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Review Article

Bioactive Compounds in Nuts and Edible Seeds: Focusing on Brazil Nuts and Baru Almond of the Amazon and Cerrado Brazilian Biomes

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Abstract

The biodiversity of the Amazon and Cerrado biomes is extremely important for the populations that inhabit these areas, through the extractive collection of non-timber forest products such as fruits, nuts and edible seeds, which generate income and employment. Brazil nut (*Bertholletia excelsa*) is native from South America being found in the Amazon biome and baru almond (*Dipteryx alata Vog.*) is native from the Cerrado biome; these are part of the group of oleaginous that can be classified as true nuts and edible seeds, respectively. Both are important sources of micronutrients that have been associated with several benefits to human health due to the presence of high levels of biologically active compounds such as minerals and vitamins. Minerals act mostly as cofactors in various reactions, selenium has high availability in Brazil nuts and from selenocysteine and its enzymes, it exerts functions in the human body as an antioxidant, regulator of thyroid hormones and protection of cardiovascular diseases. Among vitamins, tocopherol is a precursor to vitamin E, present in both Brazil nut and baru almond, being found in the form of α-tocopherol and having a role in the prevention of various diseases, including: cancer, diabetes, cataracts and cardiovascular and cerebrovascular diseases. Thus, the main objective through this literature review was to gather information about bioactive compounds of Brazilian nuts and edible seeds more specifically Brazil nuts and baru almond as they are trendy in two different Brazilian biomes and generates great income for the local population, adding value to non-timber forest products.

Brazilian Biomes and Its Products

Biome is a set of both plant and animal life, being constituted by groupings of adjacent vegetation types and that can be identified at a regional level with similar conditions of geology and climate. Historically, these have undergone the same processes of landscape formation, resulting in a diversity of flora and fauna of their own. There are several Brazilian biomes; however, the IBGE highlights six main biomes, which are Amazônia, Cerrado, Caatinga, Mata Atlântica, Pantanal and Pampa [1].

According to Brazilian Ministry of Health, the biodiversity of the biomes has a significant impact on the local populations, since it generates employment and income, and also there is an economic potential that is still poorly used. There are a range of products which can serve as a source of income for the families such as fruits, oilseeds, resins, gums, medicinal plants, etc. Products from extractive activities are of great esteem for the rural economy of developing countries. On the other hand, there are arguments that extractivism in its majority harms the flora. In addition, it is known that diverse human populations that inhabit or inhabited rich ecosystems have kept them well preserved, taking advantage of the natural resources, even though there is an increasing in the specific flora biodiversity [2].

The Cerrado biome consists of a vast heritage of renewable natural resources, with an emphasis on exotic fruit species which have unique sensory characteristics. The Brazilian Cerrado plants are known as source of compounds with high biotechnological interest, being able to be applied in the medical and pharmaceutical industry as well as in the food industry. The native fruit species are fundamental in this ecosystem and have been consumed by the local population both in fresh and processed products, such as juices, ice creams, breads and cakes for many years [3-5].

There are several extractive products that have had great importance in the economic, social and political formation of the Amazon Biome, for instance the "sertão drugs" and cocoa, rubber, Brazil nut, peach palm, açaí fruit and the extraction of wood, are among the main ones. Extractive reserves are being considered as a solution to avoid deforestation of biomes, as a better option for income and employment and as protection of biodiversity. The sustainability from extraction activity, changes with technological progress, the emergence of economic alternatives, population growth, reduction of stocks, wage levels of the economy, changes in relative prices and other factors [6].

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The objective of this work was to define nuts and edible seeds and to present the bioactive compounds and human health benefit of Brazil nuts and baru almond consumption, two important food products of the Amazon and Cerrado biomes, respectively.

Nuts and Edible Seeds

Nuts are characterized as dried fruits with high lipid and protein value. Brazil nut is an example of nuts and can be found in the Amazon biome. The nuts present an essential amino acid profile that includes most of the daily intake requirements [7].

The edible seeds have similar characteristics to the nuts (Figure 1), but with a different botanical classification. Peanuts and baru almond are examples of edible seeds. Peanuts come from an herbaceous legume and its pericarp is thick and dry, while baru is a drupe fruit, which means that it is a fibrous fruit that has only one edible seed. Nuts and edible seeds may also have nutrients and bioactive compounds [7,8].

Brazil nuts

Brazil nut (*Bertholletia excelsa*) is native to South America and found in the Amazon biome in countries such as Brazil, Bolivia, Peru, Colombia, Venezuela and Ecuador. However, it's most numerous formations are distributed in Brazil in the states of Acre, Amapá, Amazonas, Pará, Rondônia and Roraima. The fruit is also known as a hedgehog, and in its interior is found from 18 to 25 seeds to which the almonds are popularly known as Brazil nut. The Brazil nuts can present 64.94 % of lipids (essential fatty acids) and 14.11 % of proteins, 8.02 % of dietary fiber and 3.56 % of ash thus it can be a food with considerable nutritional value, totalizing 665.98 kcal of energetic value [7-9]. From a nutritional point of view, Brazil nuts include proteins, fibers, selenium (36.1 μg g^{-1}), magnesium (9678.5 μg g^{-1}), thiamine, niacin, vitamin E, vitamin B6, calcium (7432.8 μg g^{-1}), iron (74.26 μg g^{-1}), zinc (110.31 μg g^{-1}) and copper (59.44 μg g^{-1}) [10-12].

Baru almond

Baru almond (*Dipteryx alata Vog.*) is an edible seed coming from the fruit of the barueiro, woody tree legume native to the Cerrado, regionally used for human consumption. It is a drupoide fruit, fibrous, monospermic, ovoid, of brownish hue and smooth texture of the Fabaceae family, with an almond-like seed in its center. The pulp and the almond are the baru's edible parts. The baru almond presents about 530 kcal per 100 grams and nutritional composition is rich in micro and macro nutrients. Among the micronutrients, zinc, copper, iron, phosphorus, magnesium and α-tocopherol levels are similar to those of peanut oil. Its oil contains about 80 % unsaturated fatty acids, with a predominance of oleic (omega-9) and linoleic (omega-6) fatty acids [13-16]. Regarding to the macro nutrients, baru almonds present 38.2 g100 g^{-1} of fat, 23.9 g100 g^{-1} of protein,15.8 g100 g^{-1} of total carbohydrate, 13.4 g100 g^{-1} of total dietary fiber(2.5 g100 g^{-1} soluble and 10.9 g100 g^{-1} insoluble), presents significant levels of calcium (1109.4 μg g^{-1}), phosphorus (8328 μg g^{-1}) and potassium (9803.5 μg g^{-1}). Moreover, baru almond shows higher contents of total phenolic compounds than several other almonds consumed in Brazil such as pine nuts, macadamia nuts, Brazil nuts, cashew nuts, hazelnuts and peanuts [16-18].

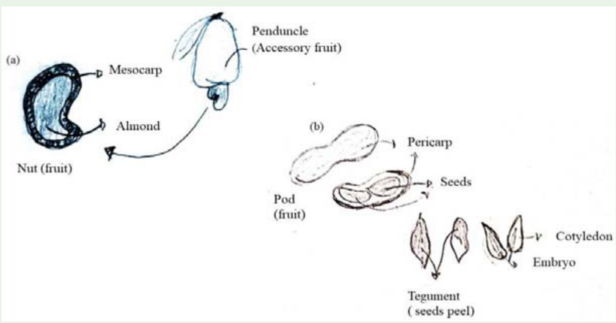

Figure 1: Morphology of a nut and an edible seed. (a) cashew nuts and (b) peanuts.

Like the majority of Leguminosae seeds, baru almond also contain a trypsin inhibitor that can be inactivated by heat treatment before human consumption to inactivate this inhibitor [19].

Main Bioactive Compounds Present in Nuts and Edible Seeds

Bioactive compounds are phytochemicals that are present in foods and are capable of modulating metabolic processes, resulting in the promotion of better health. In general, these compounds are mainly found in plant foods such as fruit, vegetables, and whole grains and typically occur in small amounts [20,21]. These compounds exhibit beneficial effects such as antioxidant action, inhibition or induction of enzymes, inhibition of receptor activities, and induction and inhibition of gene expression [22]. They can be considered an extremely heterogeneous class of compounds with different chemical structures (hydrophilic/lipophilic), distribution in nature (specific to vegetable species/ubiquitous), range of concentrations both in foods and in the human body, possible site of action, effectiveness against oxidative species, and specificity and biological action [23]. Among them, polyphenolic compounds, carotenoids, tocopherols, phytosterols, and organosulfur compounds constitute important groups in the human diet.

Oxidative stress conditions seem to be involved in the etiology of several chronic human diseases, such as cardiovascular, diabetes, cancer, genetic, metabolic and neurodegenerative diseases. The consumption of fruits and vegetables has been positively related to a reduction of the risk of developing these chronic diseases, and the potential of beneficial plants has been attributed to the presence of bioactive compounds that show antioxidant properties, acting as free radical scavengers or metal chelators, reducing the reactions that produce Reactive Oxygen Species (ROS) [24-27]. The antioxidant properties of some bioactive compounds, such as phenolics, flavonoids, estrogens and carotenoids, have been widely described in animal models or in cell culture, demonstrating animal cell protection against the action of ROS and consequently protection against chronic diseases. These bioactive compounds, which are distributed throughout all plant parts, are actually the defense system of plants in response to abiotic stress or the action of pathogens to which they are subjected [27-29].

The consumption of nuts and edible seeds has been associated with several benefits to human health due to its high levels of biologically active compounds such as minerals, vitamins, essential fatty acids and antioxidants. Some of these benefits include blood pressure control, reduction of cholesterol levels, anti-inflammatory action, among others [21-30].

Indeed, bioavailability of bioactive compounds may be modified because of interactions with other macronutrients such as fiber in low-processed foods and beverages or proteins and polysaccharides in processed food products [31]. Furthermore, when different foods come in contact in the mouth or digestive tract, various interactions may take place affecting phytochemical bioavailability (for example, fat enhances quercetin bioavailability in meals) [32].

Minerals

Among the mean minerals in nuts and edible seeds, these act as cofactors for various physiological and metabolic functions, and the most commonly found are magnesium, calcium, iron, copper, chromium and selenium. However, the amounts may vary according to the nut or edible seed such as shown in table 1. The baru almond has higher content of calcium, iron, potassium and phosphor when compared to peanut. Meanwhile, Brazil nut has higher content of calcium, iron, magnesium, selenium and zinc when compared to the others edible seeds and true nuts.

It is important to consume minerals in the diet, as these act as precursors to a well-functioning metabolism and sense of well-being. Calcium and iron prevent nutritional deficiencies of collective importance. Calcium is essential for the excitability of muscles and nerves, activates a number of reactions including oxidation of fatty acids and acts as a mitochondrial transporter for ATP along magnesium. Iron is an essential part of hemoglobin being necessary for formation and function of red blood cells. It is primordial in the synthesis of ATP because it makes easy the transference of electrons in the respiratory chain and participates in the transport of oxygen, transporting and storing oxygen in the muscle when necessary during muscle contraction [12-33].

Among other minerals, magnesium, manganese, zinc and selenium are highlighted for their regulatory and enzymatic functions as part of the antioxidant system in the human body. These minerals act as cofactors of various enzymatic reactions, particularly those involving metabolism of food components, being essential for energy metabolism [33].

Table 1: Content of minerals in edible seeds and true nuts.

Minerals	Peaunut (μgg^{-1})	Hazelnut (μg g^{-1})	Baru Almond (μgg^{-1})	Brazil Nut (μg g^{-1})
Arsenic	-	0.024	-	0.017
Calcium	21.85	2880.2	1109.4	7432.8
Chromium	-	1.74	-	1.34
Copper	5.9	59.14	-	59.44
Iron	21.85	71.58	35.7	74.26
Potassium	6261.54	-	9803.5	-
Magnesium	1948.6	4833	1643.1	9678.5
Manganese	-	128.04	-	3.4
Phosphor	6235.95	-	8328	-
Selenium	2.51	-	0.37	36.1
Zinc	39.15	54,26	-	110.31
Source	18.31	32	18	32

The Brazil nut has a research focused on the presence of selenium, due to the antioxidant action in the metabolic processes. The higher content of the selenium the in Brazil nuts, compared to other foods, ranging from 8 and 83 μg g^{-1}, depending on the soil in which the nut was cultivated [12-34]. Selenium (Se) is considered an essential nutrient for human health and its biological functions are mediated by approximately 20 selenoproteins that have selenocysteine in their active centers. Thus, the effects of selenium consumption on human health are related to the role of each of its selenoenzymes. In general, the consumption of Se and selenoenzymes has been associated with the protection of cardiovascular diseases, while nutritional research has a positive association between plasma levels of selenium with a lower atherogenic index, which is an indicator of predisposition to heart disease and antioxidant action linked to the prevention of cancer [35,36]. Among the enzymes that are dependent on selenocysteine, these are glutathione peroxidase and thioredoxin reductase, which are antioxidant enzymes, yet, iodothyronine deiodinase is another enzyme that plays a significant role in the production of thyroid hormones [36,37].

Glutathione peroxidase is a selenoprotein that acts as an antioxidant enzyme in plasma and is associated with slowing the aging process, boosting the immune system and protecting against heart disease and certain forms of cancer. However, at doses above the recommended daily intake of 55 μg day^{-1}, Se can be toxic [12]. Although Se is a fundamental element that is prized for its antioxidant activity, it is also investigated due to the ambiguity of its actions because both beneficial and toxic effects on organisms have been observed. Its therapeutic range is considered narrow, and its toxicity is partly related to the ability of some compounds containing Se to generate free radicals: therefore, the intake of such compounds should be monitored. The Recommended Dietary Allowance (RDA) for Se is 55 μg day^{-1} for adults, which is based on the amount needed to maximize the synthesis of the selenoprotein Glutathione Peroxidase (GPx), measured by the plateau in the activity of the plasma isoform of this enzyme [38]. The tolerable Upper Intake Level (UL) for adults is 400 μg day^{-1} based on selenosis, which is the adverse effect resulting from excessive intake. Studies report that consumption of 300μg day^{-1} of Se can have toxic effects on both growth hormones and thyroid hormone synthesis [39]. According to Thomson et al. [40], the consumption of two nuts (mean 100 μg day^{-1}) would be sufficient to obtain the effects of antioxidants in the body. According to that study, the consumption of peeled Brazil nuts of medium size with an edible portion equal to 4.6 g [41] provides a concentration of Se in the range of 43.2 to 179.4μg g^{-1}, which covers both the RDA and UL.

Stockler-Pinto et al. [42] studied supplementation the diet of patients undergoing maintenance Hemodialysis (HD) with of 1 unit of Brazil nut (the richest known food source of Se) a day during 3 months. Cumulative evidence indicates that oxidative stress and inflammation frequently affect these patients. The authors observed in this study that the supplementation decreased significantly the plasma Se and GPx activity increased, while cytokines, 8-OHdG, and 8-isoprostane plasma levels after 3 months supplementation. HDL-c levels increased and LDL-c levels decreased significantly. This study suggest that the consumption of only one Brazil nut per day during 3 months was effective to reduce the inflammation, oxidative stress markers, and the atherogenic risk, thereby increasing the antioxidant defenses in HD patients.

Se is an essential micronutrient that, once incorporated into selenoproteins, performs important functions in the human body, participating in antioxidant defense, in the immune system and in the regulation of thyroid function [43]. Thyroid function depends on trace mineral Selenium (Se), being at the active center of the iodothyronine deiodinase that catalyzes the conversion of the Thyroxine (T4) to the active form of thyroid hormone, Triiodothyronine (T3). Hemodialysis (HD) patients have reduced T3 levels partly due to impaired hormonal conversion that can be related to Se deficiency, a common feature in these patients [44].

Stockler-Pinto et al. [44] evaluated the effect of Brazil nuts (richest Se source) on thyroid hormone levels in 40 Hemodialysis patients (HD) that received one nut (≈5g, average 58.1 mg Se g^{-1}) per day for three months. All patients were Se deficient and presented low T3 levels at baseline. After intervention, Se plasma levels (from 17.6 ± 11.6 to 153.4 ± 86.1 μg L^{-1}), GPx activity (from 33.7 ± 5.9 to 41.4 ± 11.2 nmol min^{-1} mL^{-1}), T3 (from 27.3 ± 8.8 to 50.2 ± 4.8 ng dL^{-1}) and FT4 levels (0.87 ± 0.2 to 0.98 ± 0.4 ng dL^{-1}) were significantly increased ($p < 0.05$). The increasing Se levels via Brazil nut supplementation was associated with improvement in thyroid hormone levels in HD patients, although the amount of Se given was not able to restore T3 to normal levels.

Tocopherols

The denomination of vitamin E consists of a generic name of eight liposoluble compounds, they are alpha (α), beta (β), gamma (γ) and delta (δ) tocopherols and α, β, γ and δ tocotrienols, each one with a specific biologic activity and all of them with important antioxidant properties and health benefits. Therefore, the most abundant compounds in foods are α- and γ-tocopherol [45,46].

Alpha-tocopherol exhibits the highest biological activity and molar concentration of lipid-soluble antioxidants in the human. A handful of in vitro and in vivo assays have been conducted on the determination of vitamin E bioaccessibility and bioavailability. It is important to note that during digestion, vitamin E must be packaged into micelles to facilitate absorption, the same as carotenoids. Therefore, Reboul's simulated GI digestion procedure [47] employed in the assessment of carotenoids is also used to study vitamin E bioaccessibility, with subsequent centrifugation and filtration steps.

Studies presented α- and γ-tocopherol values of (5.00 and 4.3 mg.100 g^{-1}) for baru almond and α- and γ-tocopherol (82.90 and 116.20 mg.100 g^{-1}) for Brazil nuts, respectively [15-48]. Due to antioxidant properties, vitamin E presented an important role in the prevention of various diseases, including cancer, diabetes, cataracts, cardiovascular and cerebrovascular diseases; this vitamin is also associated with the prevention or reduction of cognitive decline. In addition, the tocopherols act by converting the free radicals into more stable species through the donation of a hydrogen atom generating electrically stable or less reactive products [49,50].

Although, the antioxidant effects can be reinforced when selenium and vitamin E are combined in the diet, together generate an overload of therapeutic actions protecting the organelles and membranes from damage caused by oxidation [12-37]. Studies suggest that the consumption of one unit of Brazil nut per day is sufficient to supply the daily requirement of selenium, since excessive intake can be toxic, causing loss of nails and hair, respiratory problems and nervous system, so specialists do not recommend the intake of selenium in dietary supplements [35-36].

Essential fatty acids

Nuts are good sources of unsaturated fatty acids including Monounsaturated Fatty Acids (MUFA) and Polyunsaturated Fatty Acids (PUFA). The fatty acid composition of tree nuts is important from several perspectives including (1) nutritional quality of the MUFAs and PUFAs (notably the ω-3 and ω-6 fatty acids) being considered more desirable than the saturated fatty acids; (2) possible health benefits offered by MUFAs and PUFAs, especially in relation to blood serum lipid profile (notably the decrease in undesirable low-density cholesterols VLDLs and LDLs); (3) flavor-desirable flavors often attributed to several fatty acids in the nut seeds; (4) contribution to texture; and (5) importance in keeping quality(shelf life), especially the propensity for generating off-flavors upon oxidation of MUFAs and PUFAs [12-34].

Brazil nuts contain approximately 15% of Saturated Fatty Acids (SFA), 25% of MUFAs, and 21% of PUFAs. Except coconuts, the saturated fat content of Brazil nuts is among the highest of all the nuts, surpassing even macadamia nuts. Brazil nuts are also important for containing omega-3 fatty acid (α -linolenic acid) near almost about 7% of the total fats. Of the remaining fats, over half is monounsaturated fat (mainly oleic), followed by 25% of polyunsaturated fat (linoleic, omega-6), and around 19% of saturated fat (palmitic and stearic) [10]. In Brazil nuts, the lipid percentage is about 66%, and the major fatty acids found are linoleic (45%), oleic (29%), palmitic (15%), and stearic (10%) [7,51]. The highly polyunsaturated nature of Brazil nut lipids (74%), makes these nuts susceptible to oxidative instability.

Fernandes et al. [52] reported that baru almond showed high content of vitamin E and low amounts of selenium, and high contents of zinc. Regarding the lipid profiles, the baru almond has more MUFA (45.49 ± 2.01 % of total of lipids), mainly oleic acid (C18:1) with concentration of 41.41 ± 2.08 %, than PUFA (24.79 ± 1.31 of total of lipids), mainly linoleic acid (C18:2) with concentration of 24.40 ± 1.31 % and Saturated Fatty Acids (SFA) of 12.98 ± 0.76 % of total of lipids.

Fernandes et al. [52] investigate the effect of these native Brazilian oilseeds on serum lipid profile and hepatic lipid peroxidation in Wistar rats. The effect against hyperlipidemia observed was related to the presence fatty acid profile of the Brazilian oilseeds, as they are rich in unsaturated fatty acids (baru almond = 70 g 100 g^{-1}; Brazil nut = 77 g 100 g^{-1} total lipids). The baru almond showed better effects on serum lipid profile and lipid peroxidation than Brazil nut, since the animals fed with baru almond had higher serum HDL-c concentration, similar to that of the reference group, and lower hepatic MDA content (hepatic tissue protein concentration) than those of Brazil nut. These differences might be related to the fatty acid profiles of these foods, especially by the high MUFA contents of baru almond.

Although fatty acids are of great importance for the human diet, the Brazil nut it is very susceptible to oxidative deterioration, which is the biggest problem in this type of food, with the altering of the texture, appearance, flavor and aroma. However, the high content of phenolic compounds inhibits lipid oxidation of these nuts, depending on the variation of the characteristic physical and chemical parameters [53,54].

Phenolic compounds

The determination of the total content of phenolic compounds in baru nuts (*Dipteryx alata*) was performed in methanol extract due to the high solubility of phenolic compounds in this medium [55]. The baru nut with peel has an average content of total phenolic compounds higher than to those found in seven others nuts (pines, macadamias, Brazil nuts, cashews, nuts, hazelnuts and peanuts) often consumed in Brazil and the United States, which had total phenolic content ranging from 32 to 420 mg GAE100 g^{-1} [52]. The content found in baru nuts also exceeds the content reported for other popular nuts and those produced in the Center-South region of Brazil, such as pequi nuts (*Caryocar brasiliense*, Camb) and two species of pindo palm nuts (*B. capitata* and, *B. eriosphata*), which recorded phenolic contents between 122 and 443 mg GAE100 g^{-1}, respectively [56,57].

Raw baru nuts with peels recorded a significantly higher content of total phenolic compounds with respect to baru nuts without peels. The highest content of phenolic compounds found in baru nuts with peels, corroborate several studies that have found high levels of phenolic compounds in fruit and vegetable peels and in other nuts [26-58].The phenolic compounds are associated with a protector system of fruit and seeds against biotic (pathogen attack) and abiotic factors (UV, drought and salt stress), which may explain the higher content of bioactive compounds [59].

Studies have demonstrated that the consumption of the baru almond protects tissues against iron-induced oxidative stress in rats with or without 10% baru nut or 1% phytic acid and supplemented daily with iron or saline by gavages for 17 days [60]. The in vivo study was conducted in male Wistar rats that were fed an AIN-93M diet. The iron supplementation reduced the body weight gain, increased the levels of iron and MDA in the liver and the spleen and increased the carbonyl levels in all three tissues. Consumption of the baru nut reduced the carbonyl levels in the liver, heart and spleen of the iron-supplemented rats ($p = 0.002$, 0.012 and 0.036, respectively) relative to the heart carbonyl level of rats that were fed the control diet ($p = 0.000$); it also marginally reduced the iron-induced lipid oxidation in the liver ($p = 0.117$) and the spleen ($p = 0.074$). Phytic acid reduced the carbonyl level in the spleen ($p = 0.020$) and marginally reduced the carbonyl level in the liver ($p = 0.098$) of iron-supplemented rats. Thus, consumption of the baru nut protects tissues against iron-induced oxidative stress, and the phytic acid from the baru nut may be partially responsible for this protective effect; however, other compounds such as phenols may also be involved.

Kornsteiner et al. [61] found a higher antioxidant activity and higher content of phenolic compounds in several nuts, such as walnuts (1,625 mg GAE100 $g^{-1}$and 179 μmol TEg^{-1}), pecans (1,284 mg GAE100 g^{-1} and 135 μmol TEg^{-1}),pistachios (867 mg GAE100 g^{-1} and 80 μmol TEg^{-1}, and pinion (pinenuts) (32 mg GAE100 g^{-1} e 7 μmol TEg^{-1}). Thus, the author reports a high correlation between the phenolic content and the antioxidant activity of the studied nuts.

The roasting process promoted a reduction in all individual phenolic contents. However, the effect of heat varied between the baru almond with and without peel. For example, the roasting process did notalter the gallic acid content in the baru nuts with peels. However, the gallic acid content decreased by more than 50% in the peeled nut. In addition, with the exception of the p-coumaric acid content that decreased significantly after heat treatment in both set of nuts (with and without peels), the contents of the other six phenolic compounds decreased significantly only in nuts with peels. Reinforcing the suggestion that the thermolability of phenolic compounds depends not only on their structure but also on the food matrix. In addition, the roasting process reduced significantly the antioxidant capacity without change the levels of gallic acid in the baru nut with peels, while the heat treatment in the nut without peels reduced significantly the levels of gallic acid without altering the antioxidant capacity [17].

However, other phenolic compounds might be the main bioactive compounds responsible for the antioxidant activity in this nut. The catechin and ferulic acid, for example, could be the main antioxidant compounds, once contents of these compounds decrease by approximately 50% upon roasting, which is in agreement with the reduction in the antioxidant capacity of nuts with peels after roasting. Those compounds might be responsible for the protective effect against oxidative stress observed in rats supplemented with oral iron and fed a diet containing baru nuts, as described in a previous study [60].

Conclusion

Brazilian biomes are rich in plant diversity; from their native fruits the inhabitants of the regions that surround them use the proceeds of the extractivism for income generation. In this study, we reported more specifically the biomes of the Amazon and Cerrado that have great potential for production of nuts and edible seeds. These foods are rich in bioactive compounds that act to maintain human health.

Brazil nut is considered a source of minerals, more abundantly selenium, and vitamins such as tocopherol (vitamin E), and researches indicate that the consumption of one nut per day is sufficient to supply the daily needs of selenium for the human being. Vitamin E is also found in high content in the baru almond from a Cerrado fruit. As for the role of health promotion, selenium and vitamin E are known to be antioxidants protecting the membranes and organelles of the body, the enzymes from selenium act in several specific metabolic reactions according to their group. It is important to emphasize that the prevention against diseases from bioactive compounds cited in this review is due to the health promotion of the individual.

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