Narrative Review Article

Comparative Effects of Energy Drinks and Naturally Caffeinated Beverages on Exercise Performance

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ABSTRACT

The review aims to guide athletes in optimizing their performance by clarifying how different caffeine sources influence athletic performance and long-term health. Caffeine is widely used by athletes to improve physical performance, and its growing popularity has led to increased consumption of energy drinks and naturally caffeinated drinks by athletes. Many athletes rely on caffeine to increase energy, focus, and endurance before practices, workouts, and competitions. This review paper compares and contrasts research on the effects of energy drinks and naturally caffeinated drinks on exercise performance, using measures such as reaction time, endurance, speed, and strength. By focusing on studies from sports medicine and physiology studies, this review paper summarizes the differences between energy drinks and naturally caffeinated drinks in terms of performance outcomes. The paper also summarizes health risks of each added ingredient in energy drinks and naturally caffeinated drinks. As a result of these health risks, the paper also explores the long-term and short-term health effects associated with each choice. It raises awareness of the ingredients being consumed and the health risks that are commonly linked to energy drinks.

Keywords: Energy drinks; naturally caffeinated drinks; caffeine; sports performance; sports nutrition; taurine; guarana

INTRODUCTION

Caffeine is one of the most widely consumed stimulants in the world, used to improve alertness, focus, and energy, all of which can be useful during exercise. It has therefore become more common in athletes' diets. Energy drinks are often seen on the benches during games and some pre-workouts supplements have also started to contain caffeine to ensure optimal sports performance. In sports and exercise, caffeine has been shown to improve several aspects of performance, including reaction time, endurance, and strength (1). Energy drinks, while containing caffeine, also include additional ingredients such as taurine, guarana, and added sugars. These ingredients may produce effects that alter sports performance differently than other caffeine sources (2). Naturally caffeinated beverages such as tea, coffee, and matcha provide caffeine along with other antioxidants and amino acids, balancing the effects of caffeine for steadier and longer focus (1, 3). However, athletes often choose an energy drink over other forms of caffeine.

Considering the growing popularity of caffeine, there are often debates over which sources are best for performance. Energy drinks have gained popularity due to their convenience and targeted marketing towards athletes; however, overconsumption poses health risks

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such as dehydration, heart strain, and energy crashes (4). On the other hand, naturally caffeinated drinks provide a steadier level of energy and additional health benefits such as improving gut health (3). Although naturally caffeinated drinks have fewer health risks, they may not give the immediate rush of energy athletes crave before competition.

Comparing the options is important and relevant since athletes rely on consistent performance, and the wrong choice of caffeinated beverage could affect their results. Reaction time, endurance, speed, and strength are key to measuring success in sports, and understanding how caffeine sources impact them can help athletes make informed decisions. This paper will compare the effects on sports performance of energy drinks and naturally caffeinated drinks, while also addressing why an athlete would choose an energy drink over other forms of caffeine. The objective of this review is to determine which caffeine source may be more beneficial for athletes by comparing the effects on sports performance and evaluating the short-term and long-term health impacts of energy drinks and naturally caffeinated drinks. While energy drinks provide a more immediate boost in performance, naturally caffeinated drinks offer steadier and longer-lasting energy and sustained benefits with fewer health risks, qualities which make them a better choice for athletes.

PHYSIOLOGY OF CAFFEINE

Caffeine is a natural stimulant that can temporarily boost alertness and physical performance, which are important traits often seen in professional athletes (5). Whether it's a cup of coffee in the morning, an energy drink before a workout, or a matcha latte, caffeine sneaks into millions of people's daily routines. Nearly 90% of adults worldwide consume caffeine daily, whether through traditional products such as coffee and tea or modern choices like soda and energy drinks (6). It's found in over sixty plants, including coffee beans, tea leaves, cacao pods, and guarana berries (7).

The concentration and presence of caffeine in common foods or drinks varies widely, depending on the source and method of preparation. Coffee typically contains between 80 and 120 milligrams of caffeine per cup, making it the strongest natural source (8). Cacao products, such as dark chocolate, contribute smaller amounts, while natural teas like yerba maté and guarana offer significant caffeine levels. Energy drinks, unlike previously stated sources of caffeine, tend to be a more concentrated source of caffeine. Their caffeine content ranges from 150 to 200 mg, and when combined with other stimulant ingredients, enhances the effects of caffeine by changing bodily responses to it (9).

Although caffeine enhances alertness and reduces feelings of tiredness, the body also produces natural energy. Biologically, the body is able to function because of a molecule called adenosine triphosphate (ATP), which fuels almost every biological process. ATP is generated within the cell by breaking down glucose and other food molecules through metabolic pathways such as glycolysis, Krebs cycle, and electron transport chain (10). As the ATP is used throughout the day, it gets broken down into adenosine–a molecule accumulates in the brain. As adenosine is accumulated throughout the day and affects a person's wakefulness. The stimulation of adenosine A1 receptors by adenosine depresses glutamate, which is an excitatory neurotransmitter. The depression of glutamate in the brain promotes sleepiness, therefore the presence of adenosine regulates the sleep-wake cycle (11).

Caffeine works as a natural stimulant and affects both physiological and biological factors in your body. As a natural stimulant, caffeine does not create extra energy, instead it interacts with the brain's chemistry to increase the release of neurotransmitters and blocks adenosine receptors (6). Adenosine regulates the sleep-wake cycle by binding to receptors found in the central nervous system that slows neural activity and promotes drowsiness (12). It also reduces heartbeat, protects neurons from overstimulation, and inhibits the release of certain excitatory neurotransmitters. As more ATP is used, more adenosine accumulates, which is why people gradually feel more tired as they stay awake longer. Caffeine's molecular structure is similar to adenosine, allowing it to bind to receptors without activating them (Figure 1). It acts as a competitor for the receptors A1 and A2A, preventing adenosine from binding (13). This sequential action triggers a larger reaction: without adenosine slowing things down, neurons fire more rapidly, and the brain increases its release of stimulating neurotransmitters such as dopamine, norepinephrine, and glutamate.

The brain also increases neuronal firing by triggering the pituitary gland to release hormones that result in the adrenal gland producing epinephrine, also called adrenaline (14). Epinephrine acts mainly as a hormone that triggers the fight-or-flight response in the body, heightening heartbeat, raising blood pressure, and mobilizing stored fats for energy. The increase

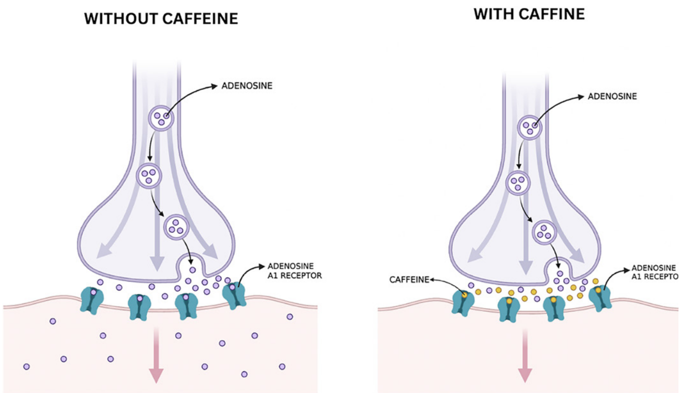

Figure 1. Illustration of Neuron Activity of Adenosine Without Caffeine and With Caffeine. *The presence of caffeine during neurotransmission of adenosine blocks adenosine from being able to bind to receptors on the receiving neuron.*

in neurotransmitters that stimulate the body and the decrease in adenosine binding contribute to the perception of being more awake and energetic. These processes activate the body's stress response, heightening heart rate, increasing alertness, and energy levels which improves an individual's reaction time.

ENERGY DRINKS

Energy drinks are widely marketed as beverages that increase alertness, energy, and improve athletic performance. While caffeine is the main component of interest, other ingredients such as glucose, guarana, taurine, and B-vitamins all contribute to enhancing the effects of caffeine (9). Sugar is one of the most common ingredients in energy drinks since it provides an almost immediate surge of energy. As sugar enters the bloodstream, it increases the blood sugar levels, which stimulates the pancreas to secrete insulin. The insulin allows glucose into the cell, rapidly creating ATP which provides extra energy (15). Although caffeine does not create more energy, sugar does, which is why it is a common ingredient found in energy drinks.

Guarana is a plant extract that is added in many energy drinks. Guarana seeds contain a high concentration of methylxanthines (primarily caffeine), flavonoids, and other phenolic compounds. Together, these compounds give guarana stimulating, antioxidant, anti-inflammatory, and metabolic effects, including increased fat oxidation, a higher resting metabolic rate, and faster cellular energy processes (16). In a systematic review, researchers found that guarana produced a small but statistically significant improvement in response times during cognitive tasks (effect size $g \approx 0.202$, $p = 0.005$) (17). Improved response times allow athletes to process information and react faster, making quicker decisions and better coordination and accuracy. Adding guarana increases the overall stimulant effect of the drink, due to its caffeine and bioactive compounds.

Many brands also add taurine to their drinks to assist the body in handling physical stress. Taurine is an amino acid found naturally in the human body that helps regulate cell volume, stabilize cell membranes, support antioxidant defenses, and control how calcium moves in and out of cells (18). Since taurine is naturally found in tissues involved in movement and metabolism, manufacturers add it to energy drinks to support muscle performance, reduce fatigue, and protect cells from stress. A meta-analysis of 10 randomized trials found that taking 1–6 grams of taurine improved time to exhaustion during endurance exercise (19). Another study showed that taurine reduced lactate buildup and improved anaerobic performance, which may help athletes perform better during short bursts of intense exercise (20). Taurine is not a stimulant like caffeine, but it may improve how the muscles and heart respond to activity. The effects of taurine combined with caffeine on muscles may be an influential deciding factor for athletes when choosing between energy drinks and naturally caffeinated drinks.

B-vitamins are often found in high amounts in energy drinks. B-vitamins are a group of water-soluble vitamins that include thiamin (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), folate (B9), and cobalamin (B12) (21). While B-vitamins don't produce the energy themselves, they are essential for biochemical processes that do produce energy (10). A study found that 28 days of a multivitamin containing B1, B2, B6, and B12 significantly improved endurance and reduced blood lactate and ammonia levels after exercise (22).

The combination of all these ingredients also comes with risks. The high sugar content in energy drinks causes rapid spikes in glucose levels, followed by a sudden drop. Sugar intake is also linked to obesity, type 2 diabetes, and insulin resistance (23). Energy drinks are also high in guarana, which has a higher concentration of caffeine than coffee. Guarana causes strong and longer-lasting stimulant effects that increase nervousness, heart strain, and dehydration (24). Along with sugar and guarana, there is also a high concentration of taurine. Especially when combined with caffeine, taurine increases dangerous heart rhythm disturbances (arrhythmias). Since energy drinks combine excessive amounts of taurine and caffeine, the combination places additional strain on the heart, especially during physical activity (25).

NATURALLY CAFFEINATED DRINKS

Naturally caffeinated drinks have been consumed for over a millennium, dating back to the Tang Dynasty, where tea was a popular beverage for its known health benefits (6). Today, coffee, tea, yerba maté, and cacao remain common sources of energy for many people. Like energy drinks, naturally caffeinated drinks also include different bioactive compounds that shape how caffeine affects the body. Compounds such as polyphenols, antioxidants, amino acids, and minerals slow down caffeine absorption, reduce oxidative stress, and limit negative side effects (26).

Chlorogenic acid (CGA), is found in plants, fruits, vegetables, and herbs, produced when a caffeic acid and quinic acid–naturally occurring acids in coffee beans–are conjugated (27). Green coffee beans contain CGA, which has been shown to reduce oxidative stress, have anti-inflammatory effects, and help regulate metabolism. CGA assists in neutralizing free radicals, causing a reduction in oxidative stress, cell damage, and increase in protective enzymes in cells (26). Research shows CGA also activates energy-related pathways such as adenosine monophosphate-activated protein kinase (AMPK) pathway. When activated, it increases fat breakdown, slows the production of fat and cholesterol in the liver, and improves how cells use glucose for energy, which leads to healthier lipid and blood-sugar levels. Additionally, CGA also has anti-inflammatory effects that may lower chronic inflammation linked to diseases like obesity and diabetes (28).

Often found in teas, L-theanine, a natural amino acid, alters caffeine's effects by improving focus and reducing caffeine-related nervousness. When combined with caffeine, it may also improve strength. A study found that combining 97 mg of L-theanine with 40 mg of caffeine improved accuracy on a task-switching cognitive test and increased alertness while reducing feelings of tiredness. However, it did not significantly improve performance on other tests like reaction time or visual search (29). Another study showed that the combination also improves physical performance by measuring results in wrestling-specific fitness tests (wall-squats, medicine ball throw, vertical jump height, and hand-grip strength). The combination led to more successful throws than either caffeine or L-theanine alone or a placebo. Reaction time and accuracy both improved, and while caffeine by itself increased anxiety, adding L-theanine reduced anxiety levels (30). Overall, these studies suggest that L-theanine works with caffeine to improve focus, alertness, and performance while reducing anxiety. Reduced anxiety maintains an athlete's concentration and prevents distractions. It also improves sleep and recovery, which are important for long-term success in athletic performance.

Yerba maté is a naturally caffeinated drink made from the leaves of Ilex paraguariensis. It contains caffeine and caffeine-related compounds theobromine and theophylline along with saponins, polyphenols, vitamins, and minerals (31). Human studies have shown that phenolic compounds found in yerba maté are absorbed and metabolized after consumption, demonstrating the bioactive compounds bioavailability (32). The presence of these compounds have antioxidant properties that may inhibit lipid peroxidation which prevents cell and tissue damage (33). Along with yerba maté, cacao is also a natural source of caffeine. Although it contains lower amounts of caffeine compared to other sources, it is high in theobromine and flavonoids. Adding on, cacao is also high in flavonoids that increase nitric oxide production and supports cardiovascular health and oxygen delivery to muscles, resulting in an improved blood flow (34).

Theobromine is a methylxanthine compound derived from Theobroma cacao and is related to caffeine, but has milder stimulant effects (35). Theobromine targets the heart and blood vessels rather than the brain, which provides longer-lasting effects without spikes in energy and jitters. This compound also widens blood vessels and improves blood flow, allowing oxygen and nutrients to reach muscles more effectively during exercise (36). Another caffeine related compound is theophylline, found in naturally caffeinated plants such as yerba maté and tea. Theophylline relaxes and opens the airways to improve airflow to the lungs, improving exercise endurance (37). Research on the two compounds show that they may have performance enhancing effects. In a study observing recreational cyclists, researchers administered caffeine (6 mg/kg) in the form of chocolate, which includes theobromine and theophylline, to participants during a simulated cycling time trial. Researchers measured ventilation, power output, blood lactate, and performance time and found that higher levels of theobromine and theophylline were correlated to changes in ventilation and longer trial times (38).

Despite the benefits, naturally caffeinated drinks can also have health risks when consumed excessively. Coffee and teas have a high content of polyphenols that can interfere with absorption of iron from plant-based foods (39). Drinking coffee or tea before a meal can significantly reduce iron absorption that leads to increased risks of iron deficiency. Chlorogenic acids found in coffee have been shown to increase the risk of tooth staining and enamel erosion when consumed excessively or without oral care (40). A study compared caffeine and theobromine by having 80 healthy adults try different doses of theobromine (250 mg, 500 mg, and 1000 mg) and caffeine (200 mg). The researchers found that high doses of theobromine have also been found to cause symptoms like headaches, nausea, and heart palpitations, and negative mood effects when consumed in large amounts. While not as strong as caffeine, its effects can still contribute to discomfort or sleep disturbances (41).

Table 1. Comparison of Performance Outcomes by Type of Ingredient/Compound.

Ingredient/ Compound	Commonly found in (beverage)	Physiological effects relevant to exercise	Potential performance outcomes	Reference
Sugar	Energy Drinks	Provides glucose for additional ATP production through cellular metabolism.	ATP is the primary source for cellular use, which is why additional ATP rapidly increases energy availability.	(10, 15)
Guarana	Energy Drinks	Enhances cellular energy processes, which makes the processes. faster. Also includes additional caffeine and antioxidant compounds.	May improve alertness and cognitive reaction times.	(16, 17)
Taurine	Energy Drinks	Supports calcium regulation and reduces lactate buildup.	May improve endurance, muscle performance, and reduce muscle fatigue.	(18-20)
B-vitamins	Energy Drinks	Assists in biochemical processes that produce energy. Also reduces blood lactate and ammonia levels.	May improve endurance and reduce muscle fatigue, aiding in faster recovery.	(10, 22)
Chlorogenic acid (CGA)	Coffee	Activates AMPK- related metabolic pathways and helps regulate glucose and lipid metabolism.	May support recovery and metabolic efficiency.	(26, 28)
L-theanine	Teas (not including yerba maté)	Modulates caffeine's effects by promoting calm alertness and reducing anxiety.	When combined with caffeine, it may improve attention, cognitive performance, and some measures of physical performance.	(29, 30)
theobromine	Coffee, teas, cacao	A mild methylxanthine that promotes blood flow and oxygen to muscle cells.	May contribute to improved oxygen delivery during exercise.	(36, 38)
theophylline	Teas	A bronchodilator that relaxes airway smooth muscle and improves airflow.	May enhance exercise tolerance by facilitating ventilation.	(37, 38)
polyphenols/ flavonoids	Yerba maté, cacao	Reduces oxidative stress and protects against cellular damage.	May support recovery and overall exercise capacity, although direct performance effects remain limited.	(32-34)

CONCLUSION

The evidence reviewed suggests that the effects of caffeinated beverages depend not only on caffeine concentration, but also the compounds being consumed along with it. The difference in combination of compounds and caffeine in each drink ultimately determines their risks and benefits. Consuming energy drinks containing taurine can cause irregular heartbeats and contribute to metabolic issues, such as insulin resistance and weight gain, due to the high sugar content. On the other hand, naturally caffeinated drinks contain antioxidants, polyphenols, and amino acids that increase alertness and focus while reducing jitters and crashes. Consuming large concentrations of coffee or tea can reduce iron absorption, increase the risk of tooth enamel erosion and staining, and extreme doses of theobromine may cause headaches, nausea, heart palpitations, or sleep disturbances. Current literature fails to make direct comparisons between complete beverage combinations, especially over longitudinal studies. The lack of direct comparisons limits our ability to determine how combinations of bioactive compounds interact and whether these interactions produce different effects on exercise performance and health. For more accurate and specific evidence, future research should investigate how different caffeine sources and even different energy drink brands affect performance under realistic training and competition conditions. Researchers should consider elements of athletic pressure, benefits of social facilitation in sports performance, and individual physiology to mimic realistic conditions and prevent confounding variables. In addition, more research is needed to identify optimal caffeine dosages and timing strategies that maximize performance while minimizing health risks. Since many naturally caffeinated beverages contain bioactive compounds, future studies should go more in depth on how they interact with caffeine and whether they contribute to performance alone without caffeine. Finally, future research needs to be conducted on how to prevent or resolve risks associated with both energy drinks and naturally caffeinated drinks including methods to minimize iron absorption interference, tooth enamel erosion, and cardiovascular strain. Addressing these gaps would provide athletes with more comprehensive evidence based recommendations regarding caffeine use and could also result in the creation of a safer and more beneficial beverage than both options.

The differences in beverages suggest that athletes should evaluate caffeine sources based not only on immediate performance goals but also on their long-term impact on health and recovery. The findings of the review indicate that naturally caffeinated drinks offer a more balanced approach to caffeine. Although naturally caffeinated drinks also pose risks, they can be easily mitigated through consuming in moderation and proper oral hygiene. The review suggests that caffeine source influences not only the performance enhancement, but also the physiological costs and risks associated with achieving it. This highlights the importance of evaluating caffeinated beverages within a broader context of athletic development, recovery, and health. For an athlete, health and recovery should be prioritized over temporary stimulation.

Overall, the available evidence suggests that naturally caffeinated beverages may provide a more balanced approach to caffeine consumption by supporting exercise performance while posing fewer health risks than many energy drinks. Athletes should consider dosage and tolerance when choosing any caffeinated beverage to optimize performance without negatively impacting recovery, sleep, or long-term health.

CONFLICT OF INTEREST

The author declares no conflicts of interest related to this work.

REFERENCES

1. Martins GL, Guilherme JP, Ferreira LH, de Souza-Junior TP, Lancha Jr AH. Caffeine and exercise performance: possible directions for definitive findings. *Frontiers in sports and active living.* 2020 Dec 11; 2: 574854. https://doi.org/10.3389/fspor.2020.574854
2. Zeidán-Chuliá F, Gelain DP, Kolling EA, Rybarczyk-Filho JL, Ambrosi P, Resende Terra S, Pires AS, Da Rocha JB, Antônio Behr G, Fonseca Moreira JC. Major components of energy drinks (caffeine, taurine, and guarana) exert cytotoxic effects on human neuronal SH-SY5Y cells by decreasing reactive oxygen species production. *Oxidative medicine and cellular longevity.* 2013; 2013 (1): 791795. https://doi.org/10.1155/2013/791795
3. Landais E, Moskal A, Mullee A, Nicolas G, Gunter MJ, Huybrechts I, Overvad K, Roswall N, Affret A, Fagherazzi G, Mahamat-Saleh Y. Coffee and tea consumption and the contribution of their added ingredients to total energy and nutrient intakes in 10

European countries: Benchmark data from the late 1990s. *Nutrients*. 2018 Jun 5; 10 (6): 725. https://doi.org/10.3390/nu10060725

4. Costantino A, Maiese A, Lazzari J, Casula C, Turillazzi E, Frati P, Fineschi V. The dark side of energy drinks: a comprehensive review of their impact on the human body. *Nutrients*. 2023 Sep 9; 15 (18): 3922. https://doi.org/10.3390/nu15183922
5. Preedy VR, editor. Caffeine: Chemistry, analysis, function and effects. *Royal Society of Chemistry*; 2012. https://doi.org/10.1039/9781849734752
6. Research, I. of M. (US) C. on M. N. (2001a). Basic Concepts. In Caffeine for the Sustainment of Mental Task Performance: Formulations for Military Operations. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK223799/
7. Drewnowski A, Rehm CD. Sources of caffeine in diets of US children and adults: trends by beverage type and purchase location. *Nutrients*. 2016 Mar 10; 8 (3): 154. https://doi.org/10.3390/nu8030154
8. McCusker RR, Goldberger BA, Cone EJ. Caffeine content of specialty coffees. *Journal of analytical toxicology*. 2003 Oct 1; 27 (7): 520-2. https://doi.org/10.1093/jat/27.7.520
9. Jagim AR, Harty PS, Barakat AR, Erickson JL, Carvalho V, Khurelbaatar C, Camic CL, Kerksick CM. Prevalence and amounts of common ingredients found in energy drinks and shots. *Nutrients*. 2022 Jan 13; 14 (2): 314. https://doi.org/10.3390/nu14020314
10. Dunn J, Grider MH. Physiology, Adenosine Triphosphate. In: StatPearls. *Treasure Island (FL): StatPearls Publishing*; 2026 Jan.
11. Reichert CF, Deboer T, Landolt HP. Adenosine, caffeine, and sleep-wake regulation: state of the science and perspectives. *Journal of sleep research*. 2022 Aug; 31 (4): e13597. https://doi.org/10.1111/jsr.13597
12. Huang L, Zhu W, Li N, Zhang B, Dai W, Li S, Xu H. Functions and mechanisms of adenosine and its receptors in sleep regulation. *Sleep medicine*. 2024 Mar 1; 115: 210-7. https://doi.org/10.1016/j.sleep.2024.02.012
13. Lazarus M, Shen HY, Cherasse Y, Qu WM, Huang ZL, Bass CE, Winsky-Sommerer R, Semba K, Fredholm BB, Boison D, Hayaishi O. Arousal effect of caffeine depends on adenosine A2A receptors in the shell of the nucleus accumbens. *Journal of Neuroscience*. 2011 Jul 6; 31 (27): 10067-75. https://doi.org/10.1523/JNEUROSCI.6730-10.2011
14. Leistner C, Menke A. Hypothalamic-pituitary-adrenal axis and stress. *Handbook of clinical neurology*. 2020 Jan 1; 175: 55-64. https://doi.org/10.1016/B978-0-444-64123-6.00004-7
15. Li J, Yan H, Xiang R, Yang W, Ye J, Yin R, Yang J, Chi Y. ATP secretion and metabolism in regulating pancreatic beta cell functions and hepatic glycolipid metabolism. *Frontiers in Physiology*. 2022 Jun 21; 13: 918042. https://doi.org/10.3389/fphys.2022.918042
16. Boasquívis PF, Silva GM, Paiva FA, Cavalcanti RM, Nunez CV, de Paula Oliveira R. Guarana (Paullinia cupana) extract protects Caenorhabditis elegans models for Alzheimer disease and Huntington disease through activation of antioxidant and protein degradation pathways. *Oxidative medicine and cellular longevity*. 2018; 2018 (1): 9241308. https://doi.org/10.1155/2018/9241308
17. Scholey A, Bauer I, Neale C, Savage K, Camfield D, White D, Maggini S, Pipingas A, Stough C, Hughes M. Acute effects of different multivitamin mineral preparations with and without guaraná on mood, cognitive performance and functional brain activation. *Nutrients*. 2013 Sep 13; 5 (9): 3589-604. https://doi.org/10.3390/nu5093589
18. Kammerer M, Jaramillo JA, García A, Calderín JC, Valbuena LH. Effects of energy drink major bioactive compounds on the performance of young adults in fitness and cognitive tests: a randomized controlled trial. *Journal of the international society of sports nutrition*. 2014 Nov 7; 11 (1): 44. https://doi.org/10.1186/s12970-014-0044-9
19. Waldron M, Patterson SD, Tallent J, Jeffries O. The effects of an oral taurine dose and supplementation period on endurance exercise performance in humans: a meta-analysis. *Sports Medicine*. 2018 May; 48 (5): 1247-53. https://doi.org/10.1007/s40279-018-0896-2
20. Kurtz JA, VanDusseldorp TA, Doyle JA, Otis JS. Taurine in sports and exercise. *Journal of the International Society of Sports Nutrition*. 2021 May 26; 18 (1): 39. https://doi.org/10.1186/s12970-021-00438-0
21. Truswell S, Milne R. The B vitamins. Essentials of human nutrition. 2002:209.
22. Lee MC, Hsu YJ, Shen SY, Ho CS, Huang CC. A functional evaluation of anti-fatigue and exercise performance improvement following vitamin B complex supplementation in healthy humans, a randomized double-blind trial. *International journal of medical sciences*. 2023 Aug 15; 20 (10): 1272. https://doi.org/10.7150/ijms.86738
23. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC, Hu FB. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *Jama*. 2004 Aug 25; 292 (8): 927-34. https://doi.org/10.1001/jama.292.8.927
24. Torres EA, Pinaffi-Langley AC, Figueira MD, Cordeiro KS, Negrão LD, Soares MJ, da Silva CP, Alfino MC, Sampaio GR, de Camargo AC. Effects

of the consumption of guarana on human health: A narrative review. *Comprehensive Reviews in Food Science and Food Safety*. 2022 Jan; 21 (1): 272-95. https://doi.org/10.1111/1541-4337.12862

25. Mihaiescu T, Turti S, Souca M, Muresan R, Achim L, Prifti E, Papuc I, Munteanu C, Marza SM. Caffeine and taurine from energy drinks-a review. *Cosmetics*. 2024 Jan 20; 11 (1): 12. https://doi.org/10.3390/cosmetics11010012
26. Nguyen V, Taine EG, Meng D, Cui T, Tan W. Chlorogenic acid: A systematic review on the biological functions, mechanistic actions, and therapeutic potentials. *Nutrients*. 2024 Mar 23; 16 (7): 924. https://doi.org/10.3390/nu16070924
27. He Y, Mao S, Zhao Y, Yang J. Research advances in the synthesis, metabolism, and function of chlorogenic acid. *Foods*. 2025 May 28; 14 (11): 1914. https://doi.org/10.3390/foods14111914
28. Namvarjah F, Shokri-Afra H, Moradi-Sardareh H, Khorzoughi RB, Pasalar P, Panahi G, Meshkani R. Chlorogenic acid improves anti-lipogenic activity of metformin by positive regulating of AMPK signaling in HepG2 cells. *Cell biochemistry and biophysics*. 2022 Sep; 80 (3): 537-45. https://doi.org/10.1007/s12013-022-01077-1
29. Giesbrecht T, Rycroft JA, Rowson MJ, De Bruin EA. The combination of L-theanine and caffeine improves cognitive performance and increases subjective alertness. *Nutritional neuroscience*. 2010 Dec 1; 13 (6): 283-90. https://doi.org/10.1179/147683010X12611460764840
30. Razazan R, Hemmatinafar M, Imanian B, Jahaniboushehri N, Rezaei R, Nazemzadegan G. Performance-enhancing effects of caffeine and L-Theanine among Iranian elite wrestlers: a focus on cognitive and specific physical performance. *Journal of the International Society of Sports Nutrition*. 2025 Dec 31; 22 (1): 2564238. https://doi.org/10.1080/15502783.2025.2564238
31. Lima ME, Colpo AC, Salgueiro WG, Sardinha GE, Ávila DS, Folmer V. Ilex paraguariensis extract increases lifespan and protects against the toxic effects caused by paraquat in Caenorhabditis elegans. *International journal of environmental research and public health*. 2014 Oct; 11 (10): 10091-104. https://doi.org/10.3390/ijerph111010091
32. Gómez-Juaristi M, Martínez-López S, Sarria B, Bravo L, Mateos R. Absorption and metabolism of yerba mate phenolic compounds in humans. *Food Chemistry*. 2018 Feb 1; 240: 1028-38. https://doi.org/10.1016/j.foodchem.2017.08.003
33. Teselkin YO, Babenkova IV, Kochetova AA, Osipov AN. Inhibitory effect of aqueous extract from yerba mate (Ilex paraguariensis) on the process of lipid peroxidation of liposomal membranes. *Biophysics*. 2022 Aug; 67 (4): 541-8. https://doi.org/10.1134/S0006350922040194
34. Kerimi A, Williamson G. The cardiovascular benefits of dark chocolate. *Vascular pharmacology*. 2015 Aug 1; 71: 11-5. https://doi.org/10.1016/j.vph.2015.05.011
35. Jaimez RE, Barragan L, Fernández-Niño M, Wessjohann LA, Cedeño-Garcia G, Cantos IS, Arteaga F. Theobroma cacao L. cultivar CCN 51: a comprehensive review on origin, genetics, sensory properties, production dynamics, and physiological aspects. *PeerJ*. 2022 Jan 5; 10: e12676. https://doi.org/10.7717/peerj.12676
36. de Mejia EG, Ramirez-Mares MV. Impact of caffeine and coffee on our health. *Trends in Endocrinology & Metabolism*. 2014 Oct 1; 25 (10): 489-92. https://doi.org/10.1016/j.tem.2014.07.003
37. Magnussen H, Reuss G, Jo R. Methylxanthines inhibit exercise-induced bronchoconstriction at low serum theophylline concentration and in a dose-dependent fashion. *Journal of allergy and clinical immunology*. 1988 Mar 1; 81 (3): 531-7. https://doi.org/10.1016/0091-6749(88)90190-X
38. Almeida BA, Sampaio-Jorge F, Barth T, Maciel TS, Morales AP, Ribeiro BG. Effects of caffeine and its metabolites, theobromine and theophylline, on performance and physiological parameters in cyclists: A randomized, double-blind, placebo-controlled, crossover trial. *Clinical Nutrition ESPEN*. 2025 Dec 1; 70: 138-45. https://doi.org/10.1016/j.clnesp.2025.08.021
39. Zijp IM, Korver O, Tijburg LB. Effect of tea and other dietary factors on iron absorption. *Critical reviews in food science and nutrition*. 2000 Sep 1; 40 (5): 371-98. https://doi.org/10.1080/10408690091189194
40. Utami TW, Zaky MR, Rinastiti M, Ratih DN, Barunawati SB, Purwanti N, Murti YB. Evaluation of chlorogenic acids and melanoidin interactions with salivary proteins and their effect on tooth discoloration. *Journal of Oral Biology and Craniofacial Research*. 2026 Jan 1; 16 (1): 93-100. https://doi.org/10.1016/j.jobcr.2025.11.006
41. Baggott MJ, Childs E, Hart AB, de Bruin E, Palmer AA, Wilkinson JE, de Wit H. Psychopharmacology of theobromine in healthy volunteers. *Psychopharmacology*. 2013 Jul; 228 (1): 109-18. https://doi.org/10.1007/s00213-013-3021-0