Development of a Sugar-Free Functional Drink to Enhance Concentration in Healthy Young Adults: A Literature-Based Formulation and Trial Proposal

Lestari Octavia[1]*, Sumbadra[2], Moch Ilham Faris Baladraf[3]
[1]Faculty of Health Sciences, Gunadarma University, Indonesia
[2-3]Global Platonesia, Indonesia

Corresponding Author's e-mail : *lestari_octavia@staff.gunadarma.ac.id*

ARMADA
JURNAL PENELITIAN MULTIDISIPLIN

e-ISSN: 2964-2981

ARMADA : Jurnal Penelitian Multidisiplin

https://ejournal.45mataram.ac.id/index.php/armada

Vol. 04, No. 05 Mei, 2026

Page: 709-718

DOI:

https://doi.org/10.55681/armada.v4i5.2153

Article History:

Received: Mei 01, 2026

Revised: Mei 13, 2026

Accepted: Mei 17, 2026

Abstract : Energy drinks and functional beverages are widely consumed to improve concentration, alertness, and cognitive performance, particularly among adolescents and young adults. However, conventional formulations often contain high levels of added sugar, which may increase metabolic and cardiovascular risks. This study aimed to review scientific evidence regarding the cognitive effects of sugar-containing and sugar-free functional beverages. A narrative literature review was conducted using articles published between 2000 and 2026 from PubMed, ScienceDirect, and other scientific databases. The included studies were classified into four categories: sugar caffeine, sugar non-caffeine, non-sugar + caffeine, and non-sugar non-caffeine. A total of 86 articles were identified, and 9 representative studies were included in the final synthesis. The findings consistently showed that caffeine is the primary component responsible for acute cognitive enhancement, particularly in concentration, attention, and reaction time. In contrast, sugar demonstrated inconsistent cognitive effects and was more closely associated with metabolic burden. Sugar-free caffeinated beverages provided cognitive benefits comparable to conventional energy drinks while offering a more favorable metabolic profile. Overall, sugar-free caffeine-based beverages appear to represent a promising formulation for cognitive enhancement with lower metabolic risk.

Keywords: Sugar-Free Energy Drink; Concentration; Cognitive Performance; Functional Beverage

Abstrak: *Minuman energi dan minuman fungsional banyak dikonsumsi untuk meningkatkan konsentrasi, kewaspadaan, dan performa kognitif, terutama pada remaja dan dewasa muda. Namun, formulasi konvensional umumnya mengandung gula tambahan dalam jumlah tinggi yang berpotensi meningkatkan risiko metabolik dan kardiovaskular. Penelitian ini bertujuan untuk meninjau bukti ilmiah mengenai efek kognitif minuman fungsional bergula dan bebas gula. Metode yang digunakan adalah narrative literature review dengan sumber artikel yang dipublikasikan pada tahun 2000–2026 dari PubMed, ScienceDirect, dan database ilmiah lainnya. Studi yang dianalisis diklasifikasikan ke dalam empat kategori formulasi, yaitu gula + kafein, gula + non-kafein, non-gula + kafein, dan non-gula + non-kafein. Sebanyak 86 artikel teridentifikasi, dan 9 studi representatif dimasukkan dalam sintesis akhir. Hasil kajian menunjukkan bahwa*

kafein merupakan komponen utama yang secara konsisten berkontribusi terhadap peningkatan fungsi kognitif akut, khususnya konsentrasi, perhatian, dan waktu reaksi. Sebaliknya, gula menunjukkan efek kognitif yang tidak konsisten dan lebih berkaitan dengan peningkatan beban metabolik. Minuman berkafein bebas gula memberikan manfaat kognitif yang sebanding dengan minuman energi konvensional, tetapi dengan profil metabolik yang lebih baik. Secara keseluruhan, minuman berbasis kafein bebas gula berpotensi menjadi formulasi yang lebih aman dan efektif untuk peningkatan fungsi kognitif.

Kata Kunci: *Minuman Energi Bebas Gula; Konsentrasi; Performa Kognitif; Minuman Fungsional*

INTRODUCTION

Energy drinks have become one of the most popular beverage categories in many countries because they are marketed as products capable of improving alertness, concentration, and physical performance (Anggadiredja et al., 2021). Consumption of these beverages is particularly high among adolescents, young adults, athletes, gamers, and workers with irregular working schedules (Anggadiredja et al., 2021). In general, conventional energy drinks contain combinations of caffeine, taurine, B vitamins, and high amounts of sugar, making them not only stimulant beverages but also significant sources of calories (Mitasari & Rismaya, 2025).

Concerns regarding the adverse health effects of sugar-sweetened beverages, including weight gain, insulin resistance, and increased cardiometabolic disease risk, have encouraged manufacturers to develop sugar-free variants using non-nutritive sweeteners (Magriplis et al., 2021; Sigala et al., 2020). Nevertheless, scientific evidence regarding the cognitive benefits of energy drinks remains inconsistent (Ajibo et al., 2024; Schwager et al., 2024). Several studies have reported improvements in reaction time, attention, and mood following energy drink consumption, whereas others have failed to demonstrate consistent benefits and instead emphasized the potential risks associated with high caffeine and taurine intake, particularly among adolescents (Soos et al., 2021; Yan et al., 2022).

Studies examining the independent effects of energy drink components provide important insights for the development of healthier functional beverages. Scholey and Kennedy (2004) demonstrated that caffeine consistently improves multiple cognitive domains, including attention, response control, memory, and psychomotor performance, whereas taurine does not exhibit stable cognitive-enhancing effects and may even attenuate the positive mood effects of caffeine. Furthermore, recent reviews and meta-analytic evidence have concluded that caffeine possesses stronger and more predictable cognitive and ergogenic effects than taurine, while evidence regarding caffeine–taurine synergism remains inconclusive (Bakti et al., 2022).

In the context of sugar-free energy drinks, studies comparing sugar-containing and sugar-free formulations have shown that both beverages significantly improve choice reaction time, whereas caffeinated soft drinks and non-caffeinated beverages do not produce comparable effects (Rubio et al., 2022). These findings suggest that the combination of caffeine and taurine may enhance certain aspects of cognitive performance even in the absence of sugar, indicating that sugar is not a critical factor in acute concentration enhancement (Rubio et al., 2022).

A randomized double-blind clinical trial investigating functional energy drinks and energy shots also demonstrated improvements in overall cognitive performance, working memory speed, and mood among healthy young adults when caffeine-containing formulations were administered (O'Shea et al., 2024). In contrast, studies involving decaffeinated energy drinks reported no significant differences between the intervention and placebo in subjective energy, alertness, or cognitive performance outcomes, thereby reinforcing the central role of caffeine as the primary active component (Jagim et al., 2023; O'Shea et al., 2024; Ward-Ritacco et al., 2021).

Several reviews have additionally highlighted potential adverse effects associated with energy drink consumption, including elevated blood pressure, increased heart rate, arrhythmias, sleep disturbances, and neuropsychiatric symptoms, particularly when consumed in excessive amounts, combined with alcohol or other stimulants, or used by individuals with cardiovascular conditions (Ajibo et al., 2024; Jagim et al., 2023; Soos et al., 2021). From a public health perspective, reducing sugar content while maintaining safe and effective caffeine levels is considered an important strategy for developing healthier functional beverages.

Based on this background, the development of sugar-free functional drinks specifically designed to enhance concentration in healthy young adults is both relevant and important. Such beverages are expected to provide acute cognitive benefits comparable to traditional energy drinks while minimizing metabolic risks and relying on more scientifically transparent formulations. Therefore, this paper aims to summarize current scientific evidence regarding energy drinks and sugar-free formulations in relation to cognitive function.

RESEARCH METHODS

This study employed a narrative literature review with a comparative analytical approach to evaluate scientific evidence regarding the effects of energy drinks and functional beverages on cognitive performance, particularly concentration, attention, reaction time, and working memory. Literature searches were conducted through PubMed, ScienceDirect, and other relevant peer-reviewed scientific databases for articles published between January 2000 and May 2026. The search strategy used combinations of the following keywords: “energy drink,” “functional beverage,” “caffeine,” “taurine,” “sugar,” “glucose,” “sweetener,” “non-nutritive sweetener,” “cognitive performance,” “attention,” “reaction time,” “working memory,” and “concentration.” Eligible studies included experimental studies, randomized controlled trials, crossover studies, systematic reviews, and review articles involving human participants and reporting outcomes related to cognitive performance after consumption of energy drinks or functional beverages. Animal studies, in vitro studies, editorials, and articles unrelated to cognitive outcomes were excluded.

To facilitate comparative interpretation, the selected studies were classified into four beverage formulation categories: (1) sugar-containing caffeinated beverages, (2) sugar-containing non-caffeinated beverages, (3) sugar-free caffeinated beverages, and (4) sugar-free non-caffeinated beverages. Data extracted from each study included author, publication year, study design, participant characteristics, beverage composition, intervention protocol, measured cognitive variables, and principal findings. The collected evidence was analyzed descriptively and comparatively to identify patterns in the cognitive effects associated with different beverage formulations, with particular emphasis on distinguishing the independent and combined effects of caffeine and sugar on concentration and acute cognitive enhancement.

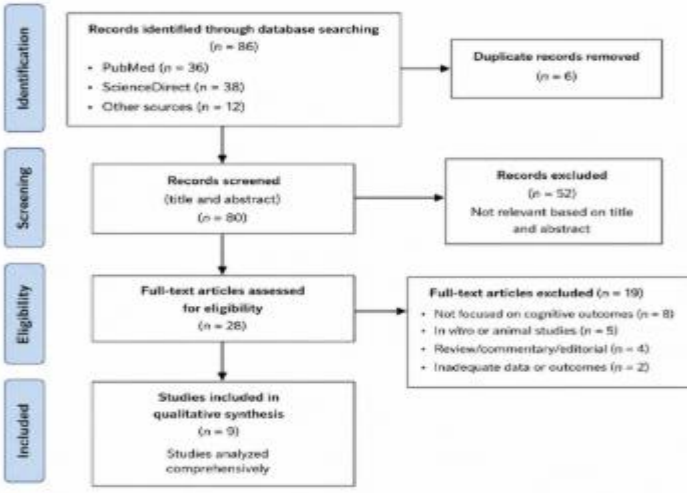

Figure 1. PRISMA Flow Diagram Of Literature Search And Study Selection

RESULTS AND DISCUSSION

Study Selection and Characteristics

The literature search identified 86 articles from PubMed, ScienceDirect, and several additional scientific databases. After removing 6 duplicate records, 80 studies remained for title and abstract screening. Following the eligibility assessment, 28 full-text articles were reviewed in detail, and 9 studies fulfilled the final inclusion criteria for qualitative synthesis. The overall study selection procedure followed a systematic screening approach and is presented in Figure 1.

The included studies were classified into four beverage formulation categories to compare the independent and combined effects of caffeine and sugar on cognitive outcomes: (1) sugar + caffeine, (2) sugar + non-caffeine, (3) non-sugar + caffeine, and (4) non-sugar + non-caffeine. This categorization enabled a more focused interpretation of how caffeine and sugar contribute to concentration, attention, reaction time, psychomotor speed, and working memory. The majority of included studies employed randomized crossover or placebo-controlled experimental designs, indicating a relatively strong methodological approach for assessing acute cognitive responses. Across studies, caffeine-containing beverages consistently demonstrated stronger and more reliable cognitive effects compared with sugar-only or decaffeinated formulations. In contrast, beverages containing sugar without caffeine produced inconsistent findings and were frequently associated with metabolic concerns rather than meaningful cognitive enhancement.

Table 1. Classification of Included Studies by Beverage Formulation

Category	Description	Number of Studies	Examples of Included Studies
Sugar + caffeine	Energy drinks containing sugar/glucose and caffeine (often with taurine)	2	Scholey & Kennedy (2004); Giles et al. (2012)
Sugar + non-caffeine	Sugar/glucose beverages without caffeine	3	Glucose-based cognitive studies and related reviews
Non-sugar + caffeine	Sugar-free caffeinated energy drinks or formulations	1	Sugar-free energy drink comparison studies
Non-sugar + non-caffeine	Decaffeinated or placebo energy drink formulations	3	Randomized placebo-controlled trials

The classification of the included studies demonstrates that most research has focused on beverages containing either sugar alone or non-caffeinated formulations, while relatively fewer studies specifically investigated sugar-free caffeinated beverages. This distribution indicates that the scientific literature has historically emphasized the role of sugar and traditional energy drink formulations in cognitive performance. However, the categorization also reveals an important comparative pattern: caffeine-containing beverages, regardless of sugar presence, were more consistently associated with cognitive enhancement outcomes than non-caffeinated formulations. These findings suggest that caffeine remains the primary component of interest in energy drink research, whereas the independent contribution of sugar appears less consistently supported across studies.

Table 2. Summary of Included Studies

Author	Design	Beverage Type	Cognitive Outcomes	Main Findings
Scholey & Kennedy (2004)	Double-blind crossover	Sugar + caffeine	Attention, memory, psychomotor function	Caffeine significantly improved cognitive performance
Giles et al. (2012)	Randomized controlled design	Sugar + caffeine	Reaction time, memory	Caffeine improved performance; glucose showed inconsistent effects

Jagim et al. (2023)	Narrative review	Sugar beverages	Cognitive function	Sugar effects inconsistent; metabolic risks noted
Fletcher et al. (2017)	RCT crossover	Energy drink (caffeine)	Cardiovascular and physiological outcomes	Caffeine increased physiological activation
Miles-Chan et al. (2015)	Experimental crossover	Sugar-free caffeine drink	Energy expenditure	Caffeine increased metabolic rate
Garcia-Alvarez et al. (2020)	Double-blind placebo-controlled	Decaffeinated energy drink	Mood, cognition	No significant cognitive benefit vs placebo
McCusker et al. (2006)	Analytical study	Caffeine content beverages	Exposure analysis	Wide variation in caffeine content
McLellan & Lieberman (2012)	Review	Energy drinks	Cognitive performance	Caffeine identified as main active compound
Graneri et al. (2021)	Experimental animal study	Sugar-free vs sugary drinks	Metabolic outcomes	Sugar-free and sugary drinks showed similar metabolic effects

Cognitive Effects of Sugar + Caffeine Beverages

The findings of this review strongly demonstrate that beverages containing both sugar and caffeine can improve several domains of cognitive performance, particularly attention, reaction time, alertness, and short-term memory. Nevertheless, the evidence consistently indicates that caffeine not sugar is the dominant active compound responsible for these improvements. Studies conducted by Scholey and Kennedy (2004) as well as Giles et al. (2012) showed that caffeine-containing formulations significantly enhanced psychomotor performance, sustained attention, and executive functioning. However, the additional contribution of glucose or sugar was inconsistent and often marginal. This pattern aligns with the neurophysiological mechanism of caffeine as a central nervous system stimulant. Caffeine acts primarily through antagonism of adenosine receptors, thereby reducing fatigue perception and increasing neuronal firing, alertness, and attentional capacity. Consequently, the acute cognitive benefits frequently attributed to commercial energy drinks appear to originate mainly from caffeine stimulation rather than from sugar supplementation itself.

Importantly, the current findings also challenge the widespread marketing assumption that sugar is necessary to maximize cognitive performance. Although glucose serves as a substrate for brain metabolism, normal physiological conditions already provide sufficient glucose availability for cognitive functioning in healthy individuals. Therefore, excessive sugar addition may contribute more to palatability and rapid energy perception than to genuine cognitive enhancement. Previous literature similarly supports this interpretation. McLellan and Lieberman (2012) concluded that caffeine represents the principal ergogenic and neurocognitive ingredient in energy drinks, while additional components such as taurine and sugar produce either minor or unclear synergistic effects. The consistency of these findings across experimental and review studies strengthens the conclusion that caffeine is the primary determinant of acute cognitive enhancement.

Cognitive Effects of Sugar-Only Beverages

The evidence regarding sugar-containing but non-caffeinated beverages was considerably weaker and less consistent. Several studies reported temporary increases in perceived energy or short-term alertness following glucose consumption; however, these effects were unstable and often failed to translate into sustained improvements in concentration, reaction time, or executive function. This inconsistency may be explained by fluctuations in blood glucose regulation. Acute sugar intake can initially elevate circulating glucose levels, potentially producing transient increases in mental energy. However, rapid glycemic responses may subsequently induce

compensatory insulin activity, leading to energy instability, reduced attentional control, and cognitive fatigue. Consequently, sugar-only beverages do not appear to provide reliable or sustainable cognitive benefits.

The review by Jagim et al. (2023) further reinforces this concern by highlighting the metabolic risks associated with high sugar intake, including obesity, insulin resistance, and impaired metabolic health. These findings are particularly important because the widespread consumption of sugar-rich beverages among adolescents and young adults is often justified using claims of improved concentration and mental performance. The present synthesis indicates that such claims are scientifically weak when caffeine is absent. Moreover, the cognitive limitations of sugar-only beverages become increasingly relevant in the context of modern dietary patterns characterized by excessive sugar exposure. Rather than functioning as effective cognitive enhancers, high-sugar beverages may contribute to long-term health burdens that indirectly impair cognitive and physiological functioning over time.

Effects of Sugar-Free Caffeinated Beverages

One of the most important findings of this review is the strong and consistent cognitive benefit observed in sugar-free caffeinated beverages. Studies involving sugar-free caffeine formulations demonstrated improvements in attention, vigilance, reaction time, and physiological readiness despite the absence of added sugar. This finding provides compelling evidence that caffeine alone is sufficient to generate acute cognitive enhancement. Miles-Chan et al. (2015) reported increased metabolic activation following caffeine intake, while Fletcher et al. (2017) demonstrated elevated physiological arousal and cardiovascular stimulation after caffeinated beverage consumption. These physiological responses likely contribute to heightened wakefulness and improved cognitive preparedness, particularly during tasks requiring sustained concentration or rapid information processing.

The significance of this finding extends beyond cognitive science into public health and functional beverage development. Sugar-free caffeinated beverages may offer a more metabolically favorable alternative to conventional sugary energy drinks because they preserve cognitive benefits while minimizing excessive caloric and glycemic load. In practical terms, this suggests that cognitive enhancement can be achieved without dependence on high sugar consumption. Furthermore, the growing popularity of sugar-free formulations in global beverage markets appears consistent with the scientific evidence identified in this review. Consumers increasingly seek products that provide mental alertness and performance benefits while reducing metabolic risk exposure. The current synthesis strongly supports this transition toward lower-sugar functional beverage strategies. However, it is important to emphasize that "sugar-free" does not automatically imply "risk-free." Excessive caffeine intake remains associated with cardiovascular stress, sleep disturbance, anxiety symptoms, and dependence-related behaviors. Therefore, the cognitive advantages of sugar-free caffeinated beverages should still be interpreted within safe dosage recommendations and responsible consumption patterns.

Effects of Sugar-Free Non-Caffeinated Beverages

The evidence from decaffeinated or placebo-controlled beverages was notably consistent in demonstrating minimal or absent cognitive benefits. Garcia-Alvarez et al. (2020) found no statistically meaningful differences between decaffeinated energy drinks and placebo conditions in measures of cognition, mood, or alertness. This finding provides further confirmation that caffeine is the essential active ingredient underlying acute cognitive enhancement. The absence of significant effects in non-caffeinated formulations also weakens the argument that additional ingredients commonly marketed in energy drinks such as taurine, vitamins, herbal extracts, or flavoring compounds can independently produce meaningful cognitive improvements. While such ingredients may contribute to product identity or nutritional value, the current evidence suggests that they do not substantially enhance cognitive performance without caffeine. This finding has important implications for both scientific interpretation and commercial marketing practices. Many energy drink products promote complex ingredient combinations as unique cognitive enhancers, yet the evidence synthesized in this review indicates that the majority of acute cognitive effects are attributable primarily to caffeine exposure.

Comparative Synthesis Across Beverage Categories

The comparative synthesis reveals a clear hierarchical pattern across beverage formulations. Caffeine-containing beverages consistently produced superior cognitive outcomes regardless of sugar presence, whereas non-caffeinated beverages showed weak or negligible effects. This demonstrates that caffeine is the dominant determinant of acute cognitive performance enhancement. At the same time, the findings indicate that sugar contributes minimally to cognitive improvement while potentially increasing metabolic burden. From both physiological and public health perspectives, the addition of sugar appears unnecessary for achieving short-term cognitive enhancement when caffeine is already present.

This conclusion is particularly significant because energy drinks are frequently consumed by adolescents, university students, athletes, and working populations seeking improved concentration and mental performance. The evidence synthesized in this review suggests that cognitive benefits can be maintained while reducing sugar exposure through sugar-free caffeinated formulations. Nevertheless, the review also highlights important safety considerations. Although caffeine improves alertness and reaction time, excessive intake may increase cardiovascular strain, elevate blood pressure, disrupt sleep quality, and contribute to anxiety-related symptoms. Therefore, the cognitive advantages of caffeine should not be interpreted as unlimited or universally safe.

Another important issue concerns the heterogeneity of caffeine dosage across commercial beverages. McCusker et al. (2006) identified substantial variability in caffeine concentration among energy drink products, raising concerns regarding consumer awareness and dosage regulation. This variability may partially explain differences in physiological and cognitive responses observed across studies. Overall, the evidence strongly supports the conclusion that caffeine is the primary neurocognitive agent responsible for acute performance enhancement, whereas sugar contributes little additional cognitive value and may increase long-term metabolic risk. Consequently, sugar-free caffeinated beverages emerge as the most efficient and metabolically favorable formulation for functional cognitive beverage development.

CONCLUSION AND RECOMMENDATIONS

This literature review demonstrates that caffeine is the primary component responsible for acute cognitive enhancement in energy drinks, particularly in improving concentration, attention, reaction time, and alertness. In contrast, sugar does not consistently contribute to cognitive improvement and may increase metabolic risk when consumed excessively. Comparative evidence indicates that sugar-free caffeinated beverages provide cognitive benefits comparable to conventional sugary energy drinks while offering a more favorable metabolic profile. Meanwhile, decaffeinated formulations consistently fail to produce significant cognitive effects, reinforcing the central role of caffeine as the dominant active ingredient in functional cognitive beverages.

Future studies should employ randomized, double-blind, placebo-controlled designs with standardized caffeine dosages and cognitive assessment methods to strengthen the evidence base. Long-term investigations are also needed to evaluate the safety, metabolic effects, sleep impact, and cardiovascular consequences of regular consumption of sugar-free caffeinated beverages. From a practical perspective, functional beverage development should prioritize moderate-dose caffeine formulations without added sugar to maximize cognitive benefits while minimizing metabolic risks.

ACKNOWLEDGEMENTS

The author expresses his gratitude to the leadership and academic community of Gunadarma University who have provided academic support and facilities during the process of compiling this article. The author also thanks his colleagues for providing scientific input related to the design of the literature review and the proposed clinical trial methodology for sugar-free functional beverages.

REFERENCES

Ajibo, C., Van Griethuysen, A., Visram, S., & Lake, A. A. (2024). Consumption of energy drinks by children and young people: A systematic review examining evidence of physical effects and

consumer attitudes. *Public Health, 227*, 274–281. https://doi.org/10.1016/j.puhe.2023.08.024

Anggadiredja, K., Putri, T. K., & Damayanti, S. (2021). Potential student dependence on energy drink consumption. *Journal of Sports and Health Science, 6*(1), 47–60. https://doi.org/10.5614/jskk.2021.6.1.6

Ayoub, C., Pritchard, M., Bagnato, M., Remedios, L., & Potvin Kent, M. (2023). The extent of energy drink marketing on Canadian social media. *BMC Public Health, 23*(1), 767. https://doi.org/10.1186/s12889-023-15437-w

Bakti, A., Ray, H. R. D., Pitriani, P., & Novian, G. (2022). Differences in the effect of caffeine dosage on hockey skill performance in hockey athletes when tired. *Journal of Sport Education (JOPE), 4*(2). https://doi.org/10.31258/jope.4.2.97-109

Fletcher, E. A., Lacey, C. S., Aaron, M., Kolasa, M., Occiano, A., & Shah, S. A. (2017). Randomized controlled trial of high-volume energy drink versus caffeine consumption on ECG and hemodynamic parameters. *Journal of the American Heart Association, 6*(5), e004448. https://doi.org/10.1161/JAHA.116.004448

Garcia-Alvarez, A., Sitges, C., López-Alonso, A. I., et al. (2020). A randomized, placebo-controlled crossover trial of a decaffeinated energy drink shows no significant acute effect on mental energy. *American Journal of Clinical Nutrition, 111*(3), 719–727. https://doi.org/10.1093/ajcn/nqz343

Giles, G. E., Mahoney, C. R., Brunyé, T. T., Gardony, A. L., Taylor, H. A., & Kanarek, R. B. (2012). Differential cognitive effects of energy drink ingredients: Caffeine, taurine, and glucose. *Pharmacology Biochemistry and Behavior, 102*(4), 569–577. https://doi.org/10.1016/j.pbb.2012.07.004

Gillespie, K. M., Kemps, E., White, M. J., & Bartlett, S. E. (2023). The impact of free sugar on human health: A narrative review. *Nutrients, 15*(4). https://doi.org/10.3390/nu15040889

Graneri, L. T., Mamo, J. C. L., D'Alonzo, V., Lam, V., & Takechi, R. (2021). Chronic intake of energy drinks and their sugar-free substitution similarly promotes metabolic syndrome. *Nutrients, 13*(4). https://doi.org/10.3390/nu13041202

Jagim, A. R., Harty, P. S., Camic, C. L., & Kerksick, C. M. (2023). International society of sports nutrition position stand: Energy drinks and energy shots. *Journal of the International Society of Sports Nutrition, 20*(1), 2171314. https://doi.org/10.1080/15502783.2023.2171314

Kim, H., et al. (2021). Drinking coffee enhances neurocognitive function by reorganizing brain functional connectivity. *Scientific Reports, 11*(1), 14381. https://doi.org/10.1038/s41598-021-93849-7

Magriplis, E., et al. (2021). Dietary sugar intake and its association with obesity in children and adolescents. *Children, 8*(8). https://doi.org/10.3390/children8080676

McCusker, R. R., Goldberger, B. A., & Cone, E. J. (2006). Caffeine content of energy drinks, carbonated sodas, and other beverages. *Journal of Analytical Toxicology, 30*, 112–114.

McKenzie, E., & Lee, S. Y. (2022). Sugar reduction methods and their application in confections: A review. *Food Science and Biotechnology, 31*(4), 387–398. https://doi.org/10.1007/s10068-022-01046-7

McLellan, T. M., & Lieberman, H. R. (2012). Do energy drinks contain active components other than caffeine? *Nutrition Reviews, 70*(12), 730–744. https://doi.org/10.1111/j.1753-4887.2012.00525.x

Miles-Chan, J. L., Charrière, N., Grasser, E. K., Montani, J. P., & Dulloo, A. G. (2015). The thermic effect of sugar-free Red Bull: Do the non-caffeine bioactive ingredients in energy drinks play a role? *Obesity, 23*(1), 16–19. https://doi.org/10.1002/oby.20905

Mitasari, M. D., & Rismaya, R. (2025). Effect of the use of stevia (Rebaudioside) on preference level and physical properties of effervescent powder energy drink products. In *National Seminar on Science and Technology Series IV* (Vol. 2, No. 2, pp. 449–458).

O'Shea, O. K., et al. (2024). Acute beneficial effects of a functional energy shot on cognitive performance and mood states during cognitively demanding task performance: A randomized, double-blind, placebo-controlled, crossover trial. *Frontiers in Nutrition, 11*, 1496092. https://doi.org/10.3389/fnut.2024.1496092

Rubio, C., et al. (2022). Caffeine, D-glucuronolactone and taurine content in energy drinks: Exposure and risk assessment. *Nutrients, 14*(23). https://doi.org/10.3390/nu14235103

Scholey, A. B., & Kennedy, D. O. (2004). Cognitive and physiological effects of an "energy drink": An evaluation of the whole drink and of glucose, caffeine and herbal flavouring fractions. *Psychopharmacology, 176*(3–4), 320–330. https://doi.org/10.1007/s00213-004-1935-2

Schwager, L. E., et al. (2024). Novel energy drink improves cognitive function and mood, without influencing myocardial oxygen demand or ventricular repolarization in adult gamers: A randomized, double-blind, placebo-controlled, crossover trial. *Journal of the American Nutrition Association, 43*(1), 33–47. https://doi.org/10.1080/27697061.2023.2207096

Sigala, D. M., et al. (2020). Effects of consuming sugar-sweetened beverages for 2 weeks on 24-h circulating leptin profiles, ad libitum food intake and body weight in young adults. *Nutrients, 12*(12). https://doi.org/10.3390/nu12123893

Soos, R., Gyebrovszki, A., Toth, A., Jeges, S., & Wilhelm, M. (2021). Effects of caffeine and caffeinated beverages in children, adolescents and young adults: A short review. *International Journal of Environmental Research and Public Health, 18*(23). https://doi.org/10.3390/ijerph182312389

Ward-Ritacco, C. L., Wilson, A. R., & O'Connor, P. J. (2021). An apple extract beverage combined with caffeine can improve alertness, mental fatigue, and information processing speed. *Journal of Cognitive Enhancement, 5*(3), 267–279. https://doi.org/10.1007/s41465-020-00204-1

Wilhelm, P., van Diepen, M. A., Nieuwenhuis, L., & Boulogne, T. L. (2013). The effect of energy drinks on the cognitive performance of adolescents. *Tijdschrift voor Psychiatrie, 55*(1), 57–62.

Yan, X., et al. (2022). Association of consumption of sugar-sweetened beverages with cognitive function among adolescents aged 12–16 years in the US, NHANES III, 1988–1994. *Frontiers in Nutrition, 9*, 939820. https://doi.org/10.3389/fnut.2022.939820