BAZAREWICZ, Jakub, ADAŚKO, Grzegorz, ŚWIDA, Michał, KUBUJ, Cezary, MAZUR, Urszula, OGONOWSKA, Paulina, DMOWSKI, Daniel, MICHALSKA, Anna, WASZAK, Julia and SIWIK, Marcin. Functional Supplements for Managing Exercise-Induced Gastrointestinal Distress: A Focused Review for Athletes. Quality in Sport. 2025;45:66517. eISSN 2450-3118.
https://doi.org/10.12775/QS.2025.45.66517
https://apcz.umk.pl/QS/article/view/66517

The journal has been awarded 20 points in the parametric evaluation by the Ministry of Higher Education and Science of Poland. This is according to the Annex to the announcement of the Minister of Higher Education and Science dated 05.01.2024, No. 32553. The journal has a Unique Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 l.p. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).
The authors declare that there is no conflict of interest regarding the publication of this paper.
Received: 09.11.2025. Revised: 10.11.2025. Accepted: 10.11.2025. Published: 12.11.2025.

Functional Supplements for Managing Exercise-Induced Gastrointestinal Distress: A Focused Review for Athletes

BAZAREWICZ, Jakub, ADAŚKO, Grzegorz, ŚWIDA, Michał, MAZUR, Urszula, OGONOWSKA, Paulina, KUBUJ, Cezary, DMOWSKI, Daniel, MICHALSKA, Anna, WASZAK, Julia and SIWIK, Marcin

Jakub Bazarewicz

Autonomous Public Health Maintenance Organisation J. Śniadecki Voivodship Polyclinical Hospital in Białystok

M. Curie-Skłodowskiej 26, 15-950 Białystok

ORCID: 0009-0006-6137-4366

bazarewiczjakub@gmail.com

Grzegorz Adaśko

Autonomous Public Health Maintenance Organisation J. Śniadecki Voivodship Polyclinical Hospital in Białystok

M. Curie-Skłodowskiej 26, 15-950 Białystok

ORCID: 0009-0004-6426-8636

grzegorz.adasko@gmail.com

Michał Świda

University Clinical Hospital in Bialystok

M. C. Skłodowskiej 24a, 15-276 Białystok, Poland

ORCID: 0009-0003-6101-7324

mi.swida@gmail.com

Cezary Kubuj
Miedzyleski Specialist Hospital in Warsaw
Bursztynowa 2, 04-749 Warszawa, Poland
ORCID: 0009-0006-1578-8541
cezary.kubuj1234@gmail.com

Urszula Mazur
Pomeranian Hospitals LLC: Polish Red Cross Maritime Hospital
ul. Powstania styczniowego 1, 81-519 Gdynia
ORCID: 0009-0006-1645-3479
urszula.mazur15@gmail.com

Paulina Ogonowska
St. Vincent's de Paul Hospital
ul. Wójta Radtkego 1, 81-348 Gdynia, Poland
ORCID: 0009-0001-3766-9985
ogonowska.p@gmail.com

Daniel Dmowski
Autonomous Public Health Maintenance Organisation J. Śniadecki Voivodship Polyclinical Hospital in Białystok
M. Curie-Skłodowskiej 26, 15-950 Białystok
ORCID: 0009-0004-2399-1342
daniel.dmowski25@gmail.com

Anna Michalska
Autonomous Public Health Maintenance Organisation J. Śniadecki Voivodship Polyclinical Hospital in Białystok
M. Curie-Skłodowskiej 26, 15-950 Białystok
ORCID: 0009-0008-1806-7699
michalskaanna731@gmail.com

Julia Waszak
Pomeranian Hospitals LLC:Polish Red Cross Maritime Hospital
ul. Powstania Styczniowego 1, 81-519 Gdynia
ORCID: 0009-0001-8725-7049
buliawaszak@gmail.com

Marcin Siwik
10. Military Clinical Hospital with Polyclinic in Bydgoszcz
Powstańców Warszawy 5, 85-681, Bydgoszcz, Poland
ORCID: 0009-0001-5621-1048
marcinsiwik5@gmail.com

ABSTRACT

Introduction: Exercise-induced gastrointestinal (GI) distress is common among endurance and high-intensity athletes. Symptoms such as nausea, cramps, and diarrhea can impair performance and recovery. Functional supplements with anti-inflammatory and gut-supportive properties are being explored as complementary strategies.

Objective: This review evaluates six functional supplements—probiotics, ginger, curcumin, berberine, black currant, and bovine colostrum—for their potential to reduce exercise-induced GI symptoms.

Methods: Recent studies (2017–2025) were identified via PubMed and Scopus, prioritizing human trials in athletic or exercise settings. Clinical models such as IBS and heat stress were also considered where athlete-specific data were lacking.

Results: Probiotics and bovine colostrum show the most consistent benefits for gut integrity and immune modulation. Ginger and curcumin offer anti-inflammatory and antioxidant

support, while black currant and berberine show promise despite limited direct sports data. Effects vary by dose, strain, and supplementation duration.

Conclusions: Functional supplements may aid in managing GI distress in athletes. However, standardized protocols and athlete-specific trials are needed. Personalized approaches based on symptom profiles and training cycles may optimize efficacy.

Keywords: Exercise-induced gastrointestinal distress, Athletes, functional supplements, Ginger, Probiotics

1. Introduction

Long-term performance of sports, especially at the professional level, in addition to the obvious health benefits, can be associated with negative conditions. Symptoms such as nausea, abdominal cramps, abdominal pain, bloating, diarrhea or heartburn occurring during or after exercise are often reported among those who participate in endurance and high-intensity sports. Exercise-induced gastrointestinal symptoms (Ex-GISs) can affect up to 30-90% [9] of professional athletes, depending on intensity, duration and environmental factors, adversely affecting their performance and even sometimes preventing them from continuing to participate in sports.

2. Pathophysiology

Exercise-induced gastrointestinal (GI) distress is a multifactorial phenomenon frequently observed in endurance athletes, characterized by symptoms including nausea, bloating, abdominal cramps, and diarrhea. These arise from a combination of physiological, mechanical,

and neuroendocrine changes occurring during prolonged physical exertion. One of the principal mechanisms is splanchnic hypoperfusion, where blood flow is diverted away from the gastrointestinal tract to support active muscles and thermoregulation. This ischemia compromises mucosal integrity and increases intestinal permeability, permitting translocation of endotoxins such as lipopolysaccharide (LPS) into circulation, leading to systemic inflammation [1,2]. Exercise-induced elevations in permeability are often evidenced by increased levels of biomarkers such as intestinal fatty acid-binding protein (I-FABP), claudin-3, and zonulin, which are indicative of epithelial injury and tight junction disruption [3,4]. These physiological changes can occur even in the absence of overt symptoms. Thermal stress intensifies GI damage by further reducing splanchnic blood flow and increasing oxidative stress. Core body temperature elevation is a critical predictor of GI barrier dysfunction during exertion, particularly in hot environments [5,6]. In parallel, gut microbiota composition is now recognized as a key factor influencing GI resilience. Endurance athletes often display distinct microbial profiles, which may modulate mucosal health and inflammation [7]. Additionally, psychological stress, including pre-competition anxiety, is linked to exacerbation of GI symptoms, suggesting an interplay between the gut and central nervous system [8].

3. Functional Supplements in Focus

3.1 Probiotics

Probiotics, live microorganisms that confer health benefits when consumed in adequate amounts, have become a central focus in sports nutrition for their role in modulating gut microbiota, enhancing immune resilience, and mitigating gastrointestinal distress—particularly in endurance athletes.

In a 2022 systematic review of randomized controlled trials involving athletes reported that probiotic supplementation—especially multi-strain formulations—reduced the frequency and severity of GI symptoms during both training and competition [23]. The most effective outcomes were associated with supplementation periods of at least four weeks and doses exceeding 10^9 CFU/day, particularly when using strains from the *Lactobacillus* and *Bifidobacterim* genera.

Further support comes from a 2022 meta-analysis showing that probiotic use not only reduced GI complaints but also lowered the risk and severity of upper respiratory tract infections in endurance athletes, underscoring the dual immunomodulatory and gut-protective effects [24].

Mechanistically, probiotics appear to enhance epithelial tight junctions, reduce endotoxemia, and downregulate pro-inflammatory cytokines such as TNF-α and IL-6 [25]. In one randomized trial, 5 billion CFU/day of a multi-strain probiotic reduced self-reported GI symptoms and improved performance metrics in non-elite runners over a 9-week intervention [26]. Another pilot study combining probiotic intake with a structured endurance training protocol showed beneficial shifts in microbiota composition and improved gut mucosal integrity [27].

Among athletes experiencing overtraining, probiotic supplementation has demonstrated additional benefits such as decreased oxidative stress, improved metabolic recovery, and even mood stabilization—suggesting broader implications via gut–brain axis modulation [28].

While efficacy depends on strain specificity, dosage, and duration, the totality of current evidence supports probiotics as a promising adjunct for managing exercise-induced GI symptoms and enhancing overall resilience in athletes.

3.2 Ginger (*Zingiber officinale*)

Ginger (*Zingiber officinale*) is a well-documented botanical with established antiemetic, anti-inflammatory, and gastroprotective properties. Its primary bioactive compounds—gingerols, shogaols, and paradols—have shown efficacy in modulating several gastrointestinal mechanisms relevant to athletes experiencing exercise-induced GI distress.

One of the principal effects of ginger is its ability to attenuate nausea through modulation of the enteric nervous system and reduction in gastric dysrhythmias. This has been demonstrated in several clinical contexts, including chemotherapy-induced nausea and postoperative recovery [10,11]. While direct evidence in athletic populations remains limited, extrapolation from these clinical domains is plausible given similar mechanistic pathways.

Recent research involving taekwondo athletes found that an 8-week ginger supplementation regimen significantly reduced post-exercise serum levels of inflammatory markers such as

COX-2, PGE2, and IL-6, indicating a potential role in attenuating exercise-induced gut and systemic inflammation [12]. This is particularly relevant given that inflammation and oxidative stress are key contributors to increased intestinal permeability during endurance exercise.

Additionally, preclinical evidence supports ginger's ability to maintain intestinal barrier function. A 2025 study identified furanodienone, a major ginger compound, as an agonist of the pregnane X receptor (PXR), which plays a regulatory role in detoxification and intestinal homeostasis. Activation of this receptor was associated with reduced gut inflammation and improved mucosal integrity in murine models [13].

The gut–brain axis may also mediate ginger's benefits. A recent animal study demonstrated that ginger root extract improved pain behaviors and reduced neuroinflammation in both the colon and brain, suggesting broad neuromodulatory effects potentially relevant to GI symptoms exacerbated by psychological stress in athletes [14].

Collectively, while more direct trials in athletic populations are needed, the anti-inflammatory, antiemetic, and gut-protective effects of ginger highlight its therapeutic potential as a functional supplement for managing GI symptoms in athletes.

3.3 Curcumin

Curcumin, the principal bioactive polyphenol in *Curcuma longa* (turmeric), is well-known for its anti-inflammatory and antioxidant properties, which have growing relevance in the context of exercise-induced gastrointestinal distress.

Preclinical studies suggest that curcumin can mitigate intestinal inflammation and preserve mucosal barrier integrity. In a dextran sulfate sodium-induced leaky gut model, curcumin supplementation significantly reduced intestinal permeability, improved antioxidant gene expression, and decreased pro-inflammatory markers in *Drosophila melanogaster* [15].

In the athletic context, curcumin has been shown to attenuate exercise-induced muscle damage and inflammation. A 2024 systematic review of 11 studies concluded that curcumin supplementation reduced delayed-onset muscle soreness (DOMS) and lowered inflammatory biomarkers when administered before or after eccentric exercise protocols [16]. Given the

shared inflammatory mediators involved in muscle and gut damage, these systemic effects may support curcumin's utility in managing GI distress in endurance athletes.

Advanced delivery technologies have also enhanced curcumin's therapeutic potential. Nanoparticle formulations designed for colon-specific release have demonstrated improved efficacy in reducing intestinal inflammation through targeted delivery and immune modulation [17].

In elite athletes, combined supplementation of turmeric (curcumin), vitamin C, and vitamin D over 16 weeks was associated with reduced gastrointestinal symptoms and decreased levels of intestinal fatty acid-binding protein (I-FABP), a marker of epithelial injury, after competitive matches [18]. This suggests that curcumin may offer practical GI protective benefits when integrated into a broader nutritional strategy.

These findings support curcumin's potential as a functional supplement to protect the gastrointestinal tract during high-intensity or prolonged exercise, particularly when delivered in bioavailable forms.

3.4 Berberine

Berberine is a natural isoquinoline alkaloid traditionally used in Eastern medicine for gastrointestinal and metabolic disorders. Its pharmacological profile includes anti-inflammatory, antimicrobial, and gut-protective properties, making it a promising candidate for mitigating exercise-induced gastrointestinal distress.

Emerging evidence highlights berberine's ability to preserve gut barrier integrity. In preclinical models, berberine significantly reduced gut-vascular barrier (GVB) permeability by modulating the Wnt/β-catenin signaling pathway, enhancing tight junction protein expression and reducing endotoxin leakage into circulation [19]. Similarly, in burn-induced intestinal injury models, berberine attenuated hyperpermeability through the S100B/β-catenin signaling axis, promoting occludin and caspase-8 expression in intestinal microvascular endothelial cells [20].

Berberine's modulation of gut microbiota also contributes to its gastrointestinal benefits. A 2024 study showed that berberine optimized microbial composition in piglets infected with

enterotoxigenic *Escherichia coli* (ETEC), significantly reducing intestinal inflammation and oxidative stress markers by downregulating TLR4/MyD88/NF-κB signaling [21]. These immunomodulatory effects align with the inflammatory pathways implicated in exercise-induced GI symptoms.

Moreover, berberine improves gut morphology, as demonstrated in dietary supplementation trials where it increased villus height and reduced crypt depth—markers of gut health—even when beneficial microbial populations were diminished [22]. This structural enhancement may translate to improved barrier function in physically stressed athletes.

While human data on berberine's GI-specific effects in athletes are sparse, its demonstrated ability to reduce mucosal inflammation, preserve tight junction proteins, and favorably influence microbial balance provides a strong mechanistic basis for further investigation.

3.5 Black Currant (*Ribes nigrum*)

Black currants (*Ribes nigrum*) are rich in anthocyanins—potent polyphenolic compounds known for their anti-inflammatory and antioxidant properties. Their ability to modulate oxidative stress and support immune function positions them as a candidate supplement for managing exercise-induced gastrointestinal symptoms.

In a pilot study, participants who consumed a New Zealand blackcurrant anthocyanin-rich extract (BAE) prior to exercise experienced accelerated recovery from oxidative stress and preserved neutrophil function. Specifically, consuming 1.6 mg/kg BAE led to a 32–34% reduction in post-exercise oxidative markers and attenuated neutrophil decline and phagocytic capacity, suggesting improved immune resilience and recovery [29].

A subsequent randomized placebo-controlled trial extended these findings, demonstrating that 5 weeks of daily BAE consumption enhanced antioxidant defense and inflammatory regulation, including increased plasma IL-10 and secretory IgA—key markers in mucosal and systemic immunity. These changes were linked to improved recovery post-exercise [30].

Anthocyanin-rich blackcurrant supplementation may also influence GI barrier function indirectly by lowering systemic inflammation and modulating the gut microbiota. Polyphenols like anthocyanins act as prebiotic substrates, promoting beneficial bacterial growth and increasing short-chain fatty acid (SCFA) production. While direct data on blackcurrant's effects on gut permeability in athletes is limited, extrapolation from preclinical models supports their barrier-protective role [31].

A review of polyphenol supplementation in athletes concluded that blackcurrants were among the most effective berry sources, with consistent findings across studies reporting reduced oxidative stress, better cardiovascular responses, and potential benefits for GI and systemic recovery during high-intensity training [32].

Though more direct GI-targeted trials in athletes are warranted, current evidence suggests that blackcurrant supplementation may contribute meaningfully to mitigating exercise-related GI distress through immune modulation, redox balancing, and microbial support.

3.6 Bovine Colostrum

Bovine colostrum (BC), the first milk secreted postpartum, is rich in immunoglobulins, growth factors, and bioactive peptides. It has emerged as a promising functional supplement for athletes due to its potential to protect the gastrointestinal tract, particularly under stress conditions associated with intense exercise.

A randomized controlled trial involving athletes during peak training found that 20 days of 500 mg/day BC supplementation significantly reduced intestinal permeability, as assessed by the lactulose/mannitol (L/M) ratio and stool zonulin levels [33]. This suggests BC can restore epithelial barrier integrity in individuals with exercise-induced GI dysfunction.

BC's protective effects are further supported by in vitro studies. One investigation using Caco-2 cell layers showed that processed colostrum milk protein concentrate enhanced epithelial

barrier function, as indicated by increased transepithelial electrical resistance, even in the presence of TNF-α-induced stress [34].

Animal models also reinforce these findings. In fattening rabbits, 2.5% BC supplementation improved duodenal morphology and enteric nervous system health, while higher doses (5%) increased permeability, indicating a dose-response relationship [35]. Gene expression studies show BC modulates tight junction proteins, inflammatory cytokines (e.g., IL-8, TGF-β), and oxidative stress markers in intestinal tissues [36].

Systematic reviews confirm that BC supplementation consistently reduces markers of gut epithelial damage and permeability in athletes exposed to thermal and physical stress, although the magnitude of symptom reduction varies [37,38].

Importantly, a recent 2024 crossover study reported that 12 weeks of high-dose BC (25 g/day) increased post-exercise salivary IgA concentrations, indicating enhanced mucosal immunity [39]. However, a meta-analysis published in 2024 raised caution by noting that BC may increase permeability in healthy individuals without prior gut barrier impairment, highlighting the importance of targeted application in at-risk populations [40].

Taken together, bovine colostrum appears to be a safe and effective strategy for preserving gut barrier function and supporting immune defense in athletes, especially under conditions of intense training. Nonetheless, dosing strategies and individual susceptibility must be considered to optimize its effectiveness.

4. Practical Considerations for Athletes and Practitioners

When implementing functional supplements to reduce exercise-induced gastrointestinal distress, it is essential to consider timing, dosage, product quality, and individual variability. Though evidence supports several compounds—such as probiotics, curcumin, and bovine colostrum—efficacy is highly dependent on proper usage strategies tailored to the athlete's context.

A critical insight from recent reviews is that personalized nutrition strategies yield better outcomes than standardized supplementation. Athletes reporting GI symptoms vary in gut

microbiota composition, physical stress levels, and baseline dietary practices, emphasizing the need for individualized protocols [41].

For example, a 2024 study showed that a 3-week fermented whey supplement reduced GI complaints and improved perceived physical well-being among athletes, but outcomes varied by baseline symptom severity and microbiota profiles [42]. Similarly, research suggests that multi-ingredient "gut primer" supplements can improve digestive function and energy levels in as little as 14 days, reinforcing the need for short- and long-term planning [43].

Supplement timing is another vital factor. While bovine colostrum shows acute effects on gut permeability after 20 days, probiotic benefits typically require consistent use for 28–84 days to impact mucosal immunity and inflammation [44]. A phased approach that aligns supplementation with training cycles may optimize protective effects during peak exertion periods.

Athletes and coaches should also consider laboratory support tools, such as vitamin status panels or microbial analysis, to track responses and avoid both under- and over-supplementation. For instance, a 3-month intervention study using a novel vitamin B test system demonstrated that personalized supplementation significantly reduced fatigue, improved sleep, and lowered infection rates in elite athletes [45].

Finally, education and compliance remain crucial. The integration of food-symptom diaries and GI symptom scoring tools like the GSRS can enhance awareness, adherence, and monitoring across teams and individuals [46].

5. Conclusions

Exercise-induced gastrointestinal distress is a common yet complex issue among athletes, particularly those engaged in endurance and high-intensity activities. Its multifactorial etiology—including splanchnic hypoperfusion, mechanical stress, gut permeability, and microbiome alterations—requires equally multifaceted strategies for prevention and management.

This focused review highlights the potential of several functional supplements—probiotics, ginger, curcumin, berberine, black currant, and bovine colostrum—to support GI integrity, reduce inflammation, and improve symptoms. Among these, probiotics and bovine colostrum offer the strongest evidence in terms of barrier protection and immune modulation. Ginger and curcumin provide complementary anti-inflammatory and antioxidant effects, while berberine and black currant contribute additional support through microbiome modulation and mucosal resilience.

However, variability in dosage, strain specificity, duration of supplementation, and individual athlete responses necessitates a personalized and evidence-informed approach. Practical integration should involve consideration of training cycles, symptom monitoring, and potential interactions with other dietary components.

While the current evidence is promising, further sport-specific, randomized controlled trials are essential to define optimal dosing strategies, long-term safety, and combined effects of these supplements. In the meantime, practitioners should employ these agents cautiously, tailoring interventions to athlete-specific needs and physiological stressors.

Disclosure

Author's contribution

Conceptualization: Bazarewicz Jakub

Methodology: Kubuj Cezary

Formal analysis: Świda Michał

Investigation: Ogonowska Paulina, Mazur Urszula

Writing-rough preparation: Adaśko Grzegorz, Waszak Julia, Dmowski Daniel,

Writing-review and editing: Adaśko Grzegorz, Siwik Marcin

Supervision: Michalska Anna

Receiving funding - no specific funding.

All authors have read and agreed with the published version of the manuscript.

Financing statement

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Conflict of interest

The authors deny any conflict of interest.

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