Consideration on tomato consumption: is organic food better for children's health?

Considerações sobre o consumo de tomate: os alimentos orgânicos são melhores para a saúde das crianças?

Consideración sobre el consumo de tomate: ¿los alimentos orgánicos son mejores para la salud de los niños?

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ABSTRACT

Objectives: to bring together investigations on the impact of the consumption of organic and non-organic foods on health, focusing on the consumption of tomatoes and the child population.

Methods: scientific articles relevant to the discussion of the topic and found in databases were included in this narrative review.

Results: Organic foods were associated with a decrease in the risk of several diseases, organic tomatoes were shown to have a higher content of bioactive compounds, which favor cognitive and immune health and reduce the risk of several diseases. However, conventionally grown (non-organic) foods are related to the development of immunological, hormonal, reproductive, neural, and cancer diseases. Children can be infected by maternal exposure during pregnancy until the end of childhood, being affected to a greater extent than adults. Such exposure increases the risk of cancer and nerve damage, which affects neurodevelopment and cognition. In addition, associations were reported between exposure to pesticide residues and respiratory diseases, allergies, inflammation, obesity, anthropometric changes, and motor development.

Conclusion: The studies included in this review support the consumption of organic tomatoes to benefit the health of adults and children.

Keywords: child, health, organic food.

RESUMO

Objetivos: reunir investigações sobre o impacto do consumo de alimentos orgânicos e não orgânicos na saúde, com foco no consumo de tomate e na população infantil. Métodos: foram incluídos nesta revisão narrativa artigos científicos relevantes para a discussão do tema e encontrados em bases de dados. Resultados: Os alimentos orgânicos foram associados à...
diminuição do risco de diversas doenças, o tomate orgânico demonstrou possuir maior teor de compostos bioativos, que favorecem a saúde cognitiva e imunológica e reduzem o risco de diversas doenças. No entanto, os alimentos cultivados convencionalmente (não orgânicos) estão relacionados ao desenvolvimento de doenças imunológicas, hormonais, reprodutivas, neurais e cancerígenas. As crianças podem ser infectadas pela exposição materna durante a gravidez até o final da infância, sendo afetadas em maior extensão que os adultos. Essa exposição aumenta o risco de câncer e danos aos nervos, o que afeta o neurodesenvolvimento e a cognição. Além disso, foram relatadas associações entre exposição a resíduos de agrotóxicos e doenças respiratórias, alergias, inflamações, obesidade, alterações antropométricas e desenvolvimento motor. Conclusão: Os estudos incluídos nesta revisão apoiam o consumo de tomate orgânico para beneficiar a saúde de adultos e crianças.

Palavras-chave: criança, saúde, alimentos orgânicos.

1 INTRODUCTION

Currently, plant foods provide much of the nutrients that sustain developing countries. While conventional agriculture makes use of pesticide application generating a loss of individual plants and four times more pesticide residues associated with the development of various diseases (Barański et. al., 2014), organic agriculture promotes the preservation of plant species and the environment, presenting a higher content of bioactive compounds, better nutritional levels, and lower levels of contamination than the conventional products (Johansson et. al., 2014; Popović et. al., 2023).
Due to the greater awareness about consuming safe foods for health, preserving the environment, and obtaining a profit/nutritional and economic benefit, there is a trend of growth in the value of organic production and the increase of its consumption (Hurtado-Barroso et al., 2019; Ishaq et al., 2021; Popović et al., 2023; Saffeullah et al., 2021). For Hurtado-Barroso et al. (Hurtado-Barroso et al., 2019) consumers are willing to pay a higher price for organic products because of their benefits. According to Johansson et al. (Johansson et al., 2014), the increase in the market and organic production is evident worldwide and can be expected to continue in the coming years. The global organic market reached $81.6 billion in 2015, with a value about 4.5 times higher than 15 years ago. The number of countries using organic farming has also increased from 77 to 179 (Hurtado-Barroso et al., 2019).

Given the potential for increased consumption and production of organic products, we seek to gather information about their health benefits, as well as the harms of consumption of non-organic products. The focus of this narrative review is tomato because it is a highly consumed vegetable in several countries (Caris-Veyrat et al., 2004) and is among the 10 most contaminated vegetables with pesticides (Hlihor et al., 2019). We also aimed to investigate how this consumption affects the child population, which is also a product consumer. In this review, scientific articles relevant to the discussion of the topic and found in databases were included.

2 DISCUSSION

2.1 ORGANIC TOMATO VERSUS CONVENTIONAL

Tomato is a vegetable recommended for daily consumption to improve health by having a rich source of macro and micronutrient essences such as iron, calcium, potassium, magnesium, and zinc. They are also an important source of vitamins A and C, polyphenols (including flavonoids that act as anti-inflammatory), and carotenoids such as lutein, lycopene, and β-carotene, which exhibit antioxidant properties (Abushita e colab., 1997; Caris-Veyrat e colab., 2004b; Hlihor e colab., 2019b; Kaboré e colab., 2022a; Meleiro e colab., 2021; Saffeullah e colab., 2021b)

They are therefore a positive influence on the proper functioning of vital organs of the human body, acting for example on digestion, hydration, regulation of blood glucose, brain activity, and immunity. Studies highlight that tomato consumption decreases the risk of obesity, diabetes, heart disease, and cancer. In addition, some authors argue that they are potentially
involved in the protection against degenerative diseases (Agarwal e Rao, 2000; Caris-Veyrat et. al., 2004; Giovannucci, 1999; Hlihor et. al., 2019; Odewale et. al., 2021; Olson e Krinsky, 1995; Zackheim, 1999). For Kaboré et al. (Kaboré et. al., 2022) tomato by-products are also rich in macronutrients and beneficial micronutrients, capable of preventing malnutrition and reducing the incidence of nutritional diseases.

In addition to its composition and benefits, the world's tomato production stands out, which was registered at 130 million tons in 2014, with 88 million tons for the fresh market and 42 million tons for processing, indicating that this is a food with high demand. However, a study that evaluated more than 1,000 tomato samples found that 49% were free of pesticide residues, while 51% contained one or more pesticides in high concentrations, generating concern about the type of cultivation of tomatoes for consumption (Hlihor et. al., 2019).

While tomato consumption is encouraged and beneficial to health, understanding whether the type of its cultivation (organic or conventional) influences in different ways on human health is essential, since: Tomato is a highly consumed food and has a high contamination rate (Hlihor et. al., 2019); Levels of carotenoids and phenolics can be affected by the type of cultivation (Saffeullah et. al., 2021); And that one in 10 people who are exposed to the consumption of food contaminated by toxins develops diseases (Kuo and Weng, 2021).

In this sense, it is noteworthy that contamination due to the use of pesticides in conventional crops is currently considered a public health problem, due to its various systemic effects on health and its association with the development of diseases such as cancer, diseases of the immune, reproductive, and hormonal system, as well as developmental changes and neurological problems, such as Parkinson’s disease for example (Johansson et. al., 2014; Kumari and John, 2019; Odewale et. al., 2021; Saffeullah et. al., 2021; Vigar et. al., 2019). The health risk is mainly due to pesticide residues in food and occurs even at relatively low levels (Bradbury et. al., 2014; Glibowski, 2020; Johansson et. al., 2014; Kesse-Guyot et. al., 2013; Kumari e John, 2019; Vigar et. al., 2019).

For Kesse-Guyot et al. (Kesse-Guyot et. al., 2013) regular consumers of organic foods have a significant decrease in the likelihood of developing overweight and obesity. Bradbury et al. (Bradbury et. al., 2014) present a significant reduction in the risk of developing non-Hodgkin’s lymphoma, a type of cancer that affects the lymphatic system. It was also demonstrated that pregnant women who consumed organic vegetables had a 24% lower risk of preeclampsia (Torjesen et. al., 2014). Some other studies have shown that the consumption of organic products reduces the incidence of metabolic syndrome, birth defects, allergic sensitization, and otitis media (Vigar et. al., 2019) as well as reports the decreased risk of
developing other chronic diseases and types of cancer (Hurtado-Barroso et. al., 2019; Johansson et. al., 2014).

For Glibowsi (Glibowski, 2020) the greater morbidity of these diseases by consumers of conventional foods is a result not only of a higher intake of pesticide residues but also of a lower intake of antioxidants. Antioxidants are found in increasing amounts in plants of organic cultivation (Brandão et al., 2020; Brandt et al., 2011; Smith-Spangler et al., 2012) which have higher antioxidant potential, and protective factors against the development of neurodegenerative and cardiovascular diseases (Barański et. al., 2014).

Without breaking the rule, tomatoes with pesticide residues also cause harmful health effects (Hlihor et. al., 2019). According to the study by Saffeullah et al. (Saffeullah et. al., 2021) which compared the effects of organic and conventional production systems on chemical properties and phenolic compounds of two types of tomatoes (standard and cherry) organic tomatoes have a higher content of bioactive compounds compared to conventional ones. Among the bioactive found in higher concentrations in the organic culture of tomato were highlighted: vitamin C, rutinoside 3-quercetin, and myricetin, which are natural antioxidants and total flavonoids, which have antiviral, antibacterial, and anti-viral properties inflammatory in addition to antioxidants. These findings indicate that the organic product is favored with a higher nutritional value, including antioxidants and minerals beneficial to health. In addition, the authors showed that organic tomatoes had a lower content of pesticide residues, nitrates, and some heavy metals and therefore the risk of diseases was significantly lower.

Besides that, an investigation into the protective effects and toxic action evaluated samples of commercial tomato puree obtained from conventional and organic cultivation systems and showed that organic tomatoes being free of pesticides have a greater cytoprotective and antigenotoxic effect than purees made with tomatoes from conventional cultivation. These compounds have a protective role against cell damage and DNA, being associated with a lower incidence of cancer, cardiovascular diseases, delayed development and progression of osteoporosis and eye diseases, cognitive performance, and modulation of the immune response. The authors suggest that the study was the first to show a greater antioxidant, cytoprotective, and geno-protective impact of organic tomato puree compared to those obtained by conventional agriculture (Mottola et. al., 2022).

Still comparing the organic and conventional tomatoes, Caris-Veyrat et al. (Caris-Veyrat et. al., 2004) evaluated the content of antioxidant microconstituents among the product types. The authors reported in their results that organic tomatoes showed a higher content of vitamin C, carotenoids, and contents of some polyphenols than conventional tomatoes. In
addition, when evaluating purees of these tomatoes also found a significantly higher content of vitamin C and phenols than in purees made from tomatoes from conventional cultivation. The study suggests that organic culture can provide tomatoes and tomato products with significantly higher levels of antioxidant microconstituents.

Based on the studies reported here we understand that organic agriculture stands out by contributing to the maintenance of an optimal state of health (Hurtado-Barroso et. al., 2019; Johansson et. al., 2014) and that there is a need to implement sustainable agriculture strategies to reduce the use of chemical pesticides and their impact on health, keeping intact the nutritional, biological, and protective characteristics of food products (Mottola et. al., 2022). Contributing to this movement of organic agriculture Zhao et al. (Zhao et. al., 2007) report no significant differences between the taste of tomatoes produced traditionally or organically. However, the various health benefits presented may influence the choice of production type.

2.2 CONSUMPTION BY THE CHILD PUBLIC

Numerous studies have evaluated the impacts of vegetable consumption with pesticide residues on human health (Calderon et. al., 2022). Studies with the child population showed adverse health effects arising from exposure to pesticides in children around the world (Buralli et. al., 2020). We gathered findings from the literature to understand the effect of organic and conventional feeding on children’s health since they make up a demographic group more vulnerable to the lasting effects of exposure to pesticides (Lanphear, 2015). Most of the studies discussed included tomato as one of the investigated vegetables.

Pesticides are identified as dangerous global poisons that are associated with increased short- and long-term morbidity in children (Lekei et. al., 2017). Greater vulnerability to the effects of pesticides on children occurs because of their immature and developing organs that are more susceptible to adverse pesticide damage (Lanphear, 2015). According to Weiss (Weiss, 2000), children are exposed to a higher risk of toxicity by pesticides than adults because the developing brain is more vulnerable to neurotoxic components.

In addition, children are more susceptible to the effects of pesticides because the concentration ingested by body mass in this group is higher than that observed in adults (Weiss, 2000) and because children have a lower activity and enzyme level for detoxification of activated forms of certain pesticides than older individuals (Holland et. al., 2006). This increased susceptibility is particularly worrying, as many foods for this age group are produced from vegetables (Calderon et. al., 2022).
Child exposure to pesticides can occur in several ways. One of them is due to maternal exposure in your gestational period. This prenatal maternal exposure is related to occupation, housing close to agricultural areas, domestic use of pesticides, and food derived from food or beverages contaminated with pesticides (Hyland and Laribi, 2017). In addition, children can be exposed through food intake contaminated with pesticide residues (Buralli et. al., 2020; Hyland and Laribi, 2017), and may even suffer chronic low-level exposure (Bradman et. al., 2007; LU et. al., 2004). Another serious factor that may expose children to pesticides is the accidental ingestion of pesticides, which is recurrent by children in rural areas and leads to acute poisoning (Dayasiri et. al., 2017). Therefore, it is concluded that children are exposed to pesticides in various ways from the prenatal period to the later stages of development in their childhood (Van Maele-Fabry et. al., 2013).

According to Muñoz-Quezada et al. (Muñoz-Quezada et. al., 2013), parental occupational exposure to pesticides was associated with the development of brain tumors in children. As for Maele-Fabry et al. (Van Maele-Fabry et. al., 2013), the exposure that comes from the prenatal period to the later stages of development may have several effects on the respiratory health of the child. In their review study showed that most studies (79%) found positive associations between pesticide exposure and respiratory and allergic effects in children such as asthma, wheezing, coughing, acute respiratory infections, hay fever, rhinitis, eczema, chronic phlegm, and impairment of lung function.

Several studies document that prenatal exposure to pesticide components is associated with lower birth weight and a higher body mass index (BMI) during childhood, altering the trajectory of weight gain and promoting overweight and childhood obesity (béranger et. al., 2020; soesanti et. al., 2020; svensson et. al., 2021; vrijheid et. al., 2020). Investigating concentrations of pesticides through biomarkers in pregnant women, significant negative associations were also found between the concentrations of pesticides and the length and cephalic perimeter of newborns (béranger et. al., 2020; matsuki et. al., 2020; soesanti et. al., 2020).

The damage is intensified with data on child neurodevelopment. Prenatal exposure to pesticide residues is negatively associated with the cognitive development of children 1 to 9 years of age (Bouchard et. al., 2011; Engel et. al., 2011; Rauh, Virginia et. al., 2011). For Engel et al. (Engel et. al., 2011) this association particularly affects perceptive reasoning, with evidence of effects starting at 12 months of age and continuing until early childhood. Other studies report that this association brings impairments to working memory and attention, especially in young children, and may lead to a significant reduction in child intelligence.
quotient (Dórea, 2021; Engel et. al., 2011; Rauh, Virginia et. al., 2011). In addition, it contributes to the development of attention deficit hyperactivity disorder in children aged 2 to 5 years (Marks et. al., 2010; Rauh, Virginia A. et. al., 2006).

The consumption of pesticide residues also affects motor development, generating, for example, abnormal reflexes in newborns (Dórea, 2021; Engel et. al., 2016) and increased risk of delay of this type of development (Rauh, Virginia A. et. al., 2006). The effects related to growth and neurodevelopment are a major public health concern because of their lifelong impacts on health and quality of life (Buralli et. al., 2023; Plouffe et. al., 2020). Child neurodevelopment is complex and can be affected by multiple environmental factors, including exposure to pesticides. Evidence shows the wide adverse effects of pesticides, which can affect brain regions such as the cortex and the hypothalamus-pituitary-thyroid axis and influence the process of growth and development of children (Hernández et. al., 2020; Lushchak et. al., 2018; Mora et. al., 2022).

According to Lushchak et al. (Lushchak et. al., 2018), there are several biological mechanisms arising from exposure to pesticides that can affect a developing nervous system. Because they have well-known neurotoxic properties, the main mechanism of action of pesticides involves the inhibition of acetylcholinesterase, but can also affect different neurochemical targets, including growth factors, neurotransmitter systems, and second messenger systems (Bouchard et. al., 2011).

In addition to the prenatal period, considering the period of childhood, Buralli et al. (Buralli et. al., 2023) show a strong indication of the harmful effects of exposure to pesticides on the growth and neurodevelopment of children. Most of the included studies pointed to adverse effects on somatic growth, diagnosis of ASD and ADHD, and performance in neurodevelopment and behavior tests, which had already been observed previously by one of the authors (Dórea, 2021). Similarly, to the damage of prenatal exposure, exposure to pesticides during childhood was associated with impaired cognitive abilities (Ruckart et. al., 2004; Sánchez Lizardi et. al., 2008), as well as worse short-term memory and worse executive function. In addition, behavioral problems and worsening of motor skills were reported (Bouchard et. al., 2010; Grandjean et. al., 2006).

Besides cognitive impairments, it was observed in different countries that pesticides negatively affect the anthropometric measures of children (Béranger et. al., 2020; Krönke et. al., 2022; Svensson et. al., 2021). According to Odewale et al. (Odewale et. al., 2021), pesticide components such as hexachlorocyclohexane can pose carcinogenic risks to children, threatening the health of children’s consumers. Most studies aimed to observe the harm to
health of pesticide residues in foods consumed by children and promote the essentiality and urgency in adopting policies and actions to prevent and remedy the exposure of children to pesticides, especially considering a precautionary and protective principle of neurodevelopment (Buralli et al., 2023; Dórea, 2021).

3 FINAL CONSIDERATIONS

The desire for a healthier diet generates a growing trend in the consumption and production of organic food. It is known that these foods are associated with a decreased risk of various health problems such as being overweight, obesity, pre-eclampsia metabolic syndrome, birth defects, allergies, otitis, cancer, and other diseases. In addition, organic foods have higher amounts of antioxidants that are considered protective against the development of neurodegenerative and cardiovascular diseases.

In the case of tomato specifically, which is already a food naturally beneficial to health due to its rich composition and association with decreased risk of various diseases, it has been shown that the organic product has a higher content of bioactive compounds (such as vitamins, antivirals, antibacterial, anti-inflammatory and antioxidant) and therefore have greater nutritional value, greater cytoprotective and antigenotoxic effect than tomatoes from conventional cultivation, being associated with improved cognitive performance, improvement of the immune response, lower risk of developing diseases (such as osteoporosis, cancer, eye, and cardiovascular diseases) and therefore a greater benefit to consumer health.

In contrast, the consumption of conventional cultivated foods is harmful to health, due to contamination by pesticide residues that are related to the development of immune, hormonal, reproductive, neural, and cancer diseases. The adverse effects of consumption of non-organic foods extend to the child population, such as cancer risks and neural disorders, which affect neurodevelopment and cognition impairing perceptive reasoning, working and short-term memory, executive functions, attention, and behavior.

For this population more vulnerable to the effects of pesticides in the body exposure to pesticide residues occurs from very early (including the prenatal period until its development during childhood) and is related to the development of several other health problems: respiratory diseases (such as asthma, acute infections and impaired lung function), allergies (such as hay fever and rhinitis), inflammation (such as eczema), obesity and overweight, anthropometric changes (head circumference at birth, weight and height at birth and during
childhood), changes in motor development (delay in childhood, abnormal changes in newborns).

The studies included in this review support the consumption of tomatoes and other organic products to benefit the health of adults and children. However, it is necessary to encourage organic farming to maintain the nutritional characteristics of food, reduce exposure to pesticide residues, and promote human health. In addition, it is essential to take care of the exposure of children (in their prenatal period and throughout childhood) to these pesticide residues as a preventive measure aimed at protecting health and child development.
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