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Review Article

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Pulses' Benefits in Children's Diets: A Narrative Review

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Abstract

Pulses are affordable, environmentally friendly, nutritious foods with a long shelf-life. In particular, they are excellent sources of protein, fiber, minerals, vitamins, and phenolic compounds and can prevent and control chronic diseases. Due to their high nutritional density, consumption of pulses may be significant for children's development. However, pulses also provide non-nutritional components that have beneficial health effects but that may have a few negative side effects if consumed improperly. The presence of such compounds, and the lack of a clear message about their potential benefits or drawbacks has, historically, influenced the consumption of legumes. The present study aims to provide a literature review of pulses' benefits in children's diets. For this purpose, we performed a search in PubMed and ScienceDirect databases of documents from the last 20 years (from 2000-2020), using the following search terms: "legume", "pulse", "consumption", "benefits", "health", "nutrition", "recommendations", and "children". Pulses help meet micro-nutrient demands in childhood and should be part of children's diets since the stage of complementary feed. Also, regular pulses' consumption may help to reduce childhood obesity and be an effective alternative to control glycemic response in diabetic children. The non-nutrients present in pulses do not represent a risk for Children's growth, as they are considerably reduced during the usual processing and cooking procedures.

Keywords

Children, Legumes, Pulses, Benefits, Non-Nutrients, Recommendations

Introduction

Legume grains are an extremely nutritious food that belongs to Leguminosae (or Fabaceae) family. They produce pods with edible seeds for humans and animals. The term "pulses" is used to denominate dry-harvested leguminous crops such as beans, lentils, chickpeas, broad beans, and lupines. It excludes legumes that are eaten fresh (e.g., green peas) or used for oil production (e.g., soybean) [1]. The words "legumes" and "pulses" can be partially interchangeable since all pulses are considered legumes [2].

Pulses are one of the first plants in the world to be domesticated. Humans have cultivated these foods as early as 10.000 years ago [3], growing in diverse parts of the world in different conditions, from hot until cold climates. Their vast geographical range allowed that pulses were included across cultures and cuisines worldwide, giving rise to many delicious dishes on all continents [4].

Pulses have been considered an inexpensive dietary source of protein, maintaining their health benefits over long shelf life periods. Also, pulses have several important environmental benefits, such as a relatively low water requirement, an innate capacity to improve soil quality and promote biodiversity [5]. As if it were not enough, increasing evidence points to a significant role of pulses in the prevention and control of frequent diseases worldwide such as obesity, diabetes, cardiovascular diseases, and cancer [6].

For all associated benefits, pulses have emerged as a strong ally against current world problems such as hunger, malnutrition, chronic diseases, and climate change [4]. Their consumption has been recommended in several contexts and diets. Nutritional agencies in diverse countries recommend pulses' consumption at least two or three times a week. About quantities, it has been suggested that 100 g of cooked pulses afford an appropriate amount of daily nutritional recommendations for adults. Still, regular consumption of 150g should improve blood lipid profile, blood pressure, and body composition [7, 8].

As pulses are nutritionally rich foods with a relevant role in health maintenance [9], they are an important dietary component, having a particular significance in periods of raised nutritional demand like childhood. However, data about pulses' recommendations, consumption, and benefits at this stage are still limited. Legumes have non-nutritional components, which can reduce the bioavailability of certain nutrients [6]. But should this constitute a reason to avoid offering pulses to children? It is timely to review the current evidence on the benefits and potential limitations of including pulses in children´s diets. Here we will focus upon actual knowledge on the role that these foods play in children's health.

Methodology

Searches in PubMed and ScienceDirect databases were performed using the following search terms: "legume", "pulse", "consumption", "benefits", "health", "nutrition", "recommendations", and "children". Written papers in English, Spanish, and Portuguese, systematic reviews, narrative reviews, meta-analysis, research articles, and expert reports from the last 20 years (from 2000-2020) were included. We screened 77 studies and selected 50 papers that contained relevant information for the present review.

Nutritional composition and impact in children's diets

In general, pulses are low in energy density, have a small quantity of fat, and are a source of proteins, complex carbohydrates, minerals, fibers, and complex B vitamins. Also, pulses are sources of several phytochemicals, containing natural antioxidants and bio-active carbohydrates [10]. The mature seeds are composed of three distinct parts: hull, cotyledon, and embryo axis. There are proteins and starch granules in the cotyledons, whereas the hull contains the highest concentration of phenolic compounds [11].

Carbohydrates are a significant component of legume seeds (60-65%). Starch is the most abundant carbohydrate, but simple sugars are also present. Although in large quantities, the carbohydrates in pulses are slowly digested due to the considerable amounts of dietary fiber [2, 12, 13]. Dietary fiber includes four main components: indigestible oligosaccharides, soluble fiber, insoluble fiber, and resistant starch. Resistant starch corresponds to a considerable fraction in pulses due to two main factors: the high proportion of amylose to amylopectin and the cell walls in whole grains, which consist of a barrier to the action of starch's digestive enzymes, even after cooking [14]. These factors could explain the low glycemic index of pulses. Fat content is usually low in pulses, but it has significant mono- and polyunsaturated fatty acids [5].

Environmental conditions and genetic factors influence protein concentration in legume grains. Legume grains provide good amounts of protein and amino acids. In general, pulses range from 17% to 40% (dry weight) of protein, which is quantitatively similar to meat (18-25%) [11, 15]. There is an imbalance in pulses' amino acid composition. Lysine is present in higher amounts, whereas the sulfur amino acids methionine and cysteine are available in limited quantities. Since pulses lack these essential amino acids, they have been considered lower-quality protein sources than animal protein [16]. However, pulses are frequently consumed with cereals, which have high sulfur amino acid levels that complement amino acid profiles forming a combination of high biological value. Accordingly, traditional meals worldwide include pulses and cereal combinations, making excellent complete protein sources [15, 17]. In developing countries, where animal protein is inaccessible for part of the population, the combination pulses plus cereal represents an affordable source of protein and minerals [4].

Figure 1 illustrates the importance of pulses consumption to meet nutritional demands in childhood. It is possible to observe that only two tablespoons (50g) of cooked pulses can

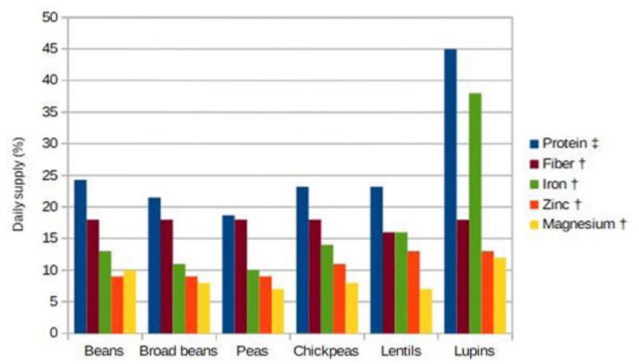

Figure 1: Percent (%) coverage of daily supply for protein, fiber, and minerals by consuming 50g of cooked pulses*.

*Based on the Portuguese food composition table for cooked pulses

‡ Percentage of daily supply (% DS) calculated based on Europe dietary reference for protein in 6 years old children

† Percentage of daily supply (% DS) calculated based on Europe dietary reference for minerals in children aged 4-6 years

provide about 20% of daily protein requirements and 18% of fiber requirements for preschool children. Pulses are also considered one of the best sources of complex B vitamins and minerals [18]. Only two tablespoons (50g) of cooked pulses per day can provide about 10% of the requirements of iron, zinc, and magnesium for preschool children (4-6 years old) (Figure 1).

In children's diets, the primary nutritional advantage of pulses consumption is to help achieve daily intake recommendations, especially for micro-nutrients. In developing countries, pulses have a fundamental role in preventing undernutrition and micronutrient deficiencies [19].

The non-nutritive compounds

Even though pulses possess valuable nutritional composition, they are often rejected because some contain non-nutrient compounds that can potentially reduce the bioavailability of nutrients or produce gastrointestinal discomfort. Nevertheless, depending on the dose consumed, these substances can also have bio-activity, exerting positive metabolic effects on the human body [6, 11]. These non-nutrient compounds can be broadly classified into two groups: proteinaceous compounds (lectins, amylase, and protease inhibitors) and non-proteinaceous compounds (phytic acid, phenolic compounds, saponins, alkaloids, and α-galactosides) (Table 1).

Some types of proteins present in legumes are the seed's defense mechanisms. Still, they may have antinutritional or toxic properties for humans, primarily due to the inhibition of digestive enzymes, including trypsin, chymotrypsin, and amylase [15]. Harmful effects of protease inhibitors, such as pancreatic hypertrophy and hyperplasia, appear in animals fed with raw legumes. Nevertheless, there is little evidence of deleterious effects in humans, even in grains consumed raw, like peanuts (*Arachis hypogaea*), which has been proven to have trypsin inhibitors [32]. For their protein constitution, digestive enzyme inhibitors can be disabled by thermal treatment such as extrusion, infrared radiation, micronization, boiling, autoclaving, steam processing or flaking, or separation by fractionation. Soybeans are the typical food that has the highest amount of trypsin inhibitors. Other legumes and processed products made from soy have a significantly lower amount of trypsin inhibitors when compared to uncooked soybean. Properly handled soy products, including soy-based infant formulas, have been exposed to enough heat processing to deactivate more than 80% of the trypsin inhibitor, lowering them to residual levels [23].

Lectins are naturally found in various species, though they are present in greater quantity in legume grains [21]. Legume lectins can be characterized by their ability to bind the glycocomponents present in different cellular and extracellular matrix parts in a generally reversible and specific manner. The mechanism of anti-nutritional effects of lectins is not fully understood. After oral ingestion by experimental animals, lectin binds sites on intestinal cells' surface, resulting in intestinal epithelial injury, diarrhea, and interference in nutrient absorption [32]. However, there is no evidence that lectins in properly processed foods are harmful to humans. The reduction of lectins to negligible values is usually achieved by cooking at a temperature of around 100° C [22].

Saponins are triterpenoid glycosides found in the seed coats of legume grains. They were considered anti-nutrients due to their hemolytic activity and capacity to cluster with iron and zinc. Saponins also have an adverse outcome on the small intestinal epithelium's permeability and decrease active nutrient transport in experimental models [33]. Due to their characteristic bitter taste, removing saponins is highly desirable to ensure better sensory quality and consumer acceptance [26]. Soaking, cooking, and germination reduce the level of saponins significantly [30].

Alkaloids also confer a bitter taste to pulses. They are nitrogenous organic compounds involved in the plant defense mechanisms. Alkaloids are toxic to humans, so they must be removed by soaking overnight, followed by cooking. After the soaking process, the immersion water must be discharged [5]

Phytic acid is a significant compound with an anti-nutritional effect present in legume grains. Phytates chelate multivalent metal ions and form insoluble compounds with several nutrients, particularly iron, zinc, and calcium [2, 25]. It is evident that phytate markedly decreases iron absorption, even in small amounts [22]. Studies suggest that iron plays an essential role in infant brain development [34]. Therefore, the presence of high amounts of phytate may be detrimental to the development of infants and malnourished children. Foods for this public should be low in phytate. Reduction in phytate content can be achieved by applying food-processing methods such as mechanical removal of the seed coat, germination, and fermentation, minimizing phytate by up to 90%. Soaking is another traditional processing method that can also reduce the phytate in legumes by about 20% [22, 26].

Phenolic compounds and their derivatives, flavanols, flavan-3-ols, anthocyanins, and condensed tannins, are the prevalent class of polyphenols in legume seeds [25]. Among polyphenols with anti-nutritional properties, tannins are one of the most ubiquitous groups. Tannins in legume grains bind iron, other metals, and proteins, reducing the absorption of these nutrients. Tannin-rich diets have been demonstrated to lower development in experimental animals. Still, it is unknown if this can be a problem in children. Some condensed tannins have an astringent flavor, which can collaborate with the rejection of foods with higher tannin levels. Tannins are thermostable and, therefore, thermal treatment does not significantly decrease their content. Immerse in a salt or sodium bicarbonate solution before domestic cooking cuts the tannin content by 37.5% to 77.0%. The immersion water must be discharged [26, 29]. The astringency of tannins can be mitigated by dehulling the seeds [25].

Non-nutritive compounds may have beneficial effects

Most of the non-nutrient compounds contained in legumes have been considered anti-nutrient. However, new evidence indicates that bio-active components may exert beneficial metabolic effects on the body [17] (Table 1).

In vitro, *in vivo,* and humans' studies have revealed

Table 1: Main non-nutrient compounds in pulses, potential beneficial and anti-nutritive effects, and strategies to reduce them.

Non-nutrient compounds	Legume grain where it is most found	Potential health benefit	Potential anti-nutritive effect	Strategy for reduction/ elimination	References
Protein nature:					
Lectins	*Phaseolus vulgaris*	Anti-carcinogenic and antimicrobial effects	Gut wall damage, intoxication	Heat processing (≥100°C)	[20-22]
Amylase inhibitors	*Glycine max* *Phaseolus vulgaris*	Reduction of blood glucose and blood cholesterol	Inhibition of digestive enzymes	Heat processing, fractionation	[15, 23]
Protease inhibitors	*Glycine max* *Phaseolus vulgaris*	Anti-carcinogenic and anti-inflammatory effects	Inhibition of digestive enzymes	Heat processing, fractionation	[15, 23, 24]
Non-protein nature:					
Phytic acid	*Phaseolus vulgaris* *Vigna unguiculata* *Vicia faba*	Antioxidant, anti-carcinogenic, prevention of renal stone, reduction of blood glucose and blood cholesterol	Decrease intestinal absorption of proteins, iron, calcium and zinc	Mechanical removal of the seed coat, germination, soaking, fermentation	[2, 25-27]
Phenolic compounds	*Vicia faba* *Vigna angularis* *Lens culinaris*	Antioxidant, anti-inflammatory, antimicrobial and analgesic activities	Decrease intestinal absorption of proteins, iron, calcium and zinc	Mechanical removal of the seed coat, soaking in salt solution and cook	[25, 28, 29]
Saponins	*Cicer arientinun* *Phaseolus vulgaris* *Pisum sativum* *Lupinus* spp	Anti-mutagenic, hypocholesterolemic, anti-inflammatory and antioxidant activities	Decrease intestinal absorption of iron and zinc	Soaking, germination and cooking	[22, 30]
Alkaloids	*Vicia faba* *Lupinus* spp (non-domesticated species)	Anti-mutagenic, anti-inflammatory and antioxidant activities	Toxic effects	Soaking overnight and cooking	[5]
α-galactosides	*Lupinus* spp *Vigna unguiculata*	Prebiotic effect	Reduction of protein bioavailability, flatulence	Soaking in water or saline solution, fermentation and germination	[31]

that protease inhibitors of the Bowman-Birk family (BBI) can play a protective or suppressive role against intestinal inflammation and colorectal cancer [24]. A randomized, double-blind, placebo-controlled trial in patients with active ulcerative colitis suggested that a BBI concentrate extract from soy achieved benefit in clinical response and remission induction concerning placebo [35]. Lectins have shown potential antimicrobial and anti-tumor activities *in vitro* [21]. An assay demonstrated that plant lectins presented marked antiviral properties against coronavirus that cause severe acute respiratory syndrome (SARS-CoV) [36]. Furthermore, legume lectins also inhibited leukemia and the acquired immune deficiency syndrome (AIDS) viruses [20].

Saponins and alkaloids also appear to have bio-active functions. They have shown anti-mutagenic, hypoglycaemic, hypocholesterolemic, hepatoprotective, immunomodulatory, and antioxidant activities in experimental animal studies and *in vitro* assays. Saponins produce an insoluble complex with cholesterol, decreasing its absorption. Studies with cell cultures reveal that the anti-carcinogenic effect of saponins may be related to altering the permeability of the cell membrane, inhibiting proliferation, and inducing apoptosis of cancer cells [22, 30].

For years phytate was classified solely as an anti-nutrient since it may inhibit the absorption of some minerals. In determining dietary situations, it may lead to calcium, iron, and zinc under-supply. Thus, several studies have been developed to discover the most suitable processing to withdraw phytate from food. Nevertheless, in recent years, a valuable characteristic of phytate has been explored in experimental and *in vitro* studies, such as antioxidant and anticancer activities and positive effects on blood glucose and cholesterol levels. Phytate also has a notable role in preventing kidney stones, as observed in animal models, observational studies, and clinical trials [27].

Polyphenols are the most studied bioactive in legumes. They are highly oxygenated molecules that have an aromatic ring with one or more hydroxyl substituents. The health benefits of legume grains are partially due to the antioxidant characteristic of phenolic acids, flavonoids, and condensed tannins present mainly in the hull [11, 28, 37]. The high concentration of phenolic compounds protects the cotyledon and is responsible for the color of some seeds [38]. The bio-active effect of phenolic compounds includes anti-atherogenic, anti-thrombotic, anti-ulcer, anti-allergenic, anti-inflammatory, and immune-modulating antimicrobial, cardioprotective, and analgesic agents. Most of those effects were observed *in vitro* [28].

Legume grains are also the food with the highest amounts of oligosaccharides. Among the oligosaccharides of legumes, the α-galactosides raffinose, stachyose, and verbascose are the most abundant [25, 39]. The α-galactosides are not digested by humans' gastrointestinal tracts, being fermented by anaerobic bacteria and producing gases. That is why legume grain ingestion is associated with flatulence, bloating, or gastric discomfort. Moreover, depending on the doses, α-galactosides can implicate protein utilization [31, 40].

In contrast, legumes' oligosaccharides have shown a potential prebiotic effect, increasing several groups of bacteria responsible for normobiosis of the colon [41]. It has been proposed that a 3 g / day dose of α-galactosides is sufficient to obtain health advantages without digestive problems. Soaking in water or saline solution with bicarbonate is the most efficient treatment for partial elimination of α-galactosides from grain [14]. Fermentation and germination are methods for sharply reducing the α-galactoside content of legumes [31].

Data about the bioactive activity of non-nutrients compounds are promising. However, more studies are required, especially in human populations, to confirm their benefits.

Are non-nutrients a risk for children's diets?

Infants and young children, which have a high growth velocity, can be sensitive to the antinutritional effect of non-nutrients compounds [26]. The impact of these compounds on nutritional status will depend on diet quality, dose consumed, and growing demand. In a well-balanced diet, non-nutritional substances should not represent a risk. However, in an unbalanced diet, these substances can reduce mineral bioavailability, compromising the food's nutritional value [6, 27], especially for infants or malnourished children [22, 26]. As processing eliminates or reduces the non-nutrient, anti-nutritional factors usually only manifest if the seed or the flour is consumed raw [38]. Thus, it is crucial to give special attention to processing when these vulnerable groups consume pulses. Under adequate handling to reduce anti-nutritional factors, it is possible to include pulses in the complementary feed. In several parts of the world, pulses compose the complementary infant diet, being well-tolerated and well-accepted by children [42].

Pulses are generally consumed after some treatment, and the most common is soaking, followed by cooking (boiled as soup). Fermentation or germination also are critical processes usually used before consumption. These treatments are expected to alter the composition, increase the bioavailability of the nutrients, and improve the taste of pulses [10, 31]. Thus, it is reasonable to assume that the regular consumption of pulses is not a risk for children's growth.

Health Benefits

In recent years, remarkable progress has occurred in elucidating the beneficial effects of pulses on health, besides achieving basic nutrient requirements [24]. There is growing evidence that sustains the role of pulses to decrease non-communicable diseases and promote weight control. Epidemiological and intervention studies indicated beneficial results on cardiovascular risk factors, body composition, inflammatory profile, and also quality and metabolism of gut microbiota [7, 43]. A meta-analysis study also revealed that high legume ingestion is related to a lower risk of general mortality [44].

In terms of glucose regulation, the pulses' benefits seem to be precise. A systematic review and meta-analysis of randomized controlled experimental trials revealed that pulses, alone or in low-glycemic-index diets or high-fiber diets, favor bio-markers of glycemic control in adult humans. According to the study analysis, benefits appear to be more evident with chickpeas consumption in diabetic individuals with controlled diets for more than four weeks [45]. In recent years, childhood diabetes has risen in many countries, with an annual increase estimated at around 3% [46]. The regular consumption of legume grains may be an effective alternative to control glycemic response in diabetic children, but few studies have investigated this question. A survey carried out with a group of insulin-dependent diabetic children (21 children with ages between 7-16 years old) offered four different diets in random order. Among the four diets, three only differed in fiber content (High fiber: 2-8 g of fiber/100 calories; Medium fiber: 0-8 g of fiber/100 calories; Low fiber: 0-3 g of fiber/100 calories; and Beans: 1-5 g of fiber/100 calories), and one was different in fiber and protein content because it contained soybeans as a fiber source. The children themselves took capillary blood samples in 30, 60, and 120 minutes after breakfast and the mid-morning snack. It was observed that the soybean diet produced better glycemic control, with more stable blood glucose levels over time. However, the group had objections to accepting the soybean diet in the long term [47]. The effect of pulses in glycemic control has been attributed to the type and amount of undigested carbohydrates present in pulses, such as fiber, resistant starch, and oligosaccharides that reduce the glucose absorption rate. In addition, pulses may promote an insulin-sparing mechanism that improves medium to longer-term glycemic control [45].

Accumulating evidence has shown that gut microbes are critical to childhood development and immunity, particularly at the beginning of life. These bacteria are responsible for assisting in the degradation of food, increasing the bioavailability of nutrients, defending against pathogens, stimulating or modulating the immune system, and exercising neurohormonal control [48]. A systematic review of human studies demonstrated that specific types of whole pulses and pulse ingredients could modulate gut microbial populations, increasing the abundance of lactic acid bacteria, bifidobacteria, and other microbial strains [9]. Also, the short-chain fatty acids, produced by bacterial fermentation activity, have a relevant role in metabolic modulation, namely in hepatic cholesterol synthesis in animal models [7].

Regular pulses consumption has also been related to lower body weight and obesity risk. A significant number of human randomized intervention studies have reported that pulses consumption increases satiety and decreases food intake. Also, intervention studies with adults, including a meta-analysis, have supported that pulse consumption reduces body weight, both with and without energy restriction [49]. Growing evidence indicates that pulses can potentially modify gut hormone production and consequently alter appetite [50].

There have been few studies investigating the association between pulses' consumption and body weight in children. A cross-sectional study examined the relation between plant food intake (including pulses) and body mass index (BMI) in different nations. It was observed that adolescents (13-14 years old) who consumed plant foods at least three times a week, and children (6-7 years old) who consumed vegetables three or more times a week, had a more reduced BMI than those who were never eating plant based foods [51]. Accordingly, including pulses and other plant foods in diets would impact prevention on childhood overweight. Similar results have been found in studies relating to children's body weight and adherence to the Mediterranean diet. There is a substantial body of evidence pointing out that adoption of a Mediterranean-like dietary pattern, which includes regular pulse consumption, is associated with lower body weight independently of other factors like age, sex, socioeconomic status, and physical activity [52-54].

Studies dealing with pulses' health benefits have been mostly performed in the adult population, where dietary intervention studies are more comfortable to implement. Evidence directly relating pulses consumption with health benefits for children is scarce. Considering the positive results attributed to the intake of a plant-based diet by children and the findings relating to the consumption of pulses and the prevention of diseases in adults, it is possible to have an idea of their benefits for the pediatric population. However, targeted observational or even experimental studies are needed.

Children's recommendations and consumption

Pulses should be introduced before the first year

"There is no consensus on the amount of pulses that should be consumed by children. However, there are recommendations for children's consumption in countries' dietary guidelines that

Table 2: Pulses dietary recommendations for children (until 13 years old) according to the dietary guidelines of different countries.

Country	Age of introduction	Frequency of consumption	Serving size (cooked legumes/pulses)	References
Australia	From 6 months	Considering as part of protein group: At least 2 servings/week	150g	Eat For Health
		Considering as part of vegetable group: *nsp**	75g	
Brazil	From 6 months	Once or twice a day	*nsp*	Alimentação e saúde: a fundamentação científica do guia alimentar para a população brasileira | Portal de Livros Abertos da USP
Canada	Explicit recommendation appears from 11 months	*nsp* (recommend regular consumprion of plant-based protein)	*nsp*	Canada's Dietary Guidelines - Canada's Food Guide Nutrition for Healthy Term Infants: Recommendations from Six to 24 Months - Canada.ca
Greece	From 7 months	3 servings/week (on average)	40-150g (depending on age group)	diatrofikoiodigoi
India	From 6 months	From ¼ to 2 ½ servings/day (depending on age group)	30g	ICMR-National Institute of Nutrition, India (nin.res.in)
Ireland	From 6 months	*nsp*	Approximately 90g (half the adult serving that is ¾ cup)	gov.ie - Healthy Ireland (www.gov.ie)
Portugal	From 8 months	From 1 to 3 years old: 1 serving/day From 4 years old: 1 or 2 servings/day	80g	www.dgs.pt/promocao-da-saude/educacao-para-a--saude/areas-de-intervencao/alimentacao.aspx
Spain	*nsp*	2 or 3 times a week or more (recommendation for general population)	*nsp*	www.observatoriodelainfancia.es/ficherosoia/documentos/ Adolescentes (thefamilywatch.org)
South Africa	*nsp* (Explicit recommendation appears from 3 years old)	*nsp* (Eat regularly)	Approximately 120g (½ cup)	as842e.pdf (fao.org)
United Kingdom	Between 9 and 12 months	*nsp* (Eat some pulses)	*nsp*	The Eatwell Guide - GOV.UK (www.gov.uk)
United States	Between 6 and 8 months	weekly	120-600g (½ to 2 ½ cup depending on age group)	2015-2020 Dietary Guidelines | health.gov

**nsp*: non-specific
Source: Links available on Food-based dietary guidelines (FAO, 2016)
<http://www.fao.org/nutrition/education/food-dietary-guidelines/regions/countries/en/>

incorporate pulses in their food patterns [55]. Marinangeli *et al*. summarized which countries recommend pulses in their food guides [8]. Based on this work, we consulted the dietary guidelines of different countries and compiled the pulse dietary recommendations for children (Table 2) when this information was accessible.

Dietary recommendations for children over two years are incorporated into most national dietary guidelines. Recommendations for infants and young children under two years are typically represented in separate guidelines. According to these recommendations, pulses should be introduced into infant feeding before the first year of life. The transition from a dairy diet to a diet with complementary foods, usually between four and six months, is a critical phase in forming eating habits. Babies have an innate fondness for sweet and salty tastes and an aversion to bitter taste [57]. Thus, the introduction of pulses at this stage is crucial for accepting these foods throughout life.

Countries such as Australia, Greece, Spain, and the United States have recommended weekly consumption. Consumption guidelines are two or three times a week in Australia and Greece, and Spain. Regarding serving sizes, in Greece and the United States, the recommended amount varies according to age. In Australia, from two years old, the recommended amount is the same for the general population. Spain does not specify this information (Table 2).

In Brazil, India, and Portugal, daily consumption is recommended. However, in Brazil, no serving is mentioned, while in India and Portugal, the number of daily portions varies according to age. Countries like Ireland, South Africa, and the United Kingdom do not specify the consumption frequency. In Ireland and South Africa, there is a recommendation that children's serving size should be half of the recommended for adults from the age of five. In the case of Canada, there is just a general recommendation to prefer plant-based protein (Table 2). There is significant variability in serving sizes and frequency of consumption recommended among countries.

Children's consumption

Data on legumes' consumption by children is limited. Given the currently available data, it is impossible to determine the worldwide consumption by children, but data are available in specific countries (Table 3).

In Canada, data from the Canadian Community Health Survey Cycle 2.2 were used to analyze legume consumption in children (2 to 18 years old), residents in Manitoba province. It was observed that only 8.2% consumed at least one legume product daily [59]. A study in Brazil analyzed Brazilian children's dietary intake (6 months to 5 years old) using a food frequency questionnaire applied to their guardians. It found that 66.2% of children followed the Brazilian guideline's recommendation to eat pulses daily (usually the typical combination of rice and beans) [58]. In a district in Northern Ghana, the children (6 to 23 months) were assessed using a quantitative 24-hour recall. A second questionnaire was applied to 20% of the children every other day. It was observed that 60% consumed pulses frequently, with an average daily consumption of 20g [19].

The "Grains and Legumes Consumption and Attitudes Study" was an inquiry that observed legume consumption in the Australian population. The participants filled an online two-day food diary questionnaire (parents answered for children). This study found that 21% of children and teenagers referred to eat legumes at least one day of the survey (once a week), having a medium serving of 77g per day [57], which is equivalent to one serving according to the Australian food guide (Table 2).

In Portugal, the National Food and Physical Activity Portuguese Survey was a large study that created a national representative database. Among other information, it collected data about the food consumption of children (3 months to 9 years) using a 2-day food diary. About 10% of the group evaluated were reported to eat legumes at least one day of the study, but the general average consumption of cooked pulses was only 5g per day [60]. It was overly lower than the Portuguese food guideline recommendation of 80g per day (Table 2).

Even though there is very little data available on legume grains intake by children, it is possible to observe that overall consumption is below the recommendations, especially in developed countries.

Conclusions and future research recommendations

Pulses are highly nutritious foods capable of supplying much of the nutritional demands raised in childhood. Their consumption should be promoted since the stage of complementary feeding. Evidence points that pulses' regular consumption may reduce childhood obesity and be an effective alternative to control glycemic response in diabetics children. Antinutritional factors present in legume seeds do not represent a risk for infant growth and development since they are considerably reduced during domestic and industrial processing. Even in legumes consumed raw in small portions, these factors should not pose risks to older children in good nutritional status.

Many questions about the role of pulses in children's diets remain undefined. Studies are needed to explain the relationship between pulses consumption and children's health, especially regarding preventing and controlling chronic diseases. It is essential to clarify the daily recommended serving size of pulses that achieves health benefits in children. Also, further dietary studies are needed to fully understand the beneficial role of non-nutrients in children's health.

Conflict of interest

None

Table 3: Children's consumption of legume grains in different origins.

Country/ Region	Age Group	Frequency of consumption	Serving size	References
Australia	≤ 19 years old	21% consumed legumes once or twice a week	77g	[57]
Brazil	6 months to 5 years old	66,2% consumed pulse daily	NP	[58]
Canada (Manitoba province)	2 to 18 years old	8,2% consumed legume products daily	NP	[59]
Ghana (Karaga sub-district)	6 to 23 months	NP	20g (average portion estimated per day)	[19]
Portugal	3 months to 9 years old	10% consumed legumes once or twice a week	5g (average portion estimated per day)	[60]

Abbreviations: NP, not provided

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Authorship

Our article represents the original work of the authors, which contributed significantly to the work's conception. Evla D.F. Vieira and Marta W. Vasconcelos did the design, data interpretation, and analysis. Evla D.F. Vieira did the writing. Marta W. Vasconcelos, Ana M. Gil & Ana M. Gomes did a critical revision of the article, read and approved the version of the manuscript. No authorship has been omitted.

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