EFFECTS OF PROBIOTICS AND THE MICROBIOTA ON SPORTS PERFORMANCE. SYSTEMATIC REVIEW

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Abstract - The gut microbiota influences health and sports performance by affecting digestion, immunity, and recovery. Factors such as diet and stress can disrupt its balance, altering intestinal permeability and triggering inflammation. Probiotic supplementation has shown benefits across various sports, improving sleep, reducing fatigue, and optimizing recovery in athletes. In cyclists, it increases VO_2 max and endurance, while in combat and strength sports, it enhances strength, muscle mass, and protein absorption. Additionally, it supports muscle recovery and aerobic capacity in disciplines such as skiing and badminton. These findings support its use in sports nutrition.

Keywords - Elite Athletes, Supplementation, Nutrition, Ergogenic Effects, Physical Capacities, Optimization, Recuperation.

I. INTRODUCTION

The gut microbiota plays a key role in health and sports performance by regulating functions such as digestion and immunity (Ochoa-Repáraz & Kasper, 2018). Factors such as diet, stress, and lifestyle changes can disrupt its balance (Karl et al., 2018), affecting intestinal permeability, whose alteration may lead to systemic inflammation and impair recovery in athletes (Bischoff et al., 2014).

In elite sports, frequent travel and competitive stress can cause dysbiosis, negatively impacting performance and recovery (Jäger et al., 2019). Probiotics have been shown to improve gut health and reduce inflammation (Zhang et al., 2023), but their role in the prevention and treatment of sports injuries still requires further research.

The aim of this review is to synthesize the existing evidence on how probiotic supplementation influences athletic performance, with the hypothesis that probiotic supplementation enhances sports performance by optimizing gastrointestinal function, reducing inflammation, and improving body composition.

II. MATERIALS AND METHODS

We conducted a review and analysis following the PRISMA guidelines (Moher et al., 2015) and the PICOS model to establish the inclusion and exclusion criteria.

3.1 Study Selection and Eligibility Criteria:
Original studies on probiotic supplementation in elite athletes, published between 2021 and 2025 in indexed journals, were included. According to the PICOS model, the inclusion criteria comprised: (population) team and/or elite athletes, (intervention) acute effects of probiotics on performance, (comparison) differences between supplementation and placebo groups, (outcomes) results in physical capacities or well-being, (study design) descriptive or quasi-experimental design, and (language) publication in English or Spanish.

The exclusion criteria were: (1) Studies published more than five years ago; (2) Studies without an intervention, systematic reviews, and meta-analyses; (3) Studies that do not examine parameters affecting sports performance; (4) Studies that do not specify the dosage used; (5) Studies conducted with non-elite athletes or older adults; (6) Studies conducted on animals.

3.2 Literature Search:
A systematic search was conducted in the PubMed, Scopus, WoS, and SportDiscus databases (2021-2025) on the effects of probiotics on elite athletes' performance, using Boolean operators to optimize the strategy. The search query was: (professional athletes OR elite athletes) AND (probiotics OR "probiotic supplementation" OR "probiotic supplement") AND ("recovery" OR "exercise performance" OR "performance" OR "exercise capacity"). Only human studies with quasi-experimental trials published in academic journals with full-text availability were included.

III. RESULTS

Author and year	Population	Supplement and dosage	Intervention	Task	Parameters	Effects
Bongiovanni et al. (2025)	n =268 G: 54% W // 46% M S: soccer (11) // general population (257)	One capsule containing 10 trillion CFU of lyophilized LA, LP, and LR) 4 capsules/day	24 weeks (12 weeks placebo, 12 weeks supplementation)	The football players their exercise routine. The general population did not exercise.	Sleep quality, recovery time after exercise, frequency of fatigue, pain, bowel movements.	⬆Sleep quality ⬇Recovery time, fatigue, pain after training, and improved and more regular bowel movements.
Cao et al. (2024)	n= 72 G: M S: strength	A dose of 3 g of milk protein concentrate + 6×10^9 CFU BC99, 8 doses/day.	12 weeks 8 doses/day	Strength tests and body composition assessment.	1RM of the barbell bench press and squat, and the number of repetitions at 80% of 1RM was scored.	⬆Strength performance, ⬆Skeletal muscle mass. ⬆Pepsin and trypsin activity⬆ baaandeaa concentrations
Fritz et al. (2024)	n = 20 G: M S: water polo	25g of vegan protein + 15 drops of Herbafer probiotic solution + a blend of natural strains: LB, LCS, LKF, LPT, LP, LBV, LR, LPC $4–5 \times 10^6$ CFU.	31 days	Training sessions and matches of the season over the 31 days.	Body composition, gut microbiota, blood parameters.	⬆Skeletal muscle mass, ⬆Cellular body mass. ⬇Body fat mass.
Imanian et al. (2024)	n = 44 G: M S: soccer	PRO group, probiotic capsule (strains of LP, LCS, LA, LD, bulgaricus, BI, BL, BB, and SST 4.5×10^{11} CFU) CAS group, 20g of casein powder.	4 weeks	Bruce Test	VO2max,VT, TTE, RCP, IAT	⬆ TTE22,22% PRO group⬆ TTE 40,74% PRO + CAS group ⬆TTE 25,93% CAS group⬆ IAT 4,81% PRO group

Lee et al. (2022)	n = 114 (26 M y 12 W/group (3 groups) G: MandW S: not specified	IG1: 100 mg of live LPC = 10 billion CFU IG2: 100 mg of heat-killed LPC = 10 billion CFU	6 weeks	Supplementation + strength and P tests.	100 maximum vertical jumps, CMJ, IMPT, and Wingate Test.	LPC alive y LPC death ⬇ Loss of muscle strength after a muscle injury and reduced the production of muscle damage and inflammation. ⬆recovery, muscle strength
Li et al. (2023)	n = 16 G: M S: cross country ski	× 10^9 CFU of BASL 4 times a day	8 weeks	Normal training	Body composition Muscle strength	⬆VO2máx and knee joint extensor strength at 60º
Mazur-Kurach et al. (2022)	n = 26 G:M S: cycling	Capsule of probiotic bacterial strains (1 × 10^{11} CFU/day): LP, LCS, LR, BB, LA, BL, BB, BI, LH, LF, LBG, LCL, and ST.	4 months	Wingate anaerobic test and endurance test.	TWV, PAmax, VO_2max, exercise duration, maximum load power, and maximum heart rate.	⬆ VO2max,TWV, power load, muscle mass average ⬇High intensity heart rate ⬇Discomfort during the endurance test
Przewłócka et al. (2023)	n = 23 G: M S: MMA	BLT, LBV, LA, BB, and LCL 2.5 × 10^9 CFU per capsule + Vitamin D3 (5ml), 4 probiotic capsules/day and Vitamin D3 4 times/day.	4 weeks	5 MMA training sessions per week, lasting between 60 and 90 minutes.	Wingate Test, repeated sprints, body composition, and blood analysis.	⬇ Lactate concentration ⬆TWV, power average, use of lactate
Salleh et al. (2021)	n = 30 G: M S: badminton	Drink containing LCS (3 × 10^{10} CFU).	6 weeks	Anxiety, stress, mood, aerobic capacity, strength, speed, power, and agility.	20 and 40 metres racing, hand grip strength, vertical jumps and T test	⬇Stress and anxiety levels ⬆Aerobic capacity

Schreiber et al. (2021)	n = 27 G: M S: cycling	Probiotic blend of 5 strains: 4.3×10^9 CFU of LH, 4.3×10^9 CFU of BASL, 3.9×10^9 CFU of EF, 2.1×10^9 CFU of BL, 0.4×10^9 CFU of BS.	90 days	Their usual training, VO2máx task and TTE	Gastrointestinal symptoms questionnaire, Anthropometric measurements, Analysis of inflammatory markers, VO_2max, and Endurance test at 85% of Pmax.	⬇Incidence of nausea, burping, and vomiting at rest. ⬇Incidence of gastrointestinal symptoms during training.
Tarik et al. (2022)	n = not specified G: M S: strength	20 g of whey protein + 2 billion CFU of BC/day.	60 days	Controlled strength exercise protocol.	Muscle strength, hypertrophy, VO_2 max, body composition, and other biochemical parameters.	⬆Protein absorption (isoleucine, leucine, and valine). ⬆1RM of leg press and vertical jump power.

We have selected twelve articles, whose results are presented in **Table 1**.

Note: CFU=Colony Forming Units; LP=Lactobacillus Plantarum; BASL=Bifidobacterium-Animalis-Subsp.-Lactis; LA= Lactobacillus-Acidophilus; LR=Lactobacillus Rhamnosus; BC=Bacillus Coagulans; LB=Lactobacillus Buchneri; LCS=Lactobacillus Casei; LKF=Lactobacillus Kefirii; LPT=Lactobacillus Pentosus; LBV=Lactobacillus Brevis; LPC=Lactobacillus Paracasei; LD=Lactobacillus delbrueckii; BI=Bifidobacterium infantis; BL= Bifidobacterium longum; BB=Bifidobacterium breve; SST=Streptococcus Salivarius Thermophilus; BB=Bifidobacterium bifidum; LH=Lactobacillus helveticus; LF=Lactobacillus fermentum; LBG=Lactobacillus bulgaricus; LCL=Lactococcus lactis; ST=Streptococcus thermophilus; BLT=Bifdobacterium lactis; EF=Enterococcus faecium; BS=Bacillus subtilis;W=Women; M=Man; G=Gender; S=Sport; IG=Intervention Group; PRO=Probiotic; CAS=Casein; VO_2max=Maximum Oxygen Consumption; VT=Ventilatory Threshold; TTE=Time To Exhaustion; RCP=Respiratory Clearing Point; IAT=Isocapnic Area Time; CMJ=Counter Movement Jump; IMPT=Isometric Mid Thigh Pull; TWV=Total Work Volume; RM=Repetition Maximum; eaa=esencial amino acids; baa=branched amino acids; APmax=Anaerobic Power Maximum; Vit=Vitamin; MMA=Mixed Martial Arts; P=Power

EFFECTS	**SUPPLEMENT AND DOSAGE**
Improvement of aerobic performance (VO_2max, TWV, TTE).	-Probiotic (LP, LCS, LA, LD, BI, BL, BB, SST) (4.5×10^{11} CFU/day) + Casein 20g. 1×10^9 CFU BASL, 4 times/day -Probiotic capsule (LP, LCS, LR, BB, LA, BL, BI, LH, LF, LBG, LCL, ST) (1×10^{11} CFU/day) -Probiotic blend (LH, BASL, EF, BL, BS) (4.3×10^9 - 0.4×10^9 CFU).
Increase in strength and muscle mass.	-3g of milk protein + 6×10^9 CFU BC99, 8 doses/day -25g of vegan protein + 15 drops of probiotics (LB, LCS, LKF, LPT, LP, LBV, LR, LPC) (4-5 $\times 10^6$ CFU) -20g of whey protein + 2 billion CFU BC/day.
Reduction of muscle damage and better recovery.	-Live/dead LPC (10 billion CFU).

Improves lactate utilization and anaerobic power.	-BLT, LBV, LA, BB, LCL (2.5×10^9 CFU/capsule) + Vit D3 (5ml)
Improvement of body composition (reduction of fat, increase in lean mass).	-Probiotic capsule (LP, LCS, LR, BB, LA, BL, BI, LH, LF, LBG, LCL, ST) (1×10^{11} CFU/day) -25g vegan protein + 15 drops of probiotics (LB, LCS, LKF, LPT, LP, LBV, LR, LPC) ($4\text{-}5 \times 10^6$ CFU).
Better sleep quality and stress reduction.	-10 billion CFU (LA, LP, LR), 4 capsules/day -Drink with LCS (3×10^{10} CFU).
Reduction of gastrointestinal symptoms.	-Probiotic mix (LH, BASL, EF, BL, BS) (4.3×10^9-0.4×10^9 CFU).

Table 2 shows the effect in relation to the administered supplement and dosage.

Studies conducted on team athletes

According to Bongiovanni et al. (2025), supplementation with LA, LP, and LR led to significant changes, improving sleep quality (45.1%), accelerating post-exercise recovery (38.5%), reducing fatigue (38.3%), muscle soreness (38.1%), and intestinal issues (34.6%) in football players. Additionally, Imanian et al. (2024) report that daily supplementation with a probiotic capsule containing LP, LCS, LA, LD, BI, BL, BB, and SST increased time to exhaustion by 22.22%, and that probiotics combined with 20 g of casein powder supplementation increased time to exhaustion by 40.74%, both producing significant changes. On the other hand, Fritz et al. (2023) demonstrate that 25 g of vegan protein and 15 drops of Herbafer probiotic solution with natural strains of LB, LCS, LKF, LPT, LP, LBV, LR, and LPC significantly reduced body fat mass by 9.66% and also increased skeletal muscle mass, although not significantly.

Studies conducted on cyclists

Mazur-Kurach et al. (2022) report that daily supplementation in cyclists with a capsule containing probiotic bacterial strains (LP, LCS, LR, BB, LA, BL, BB, BI, LH, LF, LBG, LCL, and ST) for four months led to significant increases in VO_2max by 5.97% and muscle mass by 12.95%. It also resulted in longer exercise duration (+9%), higher load on the ergometer (+4.89%), and a reduction in heart rate (-2.49%). Additionally, athletes reported less discomfort during the stress test, though these changes were not statistically significant. On the other hand, Schreiber et al. (2021) state that daily supplementation with a probiotic blend of LH, BASL, EF, BL, and BS for 90 days reduced the incidence of nausea, belching, and vomiting at rest, as well as gastrointestinal symptoms during training; however, these effects were not statistically significant.

Studies conducted in combat or strength sports

The combination of probiotics and proteins showed significant improvements in physical performance, body composition, and energy metabolism.Cao et al. (2024) reported that BC supplementation significantly increased strength (+13.31%), though muscle mass gains were more modest (+4.9%), and also raised testosterone levels while significantly reducing fat mass (-31.29%).Przewłócka et al. (2023) observed that the intake of BL, LBV, LA, BB, and LCL significantly reduced lactate levels (-24.3%) and optimized lactate utilization (+73.6%). It also improved performance in the Wingate Test (+3.76% total work, +3.75% mean power), though these changes were not statistically significant.Meanwhile, Tarik et al. (2022) demonstrated that supplementation with BC and 20 g of whey protein significantly improved protein absorption (+16.1%), increased branched-chain amino acids (+33.1%), leg press strength (+16.61%), and vertical jump power (+7.86%).

Studies conducted in other sports

Probiotic supplementation showed positive effects on muscle recovery, strength, and aerobic capacity.Lee et al. (2022) observed that LPC and BASL significantly reduce muscle damage and inflammation markers, slow down strength loss after an injury, and promote recovery, with better results in the LPC group.Li et al. (2023) reported that BASL significantly increases VO_2max (+4.37%) and knee extensor strength (+11.8%) in cross-country skiers.Meanwhile, Salleh et al. (2021) found that LCS supplementation improves aerobic capacity in badminton players (+5.9%), though the effect was not statistically significant.

IV. DISCUSSION

Improvements in physical performance and aerobic capacity:The results of Mazur-Kurach et al. (2022) show a significant increase in VO_2max with the capsule used. These findings are consistent with those provided by Li et al. (2023), who also report significant improvements in VO_2max with BASL, albeit at a slightly lower percentage. Furthermore, Przewłócka et al. (2023) observed a significant reduction in lactate and a significant improvement in its utilization, indicating an enhancement in physical performance with BLT, LBV, LA, BB, and LCL.

Recovery and fatigue reduction: Regarding recovery, Bongiovanni et al. (2025) highlight that a capsule containing lyophilized LA, LP, and LR improves sleep quality, accelerates post-exercise recovery, and reduces fatigue. These effects are also reflected in the findings of Lee et al. (2022), who report that probiotics such as LPC and BASL promote muscle recovery by reducing muscle damage and inflammation markers. Similarly, Imanian et al. (2024) found that the combination of LP, LCS, LA, LD, bulgaricus, BI, BL, BB, and SST with casein significantly increases time to exhaustion, suggesting that combined supplementation can significantly enhance performance and recovery.

Effects on body composition: Fritz et al. (2023) observed a decrease in body fat mass with supplementation of vegan proteins, Herbafer, and LB, LCS, LKF, LPT, LP, LBV, LR, and LPC, while Cao et al. (2024) found an even greater reduction in body fat mass with milk protein and BC99.

Improvements in strength and power: Tarik et al. (2022) report significant improvements in leg press strength and vertical jump power with BC and whey protein supplementation. Similar effects were also observed by Przewłócka et al. (2023), who documented improvements in high-intensity performance tests such as the Wingate Test, though these were not as significant compared to those reported by Tarik et al. (2022).

Muscle pain and gastrointestinal discomfort: Bongiovanni et al. (2025) highlight a significant reduction in muscle soreness and intestinal issues with lyophilized LA, LP, and LR supplementation, which aligns with the findings of Schreiber et al. (2021), who document an improvement in gastrointestinal symptoms during training with their probiotic strain blend, but to a much lesser extent compared to those reported by Bongiovanni et al. (2025).

V. CONCLUSIONS

Supplementation with strains containing LP, LCS, LR, BB, LA, BL, BB, BI, LH, LF, LBG, LCL, and ST, as well as supplementation with only BASL and strains with BLT, LBV, LA, BB, and LCL, leads to improvements in physical performance and aerobic capacity. The same applies to recovery and fatigue reduction with strains containing lyophilized LA, LP, and LR, strains containing LPC and BASL, and especially the combination of LP, LCS, LA, LD, bulgaricus, BI, BL, BB, and SST with casein. If the goal is to improve body composition, the optimal supplementation would be with milk protein and BC99. In the case of focusing more on increasing strength, BC and whey protein is the best option. Lastly, for muscle soreness and gastrointestinal discomfort, strains containing lyophilized LA, LP, and LR will be the best strategies.

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