

COMMENTARY

Commentary: Health Concerns of Brazil Nut Consumption

Elias E. Mazokopakis, MD, PhD and Michael I. Liontiris, MD

Abstract

Brazil nuts are the fruit of the enormous tropical tree *Bertholletia excelsa* that are produced in and exported from the territory of the Amazon. As a natural rich source of selenium (Se), the consumption of Brazil nuts is often suggested as therapeutic among patients with autoimmune thyroid diseases. In this review, the current knowledge regarding the main health concerns of Brazil nut consumption, such as Se toxicity, Se-induced type 2 diabetes mellitus, weight gain, radioactivity, aflatoxins, and allergic reactions, is presented and discussed.

Keywords: aflatoxins, autoimmune thyroid disease, Brazil nuts, diabetes mellitus, radioactivity, selenium, thyroid

Introduction

BRAZIL NUTS GROW on massive tropical trees, the *Bertholletia excelsa* of the Lecythidaceae family,^{1,2} some reaching heights over 45 m. The tree produces extremely hard spherical pods containing on average 18 seeds,² the nuts, covered by a ligneous, rough shell. Brazil nuts are native to areas around the Amazon in Brazil, Peru, Columbia, Venezuela, and Ecuador¹ and are exported to all destinations globally. The matrix of Brazil nuts is quite complex: 66%–67% fat, 14% proteins, and 13% carbohydrates.³ Nutritionally, Brazil nuts are an excellent, gluten-free source of dietary fiber, various vitamins, such as thiamin and vitamin E, and minerals, such as selenium (Se), copper, magnesium, manganese, potassium, calcium, iron, phosphorus, and zinc.³ The consumption of Brazil nuts has been associated with benefits to lipid metabolism and reductions in total and low-density lipoprotein cholesterol concentrations, thyroid function, oxidative stress, inflammatory and oncogenesis biomarkers, some cognitive functions, male infertility, and so on.^{4–9} Most of these benefits are due to the fact that Brazil nuts are one of the richest known food sources of bioavailable Se,^{3,9,10} mainly in the form of selenomethionine.^{3,11} The Se content of the Brazil nut relies heavily on the composition of the soil in which it grows. Concentrations of Se in unshelled Brazil nuts are reported to be greater than in shelled nuts.⁹ The average Se content of each Brazil nut in most elemental analyses varies ranging from 2.7 to 11 µg Se/g, but the average weight of each nut varies between 3 and 4 g.^{1,6,9,10,12} Con-

sidering the previous data and the fact that the current recommended dietary intake of Se in adults is between 55 and 75 µg per day,^{1,13–15} we conclude that 2–7 Brazil nuts are required to cover the daily Se requirement.

Se is known to be an essential element with many pleiotropic effects ranging from antioxidant and anti-inflammatory to heightening the active thyroid hormone production,^{6,13,16–19} and this year (2017) marks the 200-year anniversary after first being identified by the Swedish chemist Jöns Jakob Berzelius. Se supplementation appears to modify inflammation and immune responses in patients with autoimmune thyroid diseases (AITDs).^{13,18,19} Three meta-analyses have confirmed the suppressive effect of Se supplementation on serum thyroid peroxidase antibody (TPO-Ab) and thyroglobulin antibody (Tg-Ab) levels in patients with Hashimoto's thyroiditis (HT).^{20–22} However, another meta-analysis in the Cochrane library concluded that the evidence to support or refute the efficacy of Se supplementation in patients with HT is insufficient.²³

The consumption of Brazil nuts by humans is usually casual and preferable to alternative supplementation practices for improving their nutrition because they are sustainable, less expensive, and pose a lower risk of toxicity.⁹ Nevertheless, in clinical practice, because of their high content of natural Se, it is often suggested as therapeutic (daily consumption) especially among patients with AITDs. The aim of this study was to point out the possible harmful health effects of Brazil nut consumption based on current bibliography.

Health Concerns of Brazil Nut Consumption

The main health concerns of Brazil nut consumption are the following:

- (1) Brazil nut consumption could pose some risk if the daily Se intake from this source is much higher than the recommended amount. According to research, intake of $\sim 330 \mu\text{g}$ of Se per day could be toxic not only for growth hormones and insulin-like growth factor 1 metabolism but also in the synthesis of thyroid hormones.^{18,19} Possible major side-effects include nail and hair loss, anorexia, diarrhea, depression, hemorrhage, liver and kidney necrosis, blindness, ataxia, and respiratory disturbances.¹⁸ There have also been instances of dermatitis and central nervous system disorders in an area with high Se content in Enshi, China.²⁴ These signs and symptoms of Se toxicity are known as *selenosis*. An Se intake of $50\text{--}400 \mu\text{g/d}$ is considered a safe range for adults, while $850\text{--}900 \mu\text{g}$ could be allowed as minimum for Se toxicity.¹⁰ Evidently, the high Se content variation in Brazil nuts that depends on the soil of the nut tree origins increases the likelihood of Se toxicity, regardless of the quantity of nuts consumed. However, clinical cases of selenosis due to Brazil nut consumption have not been described in the medical literature. A human study in a region of the Brazilian Amazon with a local traditional diet rich in Se, no dermal or breath signs or symptoms of Se toxicity were associated with the ranged from normal to very high biomarkers of Se status.²⁵ Also, no clinical symptoms of selenosis were observed in preschool children who received a Brazil nut-enriched diet and biomarkers of Se exposure exceeded the reference levels.²⁶
- (2) Se supplementation may be associated with an increased risk for type 2 diabetes mellitus (T2DM).¹⁸ There is controversy regarding previous evidence associating Se supplementation with T2DM. Nonetheless, this association has been established as U-shaped by numerous studies; therefore selenoprotein levels below and above the reference range are possible risk factors for T2DM.^{17,18} This U-shaped association was revealed²⁷ in a five-study meta-analysis (13,460 participants) in which notably high prevalence of T2DM was observed in patients with relatively low ($<97.5 \mu\text{g/L}$) or high ($>132.50 \mu\text{g/L}$) serum Se levels. Thus, Se supplementation may benefit people with low Se status; however, it could lead to adverse effects in adequate-to-high status individuals and is not recommended.¹⁷ Although clinical cases of T2DM due to Brazil nut consumption have not been described in medical literature, an evaluation for the existence of metabolic syndrome (MetS) or prediabetes among consumers/patients and measurement of serum/plasma Se levels before and during Brazil nut consumption may be necessary.
- (3) Supplementation of patients who are both iodine and Se deficient with Se can deteriorate the thyroid function.^{18,19} To predict whether a patient would benefit from Se supplementation through Brazil nut consumption, the clinician should first investigate the patient's iodine status.^{18,19} This is possible by deter-

mining the urinary iodine excretion in a 24-h urine collection.

- (4) Brazil nuts are regarded as one of the most radioactive foods in the world because of the high levels of radium (Ra) they contain. The reported concentration of Ra-226 and Ra-228 varies (ranging between 0.1 and 7 pCi/g ; $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq} = 37 \text{ GBq}$ and $1 \text{ Bq} \approx 2.703 \times 10^{-11} \text{ Ci} \approx 27 \text{ pCi}$),^{28–31} but overall, the Ra concentrations in Brazil nuts are 1000 times higher than those in other foods. Indicatively, we mention that row *Lima beans* offer $2\text{--}5 \text{ pCi/kg}$ from potassium (K)-40 and 4.64 pCi/g from Ra-226, but *bananas* offer 1 pCi/kg from radon-226 and 3.52 pCi/g from K-40. A study of shelled and classified in different sizes Brazil nuts revealed that mean activities for the following Ra isotopes were: 15.77 Bq/kg for Ra-224, 104.8 Bq/kg for Ra-226, and 99.48 Bq/kg for Ra-228. For Ra-226, the levels did not vary significantly with nut sizes, although such differences were observed for Ra-224 and Ra-228.³² Another research¹⁰ discovered that the measured concentrations of Ra isotopes in Brazil nuts from four regions in South America ranged from 17 to 30 mBq/g for Ra-226 and 18 to 31 mBq/g for Ra-228. This similarity of Ra concentration in the nuts in this study indicates that it is the bioaccumulation by *B. excelsa*, not the concentrations of Ra in the soils that influence the Ra levels in the nuts.¹⁰ More specifically, accumulation of Ra in Brazil nuts is not attributable to high levels of uranium and/or thorium series in the soil where the tree grows, rather it is the considerable root system of the trees, which can reach 500–800 years old. This accounts for the stronger concentrations of Ra found in the leaves and cork than the nut.³¹ Regarding Ra intake, Gabay and Sax discovered in 1969 that the body does not retain most of the Ra consumed from Brazil nuts.³³ No information, however, is available on the biologic effects of Ra from Brazil nuts. Considering the results of the above study,³² which showed that all calculated, committed effective doses were below the maximum established by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for the radionuclides Ra-224, Ra-226, and Ra-228, we can accept that no health risk is involved in the consumption of radioactive Brazil nuts.
- (5) Brazil nuts have elevated levels of potentially toxic element barium (Ba).^{10,11} Profuse amounts of a psilomelane group of minerals called hollandite ($\text{Ba}_2\text{Mn}_8\text{O}_{16}$),^{10,11} found in the natural environment of the trees, contain 130 mg/g of Ba, and thus are probably the source of Ba in the nuts. Research¹⁰ measuring concentration of Ba in Brazil nuts from four regions in South America found a range between 96 and 1990 mg/g ; however, this range has been attributed to the varied Ba content of regional soils. Brazil nuts fed to rats were shown to increase Ba deposition in bones by Stoewsand et al.³⁴ Moreover, it was discovered by Lisk et al.³⁵ that ingestion, by humans, of a single 92 g portion of Brazil nuts resulted in just a 10% excretion of the Ba dose in urine and feces in the first 6 days. Ba toxicity is apparently

lower by the oral route.¹¹ Currently, there is no information concerning the biologic effects of the high levels of Ba contained in Brazil nuts.

- (6) Brazil nuts may be affected by the presence of aflatoxins, a highly toxic and carcinogenic group of secondary metabolites produced by *Aspergillus* section *Flavi*, chiefly implicated as predisposing hepatocellular carcinoma.^{2,32,36} The nut falls from the tree after 15 months and is not collected from the tree, but from the ground where it may sit for a few days up to many months, providing plenty of opportunities for environmental interaction.² Some studies have shown that the soil is the main source of fungal contamination of Brazil nuts.² It is also believed that the environmental conditions of Brazil nut production in the Amazon region (temperatures of 30°C–35°C and high relative humidity of 80%–95%) influence the level of water activity and moisture in Brazil nuts and favor aflatoxin production by some fungal strains.³² However, several studies have reported no detection of aflatoxins in shelled Brazil nuts.³²
- (7) Excessive Brazil nut consumption can probably increase body weight because of its high caloric value. One hundred grams of raw Brazil nuts provide about 618 Kcal.³⁷ Their high caloric content is principally attributed to their fats (total fat: 61.76 g per 100 g Brazil nuts).³⁷ Weight gain as a result of excessive Brazil nut consumption with Se could contribute to the onset of T2DM in prediabetic individuals.
- (8) Brazil nuts can, as other nuts, trigger potentially fatal allergic reactions in sensitive people of all ages with a strong family history of atopy.^{38,39} In a study³⁸ among 56 children and adults with a history of allergic reactions to Brazil nuts or evidence of sensitization, combined history, skin prick test, and serum-specific IgE was enough to arrive at a diagnosis in the majority of patients (77%) with suspected Brazil nut allergy. Due to the pervasiveness and life-threatening properties of nut and peanut allergies, as with laryngeal edema, it is advisable that atopic individuals refrain from their consumption to avoid acquiring the allergy.³⁹ Also, a person who is allergic to other nuts, like peanuts, might be allergic to Brazil nuts as well.

Conclusions/Recommendations

This evidence indicates that the health concerns of Brazil nut consumption should mainly focus on possible high Se intake resulting in Se toxicity (selenosis) and Se-induced T2DM, such as weight gain, their radioactivity, the aflatoxins produced by *Aspergillus*, and allergic reactions. The reported concerns about Se toxicity and Se-induced T2DM are not specific to the consumption of Se contained within Brazil nuts. Because the Se content in Brazil nuts is not stable, but shows great variation, the possibility for Se toxicity is increased even if the number of consumed nuts is small. To predict whether a patient with AITD would benefit from Brazil nut consumption, the clinician should first investigate the patient's iodine and Se status and inform him/her about possible side-effects. For patients with MetS who consume Brazil nuts, monitoring body weight, serum Se, and glucose levels, before and during consumption, is re-

quired. Further studies will be necessary to confirm the health concerns of Brazil nut consumption in clinical practice and determine the mechanism(s) of action of Brazil nut components on varied clinical parameters.

Author Disclosure Statement

No competing financial interests exist.

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Address correspondence to:
 Elias E. Mazokopakis, MD, PhD
 Department of Internal Medicine
 Naval Hospital of Crete
 Souda 73 200
 Chania, Crete
 Greece

E-mail: emazokopakis@yahoo.gr