Acta et Commentationes, Exact and Natural Sciences ISSN: 2537-6284
Volume 19(1), 2025, Pages 114–130 E-ISSN: 2587-3644
CZU: 615.322 DOI: 10.36120/2587-3644.v19i1.114-130

Benefits of consuming *Coffea arabica*

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Abstract. Coffee is one of the most important tropical crops in developing countries, but has been relatively little studied from a nutritional and agricultural management perspective. Arabica coffee (*Coffea arabica*), which is part of the genus *Coffea* of the Rubiaceae family, is the most widely cultivated species worldwide, accounting for over 75% of total coffee production. This plant contains a complex combination of chemical compounds with beneficial effects on health. Over time, various parts of coffee have been used in traditional medicine, and modern research has confirmed its antioxidant, antiinflammatory and antimicrobial properties. Coffee consumption is associated with benefits for the nervous system, metabolism and cardiovascular health, with preventive potential in diseases such as diabetes and neurodegenerative disorders. This paper aims to explore the positive effects of Arabica coffee on health, highlighting the importance of its bioactive compounds.

Keywords: *Coffea arabica,* beneficial effects, caffeine and health, neuroprotective.

Beneficile consumului de *Coffea arabica*

Rezumat. Cafeaua este una dintre cele mai importante culturi tropicale în țările în curs de dezvoltare, însă a fost relativ puțin studiată din perspectiva nutriției și managementului agricol. Cafeaua arabică (*Coffea arabica*), care face parte din genul *Coffea* al familiei Rubiaceae, este cea mai cultivată specie la nivel mondial, reprezentând peste 75% din producția totală de cafea. Această plantă conține o combinație complexă de compuși chimici cu efecte benefice asupra sănătății. De-a lungul timpului, diverse părți ale cafelei au fost utilizate în medicina tradițională, iar cercetările moderne au confirmat proprietățile sale antioxidante, antiinflamatoare și antimicrobiene. Consumul de cafea este asociat cu beneficii pentru sistemul nervos, metabolism și sănătatea cardiovasculară, având potențial preventiv în boli precum diabetul și afecțiunile neurodegenerative. Această lucrare își propune să explorează efectele pozitive ale cafelei arabice asupra sănătății, evidențiind importanța compușilor săi bioactivi.

Cuvinte-cheie: *Coffea arabica*, efecte benefice, cofeină şi sănătate, neuroprotector.

1. Introduction

In a world where nature continues to surprise us with its healing gifts, *Coffea arabica*, Rubiaceae family stands out with its rich history and exceptional properties. Used for

centuries in traditional medicine, this plant has become the subject of numerous scientific studies that confirm its beneficial effects on health. Unlike synthetic treatments, which can cause unwanted side effects, *C.arabica* acts in a balanced and gentle way on the body. The natural compounds present in this plant blend with the body's processes, providing long-term benefits without creating a negative impact on internal systems.

The isolation of natural components from plants is an essential process in drug discovery. The isolated components have biological activity and exhibit antioxidant, anticancer, gastrointestinal and systemic, antibacterial, etc. properties [1]. Thus, the process of extracting biologically active components plays an essential and determining role in the study of medicinal plants. Coffee is one of the most popular beverages in the world, and it occupies an important place in the global industry, being the second largest in the world market after gasoline [37]. Its economic value is correlated with genetic diversity, which plays a crucial role in the adaptation of crops to dynamic environmental conditions and in the development of varieties with increased yields, disease resistance and improved characteristics [4].

C.arabica has its primary center of diversity in the mountainous regions of southwestern Ethiopia, on Mount Marsabit in Kenya and on the Boma Plateau in Sudan. Its commercial cultivation is based on two genetic bases: Typica and Bourbon, which were spread from Yemen since the 18th century. These genetic bases have given rise to most of the arabica varieties cultivated worldwide [3]. The genus *Coffea* comprises approximately 103 species, which are divided into two subgenera: *Coffea* and *Baracoffea*. The subgenus *Coffea* includes the species used in coffee production. Of all the species, the most economically and commercially important are *C.arabica* (Arabic coffee) and *Coffea canephora* (Robusta coffee). However, *C.arabica* alone accounts for approximately 75–80% of global coffee production [5].

Coffee has a complex composition, consisting of caffeine, proteins, chlorogenic acids, lipids, sucrose, kahweol and cafestol, compounds that influence both the quality of the drink and its effects on health. Caffeine acts as a stimulant through chlorogenic acids that have antioxidant properties, and kahweol has anticancer effects, while cafestol can increase cholesterol levels [6]. Studies have also shown that this species can reduce the risk of type 2 diabetes by improving insulin sensitivity and regulating glucose metabolism. In addition, *C.arabica* products can improve cognitive functions and mood, thus reducing the risk of neurodegenerative diseases such as Parkinson's and Alzheimer's disease [39]. In traditional medicine, various parts of the plant are used to treat conditions such as anemia, edema, hepatitis and respiratory problems. These beneficial effects make *C.arabica* products not only a beverage appreciated worldwide but also a valuable health ally [7].

2. Methods

In this study, all data were obtained through a comprehensive review of the specialized articles, available in the following databases: Google Scholar, ResearchGate, PubMed, Elsevier and ScienceDirect. We used the combination of the following keywords: "*C.arabica*", "caffeine and health", "cardiovascular", "neuroprotector" and "herbal medicine" to search these databases. Chapters and books were also checked. The most representative references used were written in English. The following steps were performed: (i) development of the article scheme and formulation of questions; (ii) recognition of relevant works; (iii) selection and grouping of works; (iv) data collection, summarization, organization and interpretation of available research; (v) manuscript drafting and final editing.

3. Results and Discussions

3.1. Botanical history

C.arabica has a rich history, linked to the regions of southwestern Ethiopia, especially the provinces of Kaffa and Illubabor. According to research, C.arabica grows spontaneously in the montane rainforests of these areas, at altitudes between 900 and 1,800 meters. It is believed that this plant was first discovered by Ethiopian shepherds, who noticed the energizing effects on goats that ate its fruits [8].

The use of the species *C.arabica* in Arabia is believed to have begun around 1450 when it was brought from Ethiopia to Yemen [9]. From Yemen, coffee spread to other parts of the world through pilgrims and traders [10]. Coffee spread rapidly throughout the rest of the Middle East, reaching Cairo in 1510, Constantinople in 1554, and Europe in the early 17th century. The Dutch brought coffee plants to Java in 1696, and the French introduced it to Martinique in 1723, from where it spread to the Caribbean and Latin America. In Brazil, coffee was brought in 1727 by Francisco de Melo Palheta, who later became the world's largest producer [9].

Coffee consumption became an important part of Ethiopian culture, with various uses and specific rituals, from preparing energizing cakes to using the leaves in infusions. Coffee also played an important role in religious and social practices, often being offered to guests as a sign of respect. Today, Ethiopia is not only recognized as the place of origin of Arabica coffee, but also remains a major global producer, preserving traditional cultivation and harvesting methods that reflect its cultural and historical heritage [10].

3.2. Plant Morphology and Anatomy

3.2.1. Morphology of *Coffea arabica*

C.arabica is a species of evergreen shrub belonging to the Rubiaceae family [10]. It grows at altitudes of 1600–2800 m in tropical areas [11]. It is characterized by relatively slow growth and an erect habit (orthotropic axis), with plagiotropic lateral branches [12].

The leaves are opposite, elliptical, with a glossy surface and an intense green color. They have a lifespan of approximately 8 months [5]. The leaves are green, glossy, elliptical in shape, and the flowers are white and grow in clusters at the base of the leaves [11].

The fruits are small drupes, initially green, turning red at maturity. Each fruit usually contains two seeds, known as coffee beans [12].

3.2.2. Anatomy of *C.arabica*

The leaves of *C.arabica* have an anatomy adapted to tropical conditions, with a complex structure of the cell walls.

Cell wall and polysaccharide composition – The cell walls of C.arabica leaves contain hemicelluloses, pectins, and lignin. Under salt stress, the extractability of these compounds changes, indicating an increase in cell wall rigidity [5].

Epidermal tissue – the leaves have a waxy cuticle and stomata that regulate gas exchange are distributed on the lower surface [5].

Mesophyll structure – The mesophyll of the leaves is made up of a layer of palisade parenchyma and one of lacunar parenchyma, allowing gas exchange essential for photosynthesis [12].

Stomata – They are distributed mainly on the lower surface of the leaf and play a crucial role in regulating transpiration and gas exchange [12], and their shape is correlated with the efficiency of stomatal opening and adaptation to various environmental conditions [11].

These anatomical and physiological characteristics influence both the plant's ability to withstand adverse environmental conditions and the quality of coffee beans.

3.3. Major Chemical Compounds of *C.arabica*

C.arabica is one of the most appreciated coffee species, it contains a series of biochemical compounds that contribute to its distinctive aroma and taste characteristics (Table 1). Among the most important chemical compounds in *C.arabica* beans are caffeine, chlorogenic acid, cafestol, kahweol and trigonelline.

Table 1. Chemical composition of the plant *C.arabica* [40], [41], [42], [43], [44], [45].

Constituents	*C.arabica* organs (content in %)	Components/ observations
Soluble carbohydrates	Seeds (grains): ~43% of dry weight (DW) Stem: data not reported (NR) Root: NR Leaves: estimated <10% DW	
Monosaccharides	Seeds: Glucose 0.3–0.38%, Fructose 0.23–0.3% Stem, root, leaves: NR	Fructose, glucose, galactose, arabinose (traces)
Oligosaccharides	Seeds: <1% (sucrose, raffinose, stachyose) Stem, root, leaves: NR	Sucrose (>90 %), raffinose (0-0,9%), stachyose (0-0,13%)
Polysaccharides	Seeds: Galactomannans (22–24%), arabinogalactans (17%) Stem, root: NR Leaves: <5%	Compounds that give body to coffee liquid; soluble in hot water.
Insoluble polysaccharides	Seeds: Cellulose ~8%, total structural up to 47–60% Stem: predominant (cellulose, hemicelluloses) Root: structural (estimated 10–15%) Leaves: in cell walls, estimated 5–10%	
Hemicelluloses	Seeds: ~20–25% DW Stem: estimated 20–30% Root: NR Leaves: ~5–10%	Polymers of galactose (65-75%), mannose (25-35%), arabinose (0-10%)

Cellulose	Seeds: ~8–10% DW Stem: estimated 30–40% Root: NR Leaves: 5–12%	
Volatile acids	Seeds: 0.1 Stem, root, leaves: NR	
Nonvolatile aliphatic acids	Seeds: 2-2.9 Stem, root, leaves: NR	Citric acid, malic acid, quinic acid
Chlorogenic acid	Seeds: 5–8% DW Leaves: 3–6% Stem/Root: NR	Mono-, dicadeoyl-, feruloylquinoic acids
Lignin	Seeds: 2–5% DE Stem: 15–20% Leaves, Root: NR	
Lipid	Seeds: 10–15% DW Leaves: 1–3% Stem/Root: NR	
Oils	Seeds: 10–15% Stem, root, leaves: NR	Main fatty acids: 16:0 and 18:2 (9,12)
Protein	Seeds: 8–12% DW Leaves: 2–5% Stem/Root: NR	
Caffeine	Seeds: 1–2% DW Leaves: 0.1–0.5% Stem/Root: NR	
Trigonelline	Seeds: 0.5–1.5% Leaves: 0.1–0.3% Stem/Root: NR	
Mineral	Seeds: 3–5% DW Leaves, Stem, Root: NR	

Caffeine is an alkaloid, also known as 1,3,7-trimethylxanthine, which acts as a stimulant of the central nervous system, improves concentration and alertness. At the same time, it contributes to increasing the metabolic rate and fat oxidation, thus playing an important role in regulating body weight. The overall concentration of caffeine in the entire *C. arabica* plant has been reported to range from 1.13% to 1.60% (DW) [13].

Figure 1. Caffeine (Methylxanthine) National Center for Biotechnology Information (2025).

Chlorogenic acid (CGA) with remarkable antioxidant effects, plays a special role in glucose and lipid metabolism, having anti-diabetic, anti-inflammatory and anticancer potential. At the same time, chlorogenic acids contribute to the prevention of cardiovascular diseases and obesity [14].

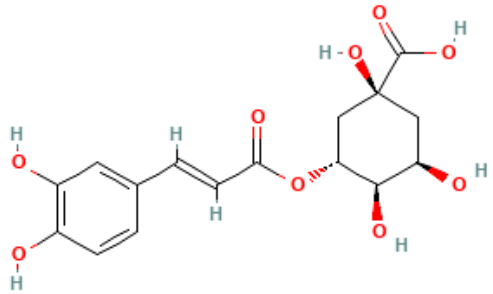
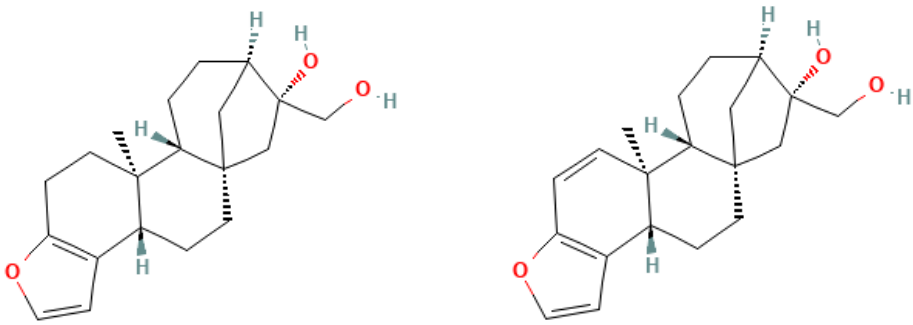


Figure 2. Chlorogenic acids (Polyphenol) National Center for Biotechnology Information (2025).

Cafestol and kahweol are two diterpenes specific to the seeds of *C.arabica* that may have anticancer effects and reduce the genotoxicity of some carcinogens. However, these compounds may contribute to increased serum cholesterol levels, especially when consumed in unfiltered coffee [14].



Cafestol Kahweol

Figure 3. Coffee lipids (Cafestol și Kahweol) Center for Biotechnology Information (2025).

Trigonelline (N-methyl nicotinic acid) is an alkaloid that contributes to the formation of aromatic compounds during the roasting process, such as niacin and various pyran and pyridine compounds. The trigonelline content varies between 0.93% and 1.20% in the seeds of *C. arabica* [13, 40].

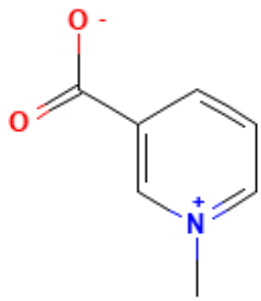


Figure 4. Trigonelline Center for Biotechnology Information (2025).

The chemical composition of *C.arabica* not only influences the aroma and taste of coffee, but also brings important health benefits. Caffeine improves concentration and reduces fatigue, chlorogenic acids have antioxidant and anti-inflammatory effects, and kahweol and cafestol may have protective roles against chronic diseases. Thus, *C.arabica* is not only a source of sensory pleasure, but also an ally of health, when consumed in moderation.

3.4. Health benefits of consuming *C.arabica*

A diet that includes coffee consumption has positive effects on psychoactive response (such as mood swings, alertness), neurological disorders (Alzheimer's and Parkinson's diseases), and metabolic diseases (such as diabetes or liver cirrhosis) [5]. It has also been observed that polyphenols and chlorogenic acids in coffee contribute to the regulation of blood pressure, having a possible effect of reducing it [20]. Recent studies have also highlighted antioxidant and anti-inflammatory properties of coffee, suggesting that a balanced consumption may have an important role in maintaining general well-being and preventing chronic diseases.

3.4.1. Antidiabetic activity

Studies show that regular roasted coffee beans consumption can reduce the risk of type 2 diabetes by up to 25-30% [21]. Roasted coffee beans contains polyphenols, chlorogenic acid and caffeine, which improve insulin sensitivity and reduce intestinal glucose absorption [22]. Chlorogenic acid slows down glucose absorption, preventing sudden fluctuations in blood glucose [20]. They contribute to the protection of pancreatic cells against oxidative stress, thus favoring insulin secretion [23]. Both caffeinated and decaffeinated coffee offer benefits, but should be consumed without large amounts of added sugar. For maximum effects, a balanced diet and regular physical activity are recommended.

3.4.2. Antifungal and antibacterial activities

C.arabica beans are a source of bioactive compounds with significant antimicrobial properties. Phenolic acids, caffeine and flavonoids can inhibit the growth of pathogenic microorganisms. Studies have shown that coffee extracts can prevent the growth of dangerous bacteria, such as *Escherichia coli*, *Staphylococcus aureus* and *Salmonella spp.*, thus reducing the risk of gastrointestinal infections. At the same time, coffee has beneficial effects on oral health, acting against *Streptococcus* mutans bacteria, responsible for the occurrence of dental caries and periodontal diseases [24]. Coffee also has antifungal properties, helping to inhibit the growth of Candida species, thus preventing oral and intestinal fungal infections. These effects are attributed to the high content of polyphenols and organic acids in coffee. Another benefit of coffee is its positive influence on the intestinal microbiome [25]. Regular consumption can stimulate the development of beneficial bacteria in the intestine, helping to maintain microbial balance and reduce pathogenic bacteria [26].

3.4.3. Anticancer effects

C.arabica beans may have anticancer potential due to their bioactive compounds, the most representative of which is caffeine. Recent studies have shown that this substance can influence cellular processes involved in cancer development through several mechanisms. One of the most representative ways in which caffeine acts in cancer prevention is through its antioxidant properties [27]. Free radicals play an essential role in DNA damage and the initiation of oncogenic processes, and through the action of antioxidants in coffee, these free radicals can be neutralized and thus healthy cells can be protected [29].

At the same time, the consumption of *C.arabica* beans has been associated with the inhibition of angiogenesis, the process by which tumors develop new blood vessels to support growth. By blocking this mechanism, bioactive compounds in coffee limit the spread of tumors and prevent metastasis [28]. Epidemiological studies have suggested an association between regular coffee consumption and a reduced risk of liver, colorectal and breast cancer [5]. These beneficial effects are attributed to both caffeine and other bioactive substances, which support the immune response and cellular detoxification mechanisms.

Therefore, *C.arabica* is not only a source of energy, but also a potential protective factor against cancer, due to its antioxidant, anti-inflammatory and cell proliferation regulating properties.

3.4.4. Antioxidant effects

C.arabica beans are known for its high antioxidant content, which helps reduce oxidative stress and protect cells against free radical damage [24]. The main compounds with antioxidant activity are polyphenols, chlorogenic acids, cafestol and kahweol, which have been identified in coffee extracts [22]. Studies have shown that *C.arabica* extracts can inhibit lipid peroxidation and increase the activity of antioxidant enzymes, suggesting a protective role against chronic diseases associated with oxidative stress [24]. It has also been noted that these compounds can reduce oxidative damage to DNA and protect cellular structures from the harmful effects of reactive oxygen species [22].

In addition, it has been observed that chlorogenic acids in coffee have a beneficial effect on metabolism, thus contributing to the regulation of blood glucose levels and the prevention of diabetes [22]. The antioxidant properties of coffee are also correlated with the reduction of the risk of neurodegenerative diseases, such as Alzheimer's and Parkinson's disease [20]. Due to its rich antioxidant content, *C.arabica* may contribute to the prevention of degenerative diseases, protection against oxidative stress and maintenance of general health [24].

3.4.5. Antiviral effects

The antiviral activity of coffee has been highlighted in numerous studies, suggesting that it can help reduce the negative effects of viral infections on the body [5]. According to research by Namba and Matsuse (2002), coffee consumption can reduce the physiological damage caused by viral infections. Also, increased coffee consumption has been correlated with a lower mortality rate and an improved response to interferon-based antiviral therapy used in the treatment of hepatitis C [30].

3.4.6. Hepatoprotective effects

Coffee has been shown to have a protective effect against the development of cirrhosis associated with hepatitis B and C infections, suggesting a beneficial role in the prevention of non-alcoholic cirrhosis. Coffee consumption has also been repeatedly associated, in both clinical and epidemiological studies, with reduced serum levels of γ-glutamyl transferase, a marker of hepatobiliary diseases, thus indicating a protective effect on the liver [20].

3.4.7. Anti-inflammatory effects

Polyphenols, chlorogenic acids and diterpenes such as cafestol and kahweol are bioactive compounds that give coffee its anti-inflammatory properties [32]. These compounds have been shown to reduce inflammation by inhibiting oxidative stress and inflammatory mediators. Coffee influences several signaling pathways involved in inflammation, including NF-κB (nuclear factor kappa-light-chain-enhancer of activated B cells) and Nrf2 (nuclear factor erythroid 2-related factor 2). Activation of Nrf2 leads to an increase in antioxidant enzymes, thereby reducing oxidative stress, a key factor in chronic inflammation [34]. *C.arabica* leaf extract was tested for its anti-inflammatory effects, and the results indicated a significant reduction in the inflammatory response, making it a promising candidate for use in cosmetic and pharmaceutical skin care products [33].

C.arabica beans may also influence the composition of the gut microbiome, favoring the growth of beneficial bacteria, such as Bifidobacterium spp., which have anti-inflammatory effects. This effect may contribute to reducing intestinal permeability and, implicitly, to reducing systemic inflammation [34].

3.4.8. Effects against neurodegenerative diseases

Numerous studies have reported the correlation between coffee consumption and the incidence of Parkinson's disease [7]. These studies suggest that certain components of coffee have a neuroprotective role, especially caffeine [35]. Caffeine is a natural stimulant of the central nervous system [38], it has the ability to act as an antagonist of adenosine

receptors, having a positive impact on dopaminergic neurotransmission, which contributes to reducing the risk of Parkinson's disease and improving symptoms in diagnosed patients [36].

In addition to caffeine, coffee also contains a wide range of antioxidants, such as polyphenols, which can combat oxidative stress and inflammation, two factors involved in neurodegeneration. Thus, these compounds may contribute to slowing the progression of Parkinson's disease. Another possible mechanism by which coffee provides neuronal protection is by reducing the abnormal aggregation of proteins involved in Parkinson's disease pathology, such as alpha-synuclein. Studies in animal models suggest that certain compounds in coffee may influence molecular pathways associated with this disease, having a potential therapeutic role [36].

In conclusion, scientific evidence suggests that moderate coffee consumption may provide benefits in the prevention and management of Parkinson's disease, due to the neuroprotective effects of caffeine and other bioactive compounds. However, further studies are needed to fully understand the mechanisms involved and determine optimal recommendations for patients.

3.5. Potential risks associated with the consumption of *C.arabica*

Although moderate consumption of *C.arabica* products is associated with numerous beneficial health effects, many specialized studies also report possible adverse effects and risks when caffeine intake is excessive or under different physiological conditions.

3.5.1. Psychoneurological effects of caffeine

Caffeine is the main methylxanthine alkaloid present in the seeds of *C.arabica* and is a stimulant of the central nervous system through competitive antagonism on adenosine receptors of the A1 and A2A types. Adenosine is a neuromodulator with an inhibitory role that is involved in the regulation of neuronal excitability as well as sleep. By blocking A2A receptors in the striatum and nucleus accumbens, caffeine favors the release of glutamate and dopamine, which explains the effects of vigilance and the anxious states that it induces [46].

Daily consumption of more than 400 mg of caffeine has been correlated with the appearance of symptoms specific to the "caffeinism" syndrome, such as anxiety, insomnia, tachycardia, agitation and gastrointestinal discomfort, all of which can be aggravated in the context of increased psychophysiological stress [47]. In the long term, chronic consumption has been associated with increased blood pressure, sleep disturbances and

possible cardiostimulatory effects. In addition, isolated cases of caffeine-induced psychotic episodes have been reported, especially for doses exceeding 600 mg [48].

3.5.2. Cardiovascular and metabolic implications

Caffeine activates the sympathetic nervous system by stimulating the release of catecholamines and increasing the concentration of cyclic AMP (cAMP), as a result of inhibiting the enzyme phosphodiesterase (PDE). At the level of cardiomyocytes, the accumulation of cAMP causes an increase in the influx of Ca^{2+} ions into the sarcoplasmic reticulum, thus amplifying the force of myocardial contractions and heart rate. For people with a hypertensive predisposition, these mechanisms can lead to transient or sustained increases in blood pressure, tachycardia and, rarely, the occurrence of arrhythmias. Caffeine also has a mild diuretic effect by inhibiting sodium reabsorption in the renal tubules, with an additional impact on electrolyte balance [49].

3.5.3. Disorders of calcium-phosphorus metabolism and effects on bone

Caffeine can affect calcium homeostasis through several mechanisms, including the reduction of TRPV6 channel expression and calbindin-D protein in the intestine, which leads to a decrease in active calcium absorption. In the kidney, it inhibits tubular reabsorption, thus increasing urinary Ca^{2+} excretion. In parallel, caffeine can activate the RANK/RANKL pathway in osteocytes, stimulating osteoclastogenesis and promoting bone resorption. At the molecular level, caffeine can reduce the expression of the OCN (osteocalcin) gene and negatively influence bone formation markers. Thus, these processes contribute to low bone mineral density and an increased risk of fractures [50].

3.5.4. Risks to pregnancy and fetal development

Caffeine can cross the placenta by passive diffusion and be metabolized slowly in the fetus due to immaturity of liver enzymes. Its accumulation in the fetal circulation may affect cell proliferation, nutrient transport and placental angiogenesis. Furthermore, excessive consumption during pregnancy may be correlated with intrauterine growth retardation and low birth weight of the fetus as well as the risk of spontaneous abortion [51], [52].

3.5.5. Other documented adverse effects

Caffeine can increase gastric hydrochloric acid secretion by directly stimulating parietal cells, thus explaining the occurrence of symptoms of gastroesophageal reflux and dyspepsia in sensitive consumers. At the same time, by interfering with hepatic enzymatic

activity (CYP1A2), it can alter the metabolism of drugs such as theophylline, clozapine or tricyclic antidepressants [53].

Therefore, although *C.arabica* products has numerous benefits, consumption in moderation is recommended, especially among vulnerable populations such as hypertensives, pregnant women and people with sleep disorders or anxiety. Moderation of consumption and individual assessment of caffeine tolerance are essential to prevent potential adverse effects.

4. Conclusions

In conclusion, coffee is not only a globally appreciated beverage for its aroma and taste, but also an important source of health benefits. Specialized studies have shown that moderate coffee consumption can contribute to improving cognitive functions, reducing the risk of neurodegenerative diseases, protecting the liver and improving metabolism. Also, the antioxidant compounds in *C.arabica* beans play an essential role in combating oxidative stress and inflammation. However, to fully benefit from its positive effects, it is essential that it be consumed in moderation and according to the individual needs of each person.

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Received: April 01, 2025 *Accepted: July 03, 2025*

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