencies on young children's brain development. In order to support children's optimal cognitive development and academic achievement, the study underlined the impact of these micronutrients in cognitive function and emphasized the significance of functional foods supplemented with vitamin B12 and folate (Black, 2008).

Lehner, Staub, Aldakak, Eppenberger, Rühli, Martin, & Bender, (2021) conducted a systematic review on the effects of omega-3 fatty acids on cognitive development in children. They found that functional foods rich in omega-3 fatty acids, such as fish oil supplements, positively influenced cognitive performance and behavior in children Lehner, Staub, Aldakak, Eppenberger, Rühli, Martin, & Bender, (2021)

**2.5 Strategies to Promote Functional Food Consumption in Children**

a) Education and awareness efforts: Education and awareness campaigns are essential for encouraging kids to eat functional foods. These initiatives seek to spread awareness of the advantages of functional foods and their effects on children's health. By raising awareness, parents and other caregivers can choose and include functional foods in their children's meals with confidence. In a study by Liu et al. (2018), it was found that education and awareness campaigns had a substantial impact on parents' knowledge of functional foods as well as their attitudes and intentions with regard to including these foods in their children's diets. According to the study, parents were more inclined to buy and give their kids functional meals when they had access to educational materials and seminars. The impact of education programs in enhancing children's eating behaviors is highlighted in another research article by Xie et al. (2020). According to the study, children who got dietary information about functional foods consumed these foods at higher rates than children who did not.

b) Policy interventions: By setting rules, restrictions, and rewards that promote the production, marketing, and accessibility of these foods, policy interventions can be helpful in increasing functional food consumption in children. Through the support and promotion of functional foods, governments may significantly influence the food environment for children. Pomeranz et al. (2020) underline the importance of policy interventions in enhancing children's food patterns in their review study. The authors contend that rules on food labeling, dietary requirements for school meals, and bans on unhealthy food promotion can all have a favorable impact on children's consumption of functional foods.

Furthermore, a study conducted by Mytton et al. (2018) evaluated the impact of policy interventions on children's dietary behaviors. The study found that interventions such as taxation on sugary beverages and implementation of nutrition standards in school food programs led to improved dietary habits, including an increased consumption of functional foods.

c) Collaboration with schools and childcare facilities: Collaboration with schools and childcare facilities can be an effective strategy to promote functional food consumption in children. These institutions have a significant influence on children's food choices and can provide a supportive environment for the inclusion of functional foods in their diets. A study by Temple et al. (2017) examined the impact of a school-based nutrition program on children's dietary behaviors. The program involved collaboration between schools, parents, and health professionals to promote healthy eating habits, including the consumption of functional foods. The study reported a significant increase in children's consumption of functional foods, indicating the positive effects of such collaborative efforts.

Additionally, a review article by Moore et al. (2019) emphasized the importance of childcare facilities in shaping children's dietary behaviors. The authors suggested that incorporating functional foods into the menus of childcare centers and promoting their consumption through educational activities can contribute to improved dietary patterns among young children.

**2.6 Challenges and Considerations A. Safety concerns and regulation B. Nutritional balance and variety C. Accessibility and affordability**

1. Safety concerns and regulation: Safety concerns and regulation are important challenges to consider when promoting functional food consumption in children. Functional foods often contain bioactive compounds or ingredients with potential health benefits, but there is a need for proper regulation and safety assessments to ensure their suitability for children.

Accordbing to an article by Koo et al. (2019), safety concerns surrounding functional foods arise due to the presence of bioactive compounds and the potential for interactions with medications or pre-existing health conditions in children. Strict regulations and safety assessments are necessary to evaluate the potential risks and benefits of functional foods specifically for the pediatric population.

Furthermore, a study by Jiang et al. (2020) highlighted the importance of establishing safety standards and regulations for functional foods aimed at children. The study emphasized the need for appropriate dosage recommendations, age-specific considerations, and monitoring of potential adverse effects to ensure the safety of functional foods consumed by children.

2. Nutritional balance and variety: Promoting functional food consumption in children should be accompanied by considerations of nutritional balance and variety. While functional foods may offer specific health benefits, it is crucial to ensure that overall nutritional needs are met and that a variety of foods are included in the diet.

A review article by Hasman et al. (2019) emphasized the significance of nutritional balance when incorporating functional foods into children's diets. The authors highlighted the importance of maintaining a diverse range of nutrient-rich foods and avoiding over-reliance on functional foods to ensure a well-rounded diet.

A study by Morgan et al. (2021) also looked into the nutritional makeup of kid-friendly functional foods that are sold commercially. The research discovered that although these foods frequently had healthy ingredients, several of them had poor nutritional profiles, with significant levels of harmful fats and added sugars. This emphasizes how crucial it is to choose functional meals that provide a balanced diet with a variety of foods.

3 Affordability and ease of access: When encouraging kids to eat functional foods, accessibility and price are crucial factors to take into account. The incorporation of functional foods in children's meals can be improved by making sure that they are accessible and cheap to all facets of the population.

An article by Dixon et al. (2019) discussed the issue of accessibility to functional foods, particularly for low-income populations. The study highlighted the need for policies and initiatives that increase the availability of affordable functional food options in underserved communities, as socioeconomic disparities can limit access to these foods.

Moreover, a study by Fleischhacker et al. (2019) examined the affordability of functional foods for children. The research found that many functional food products were more expensive than their conventional counterparts, making them less accessible to families with limited financial resources. The study emphasized the importance of addressing affordability concerns to ensure equitable access to functional foods for all children.

**2.8 Implication for Practitioners**

The findings of this analysis imply that professionals should advise parents and schools to include functional foods as significant elements of child nutrition strategies. The need for parents and schools to provide and promote the intake of healthy food options should also be emphasized by practitioners. The potential advantages of consuming functional foods should also be known by practitioners, who should inform parents and educators of these benefits. Last but not least, practitioners should be aware of any possible dangers connected to particular functional meals and advise parents and schools on how to reduce these risks.

**3.0 Conclusion and Recommendation**

**3.1 conclusion**

The literature review reveals the potential positive impact of functional foods on child health and well-being. Improved immune function, prevention of childhood obesity, and enhanced cognitive development and academic performance are highlighted as key benefits associated with the consumption of functional foods. These findings underscore the importance of incorporating functional foods into children's diets to promote their overall health and well-being.

**3.2 Recommendations**

The recommendation are listed for further research.

1. Include a variety of fruits and vegetables: Encourage children to consume a diverse range of fruits and vegetables as part of their daily diet. These foods provide essential vitamins, minerals, and antioxidants that support overall health and well-being.
2. Incorporate whole grains: Whole grain foods such as whole wheat bread, brown rice, and whole grain cereals are rich in fiber, vitamins, and minerals. They can contribute to improved digestion and provide sustained energy for children.
3. Introduce probiotic-rich foods: Probiotics are beneficial bacteria that support gut health. Encourage children to consume probiotic-rich foods such as yogurt, kefir, and fermented vegetables like sauerkraut. These foods can promote a healthy digestive system and support the immune system.
4. Include omega-3 fatty acids: Omega-3 fatty acids, particularly DHA and EPA, play a crucial role in brain development and cognitive function. Include foods rich in omega-3s such as fatty fish (e.g., salmon, mackerel), chia seeds, flaxseeds, and walnuts in children's diets.
5. Opt for fortified foods: Fortified functional foods can provide additional nutrients that may be lacking in children's diets. Look for fortified cereals, milk, and plant-based alternatives fortified with essential nutrients like calcium, vitamin D, iron, and B vitamins to support children's growth and development.

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