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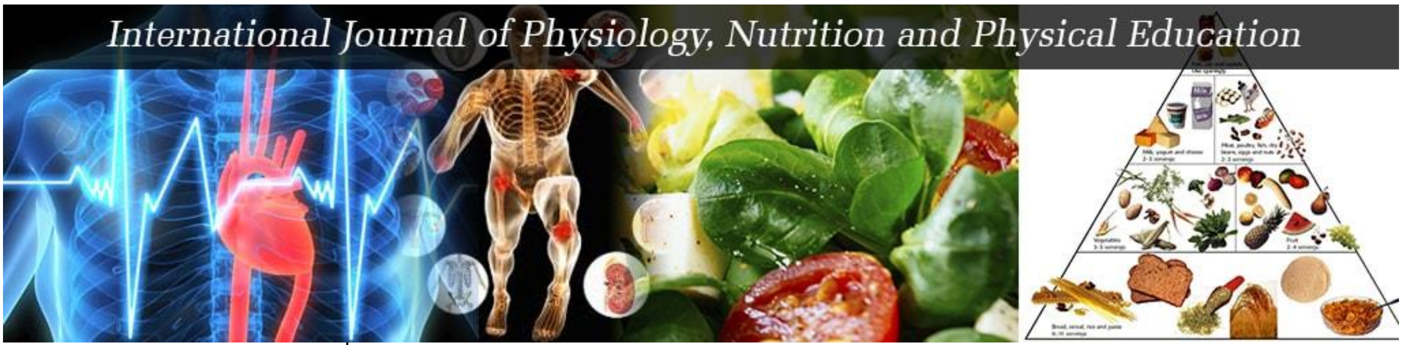

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Effects of watermelon consumption on variables related to performance, muscle recovery, and physiological responses to exercise: An integrative review

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Abstract
Watermelon (*Citrullus lanatus*) is the main dietary source of L-citrulline, a precursor of nitric oxide (NO) with the potential to influence exercise performance and recovery. However, the effects of the complete food matrix, as opposed to supplementation alone, are not yet fully understood. Objective: To synthesize and critically analyze the evidence on the effects of watermelon consumption in different forms on physical performance, muscle recovery, and exercise-related physiological parameters. Methods: An integrative review was conducted in the PubMed, Scopus, and Web of Science databases, using the descriptors "watermelon," "citrulline," "exercise," "strength training," and "muscular endurance." Fifteen clinical trials investigating the effects of watermelon in humans undergoing exercise protocols were included. Results: Watermelon consumption in different forms (juice, puree, concentrate) consistently reduced delayed onset muscle soreness and markers of muscle damage, in addition to increasing antioxidant capacity and plasma concentrations of L-arginine and nitrite. The effects on physical performance were heterogeneous, with some studies showing improvement in fatigue and strength, while most found no significant benefits in aerobic endurance tests. Conclusion: Watermelon stands out as an effective functional food for accelerating muscle recovery and modulating physiological responses to exercise stress, mainly due to the synergistic action between L-citrulline and other bioactive compounds present in its matrix. Its role as a direct ergogenic agent in performance appears to be dose- and exercise-context dependent, but its benefits in post-exercise recovery are robust and clinically relevant.

Keywords: L-Citrulline, performance, muscle recovery, nitric oxide

1. Introduction

Physical exercise is widely recognized as an essential tool for promoting health, contributing to improved functional capacity, body composition, and the prevention of cardiometabolic diseases (Debes *et al*., 2024) [11]. Among the most relevant modalities, strength training stands out for stimulating hypertrophy, increasing bone mineral density and muscle strength, promoting glycemic control, and improving tolerance to exertion (Debes *et al*., 2024; Wan & Su, 2024) [11, 39]. In parallel, nutritional strategies have received increasing attention for their potential to modulate physiological pathways that influence muscle performance and recovery, especially those related to tissue perfusion and oxygen availability during exercise (Drohomirecka *et al*., 2023; Flores-Ramírez *et al*., 2021; Thomas *et al*., 2016) [12, 15, 35].

In this context, compounds capable of increasing nitric oxide (NO) production have become a focus of interest in sports nutrition (Tan *et al*., 2022) [32]. NO is of great importance because it participates in modulating vascular tone and promotes greater blood flow to active muscles. Its production can occur via the nitrate pathway or via the arginine pathway, in which case ingested L-citrulline is converted to L-arginine, which is subsequently used in the arginine-citrulline pathway where it is converted to citrulline and NO through nitric oxide synthase (Allerton *et al*., 2018; Dusse *et al*., 2003; Flora Filho & Zilberstein, 2000) [5, 13, 14]. Unlike L-arginine, which undergoes intense intestinal and hepatic metabolism, L-citrulline has greater systemic bioavailability and more efficiently increases plasma arginine concentration, and is therefore considered a physiologically promising compound to influence performance, fatigue and muscle recovery (Rodriguez *et al*., 2017; Romero *et al*., 2006; Schwedhelm *et al*., 2008) [26, 27, 28].

Although much of the available literature investigates isolated L-citrulline supplements, this approach does not necessarily reflect the physiological response obtained when the amino acid source is a food, whose set of bioactive compounds, digestive kinetics and synergistic effects can modify the bioavailability and magnitude of the responses (Trexler *et al*., 2019) [36]. Watermelon (*Citrullus lanatus*) stands out as the main natural food source of L-citrulline, containing relevant concentrations of the amino acid, in addition to lycopene, carotenoids, and phenolic compounds that can modulate oxidative stress, inflammation, and the stability of NO itself (Aguayo *et al*., 2021; Rimando & Perkins-Veazie, 2005; Volino-Souza *et al*., 2022) [2, 24, 38]. These components have the potential to act in combination, representing a distinct model from the purified supplement.

Preliminary evidence suggests that watermelon consumption may influence parameters related to physical exercise, such as perceived exertion, muscle recovery, and hemodynamic parameters (d'Unienville *et al*., 2021; Viribay *et al*., 2022) [10, 37]. However, the results are still heterogeneous, with important differences between studies regarding the form of preparation (i.e., juice, extract, pasteurized pulp) (Martínez-Sánchez, Alacid, *et al*., 2017; Martínez-Sánchez, Ramos-Campo, *et al*., 2017; Shanely *et al*., 2016) [18-18, 29], dose, actual citrulline content, and type of exercise protocol. In addition, most findings derive from small samples or acute interventions, which limits the generalization of the observed effects.

Given the predominance of research based on isolated supplementation and the scarcity of syntheses that specifically address the food and its matrix, an important gap remains in the understanding of the role of watermelon in the context of exercise. Evaluating the effects of the fruit, and not just its isolated compounds, is fundamental to understanding the practical viability, the magnitude of physiological responses, and the real ergogenic potential under conditions applicable to human consumption.

It is also important to recognize that the intrinsic variability in the concentration of L-citrulline and phytochemicals between matrices (pulp vs. juice vs. concentrate vs. rind juice), and the effects of processing (pasteurization, concentration) can substantially influence the bioavailability and physiological results observed in human interventions (Aguayo *et al*., 2017; Milczarek *et al*., 2020; Tarazona-Díaz *et al*., 2017) [20, 3, 34]. Comparative studies have shown that free citrulline and its intestinal absorption vary according to the processing of the juice, suggesting that direct extrapolations between studies using different formulations (natural, enriched, or concentrated) are risky without analytical standardization of the administered content. This consideration justifies a synthesis focused not only on the presence of citrulline, but also on the form and processing of the watermelon derivative.

Therefore, the present integrative review aims to synthesize and critically analyze the available evidence on the consumption of watermelon in different forms on physical performance, muscle recovery, and physiological parameters related to exercise, highlighting the particularities of the food matrix and its implications for sports and clinical practice.

2. Materials and Methods: This study is an integrative review, which consists of gathering numerous articles on a given subject and analyzing them in order to verify the current knowledge of a given area (Canuto & Oliveira, 2020; Souza Filho, 2023; Souza *et al*., 2010) [8, 30, 31]. Thus, this study sought to gather different articles that addressed the effects of watermelon, ingested in different ways, on muscle performance, whether strength or endurance. To this end, the search for articles was carried out in the PubMed, Scopus, and Web of Science databases, without time limits, and without restrictions regarding language or study design. The strategy for identifying articles was based on the combination of terms related to the compound and the intervention of interest, namely, "watermelon" and "citrulline," with three terms associated with the outcomes, "exercise," "strength training," and "muscular endurance." These combinations were applied independently in each database, resulting in six search pairs, whose records were exported and consolidated in a spreadsheet, proceeding to the removal of duplicates before screening.

2.2. Eligibility criteria and article selection

The selection of articles took place in several stages, initially comprising the reading of titles and abstracts, followed by the evaluation of the full text of those considered potentially relevant. Both phases were conducted by two reviewers independently, with disagreements resolved by consensus. From the selected studies, information was extracted regarding the methodological design, sample characteristics, type of intervention with watermelon, doses and preparation methods, exercise protocols used, outcomes evaluated, and main results observed. This data was organized in a comparative way to facilitate the synthesis of the evidence.

Eligible studies were experimental studies conducted on humans undergoing some type of physical exercise protocol, provided that watermelon was used in one of its different forms of consumption, whether as juice, pulp, extract, or minimally processed preparations as a dietary intervention, with or without quantification of citrulline content. Investigations that evaluated outcomes related to performance, fatigue, recovery, or hemodynamic, metabolic, or oxidative parameters were included. On the other hand, studies that exclusively used isolated supplements of L-citrulline, L-arginine, or synthetic combinations were excluded, as well as studies in animal or *in vitro* models, research without exercise-related outcomes, texts unavailable in full, and interventions based on ultra-processed formulations that did not preserve the food matrix of watermelon.

3. Results

The search resulted in the identification of 1,445 articles, of which 806 duplicates were removed, and 15 studies were considered eligible for this integrative review, according to the established inclusion and exclusion criteria. The selected studies, published between 2013 and 2025, are predominantly randomized, double-blind, crossover clinical trials, which provide a high level of evidence for analyzing the effects of watermelon and its derivatives in the context of exercise.

3.1. Characteristics of the Included Studies

The 15 included studies were conducted in several countries. The study population was heterogeneous, ranging from elite athletes (taekwondo, athletics, cyclists) and individuals trained in resistance, to healthy non-athlete men and women and adolescents.

The primary intervention in all studies was watermelon consumption, varying significantly in form of consumption and dose. The intervention was offered in the form of

Watermelon Juice, being the most common method, used in both the natural version and enriched with synthetic L-citrulline. One point study performed a Watermelon "puree", used in a chronic intervention study (two weeks) (Shanely *et al*., 2016) [29]. Another alternative found was through Watermelon Rind juice (Al-Faruqi & Ichwan, 2021) [4], evaluated in a study focused on muscle endurance. And also a Watermelon Juice concentrate, used in short-term supplementation studies (2 weeks) (Gonzalez *et al*., 2022) [16].

The doses of L-citrulline administered varied widely, from 780 mg (in 355 mL of juice) to 6 g (in 500 mL of enriched juice), reflecting the diversity of formulations and the focus on different outcomes.

3.2. Effects on Muscle Performance and Recovery

The findings on physical performance and muscle recovery observed after watermelon consumption are the central focus of this review and present mixed results, but with promising trends regarding recovery. It is important to highlight that the outcomes related to physical performance and muscle recovery addressed in the included studies do not represent unique or directly measurable concepts. Physical performance encompasses multiple functional variables, such as power, speed, endurance, while muscle recovery involves perceptual, functional, and biochemical components, including delayed onset muscle soreness, transient loss of strength, and markers of muscle damage. Thus, the findings presented below refer to specific variables related to these domains, and do not, in isolation, allow for the determination of direct effects on overall performance or on muscle recovery as integrated constructs.

3.2.1. Physical Performance

Most acute (single dose) and short-term (up to 7 days) studies have not demonstrated significant improvement in aerobic or anaerobic exercise performance, such as time to exhaustion on a cycle ergometer (Blohm *et al*., 2020; Tarazona-Díaz *et al*., 2013) [7, 33], isometric strength and power in the bench press (Cutrufello *et al*., 2015) [9], or half-marathon running performance (Martínez-Sánchez, Ramos-Campo, *et al*., 2017) [19].

In a study with adolescents, watermelon juice was compared to a carbohydrate drink (Gatorade) and there was no difference in time to exhaustion (Mohammadnia Ahmadi *et al*., 2024) [21]. In contrast, a study that used watermelon juice enriched with L-citrulline and pomegranate ellagitannins observed an increase in peak force and a drastic reduction in torque drop after an intense squat protocol, suggesting an ergogenic effect in strength exercises (Martínez-Sánchez, Alacid, *et al*., 2017) [18]. In another study, this one with recreational soccer players, it was observed that the ingestion of watermelon drink significantly decreased the fatigue index (FI) in the RAST test (Rizal *et al*., 2019) [25]. Watermelon rind juice has also shown potential to improve muscle endurance in non-athletes, with 50% of volunteers showing an increase in the number of push-ups (Al-Faruqi & Ichwan, 2021) [4].

3.2.2. Muscle Pain and Recovery

The results are more consistent with regard to recovery variables and the reduction of delayed onset muscle soreness (DOMS). Three separate studies with different populations (half marathon runners, athletes, and non-athletic men undergoing resistance training) reported that consumption of watermelon juice or enriched juice significantly reduced the perception of muscle pain (LMSP) 24 and 48 hours after exercise, compared to placebo (AghabeigiAmin *et al*., 2025; Martínez-Sánchez, Alacid, *et al*., 2017; Martínez-Sánchez, Ramos-Campo, *et al*., 2017; Norouzzadeh *et al*., 2025; Tarazona-Díaz *et al*., 2013) [1, 18, 23, 33].

In half marathon runners, L-citrulline-enriched juice maintained jump height after running, while placebo resulted in a significant decrease, indicating better preservation of muscle function (Martínez-Sánchez, Ramos-Campo, *et al*., 2017) [19]. In taekwondo athletes, chronic supplementation (6 weeks) resulted in significantly lower levels of muscle pain 24 and 48 hours after exercise (Aghabeigi Amin *et al*., 2025) [1].

3.3. Biochemical and Physiological Markers

3.3.1. Bioavailability of Nitric Oxide (NO)

Watermelon has been shown to be effective in increasing nitric oxide (NO) precursors in plasma. Both acute and chronic supplementation with watermelon juice significantly increased plasma concentrations of L-citrulline, L-arginine, and nitrite (a biomarker of NO) (20, 37). A study using watermelon puree for two weeks in cyclists also confirmed the increase in plasma concentrations of L-citrulline, L-arginine, and total nitrate (Shanely *et al*., 2016) [29].

3.3.2. Oxidative Stress and Muscle Damage

The antioxidant and muscle-protective effects are evident in several studies. Watermelon consumption increased antioxidant capacity in trained cyclists (Shanely *et al*., 2016) [29], and chronic supplementation (6 weeks) in taekwondo athletes led to a significant increase in Total Antioxidant Capacity (AghabeigiAmin *et al*., 2025) [1].

In terms of muscle damage, juice enriched with citrulline and ellagitannins maintained stable levels of LDH and myoglobin (markers of muscle damage) and preserved post-exercise blood glucose, suggesting lower metabolic stress (Martínez-Sánchez, Alacid, *et al*., 2017) [18]. In runners, the enriched juice resulted in significantly lower plasma lactate and glucose concentrations immediately after running (Martínez-Sánchez, Ramos-Campo, *et al*., 2017) [19].

3.3.3. Cardiovascular and Metabolic Responses

A notable finding was the protective effect of watermelon juice on post-exercise blood pressure in women, preventing the increase that occurred with other beverages (water, Gatorade) (Blohm *et al*., 2020) [7].

However, a study of chronic supplementation (16 days) with watermelon juice concentrate observed an increase in resting systolic blood pressure, an atypical finding that the authors attributed to the high sugar content of the concentrate (Bailey *et al*., 2016) [6]. Regarding muscle oxygenation, supplementation with watermelon juice improved muscle oxygenation during moderate-intensity exercise (Gonzalez *et al*., 2022) [16].

4. Discussion

The objective of this integrative review was to synthesize and critically analyze the available evidence on the consumption of watermelon in different forms on variables of physical performance, muscle recovery, and exercise-related physiological parameters, highlighting the particularities of the food matrix. The 15 studies analyzed reveal a complex scenario, where the benefits of watermelon appear to be more consistent in modulating physiological pathways and accelerating muscle recovery than in directly improving acute performance (Martínez-Sánchez, Alacid, *et al*., 2017;

Martínez-Sánchez, Ramos-Campo, *et al*., 2017; Tarazona-Díaz *et al*., 2013) [18, 19, 33]. Part of the observed inconsistency may be related to the sensitivity of the instruments used, since outcomes such as maximum strength or maximum oxygen consumption tend to be less responsive to short-term nutritional interventions, while submaximal perceptual and functional measures appear to be more sensitive.

4.1. The Role of L-Citrulline and the Dietary Matrix

Watermelon is recognized as the main dietary source of L-citrulline, an amino acid precursor of L-arginine and, consequently, of nitric oxide (NO) (Bailey *et al*., 2016) [6]. Most studies have confirmed that consuming watermelon juice or puree significantly increases plasma concentrations of L-citrulline, L-arginine, and nitrite, a biomarker of NO (Bailey *et al*., 2016; Mohammadnia Ahmadi *et al*., 2024; Shanely *et al*., 2016) [6, 21, 29]. This increase in NO bioavailability is the central physiological mechanism that underpins the ergogenic potential of watermelon, as NO acts as a potent vasodilator, improving blood flow to active muscles and optimizing muscle oxygenation (Khasati *et al*., 2019) [17]. Although the doses of citrulline provided by watermelon are, in many cases, lower than those used in protocols with isolated supplementation, some studies have reported effects on perceptual outcomes, suggesting that the dietary matrix may modulate the physiological response independently of the isolated dose of the amino acid.

The food matrix of watermelon has proven to be a relevant factor, and this corroborates the *in vitro* and *in vivo* comparative study that suggested that the bioavailability of L-citrulline is greater when contained in the natural matrix of watermelon juice and when unpasteurized (Tarazona-Díaz *et al*., 2013) [33]. While isolated L-citrulline supplementation has variable results, watermelon juice, even at lower doses of citrulline, has proven to be as effective as enriched juice (6 g) in reducing muscle soreness (Tarazona-Díaz *et al*., 2013) [33]. This fact suggests that the food matrix, rich in lycopene, carotenoids, and other phenolic compounds, exerts a synergistic effect that potentiates the benefits of L-citrulline (Martínez-Sánchez, Alacid, *et al*., 2017) [18]. The antioxidant components of watermelon can neutralize exercise-induced oxidative stress, protecting NO from degradation and contributing to the reduction of muscle damage (Mohammadnia Ahmadi *et al*., 2024; Shanely *et al*., 2016) [21, 29]. The combination with other bioactive compounds, such as pomegranate ellagitannins, reinforces this hypothesis, resulting in better performance and accelerated recovery (Martínez-Sánchez, Alacid, *et al*., 2017) [18].

4.2. Effects on Muscle Recovery and Pain

The most robust finding of this review is the consistent effect of watermelon in reducing DOMS and improving recovery (Martínez-Sánchez, Alacid, *et al*., 2017; Martínez-Sánchez, Ramos-Campo, *et al*., 2017; Mohammadnia Ahmadi *et al*., 2024; Tarazona-Díaz *et al*., 2013) [18, 19, 21, 33]. The decrease in DOMS, observed in different populations and exercise protocols, is a direct indicator of watermelon's ability to mitigate muscle damage and post-exercise inflammation. The maintenance of jumping ability after a half marathon in runners who consumed fortified juice (Martínez-Sánchez, Ramos-Campo, *et al*., 2017) [19] and the reduction of muscle damage markers (LDH and myoglobin) (Martínez-Sánchez, Alacid, *et al*., 2017) [18] corroborate the protective role of watermelon.

The improvement in recovery is multifactorial, linked both to the increased bioavailability of NO, which facilitates nutrient delivery and metabolite removal, and to the antioxidant action of phytochemicals. The observation of significantly lower plasma lactate and glucose concentrations after exercise in runners who consumed fortified juice (Martínez-Sánchez, Ramos-Campo, *et al*., 2017) [19] suggests an optimization of energy metabolism and better clearance of metabolites associated with fatigue. These findings support the hypothesis that the most robust effects of watermelon are of a restorative and muscle damage-modulating nature.

4.3. Physical Performance: Heterogeneous Results

In contrast to the effects on recovery, the results on the direct improvement of physical performance are heterogeneous. Most studies did not find a significant ergogenic effect in time-to-exhaustion tests (Bailey *et al*., 2016; Blohm *et al*., 2020) [6, 7] or in measures of strength and power in acute protocols (AghabeigiAmin *et al*., 2025; Al-Faruqi & Ichwan, 2021; Khasati *et al*., 2019) [1, 4, 17].

This inconsistency can be explained by several methodological factors, such as the dose and duration of the intervention. The dose of L-citrulline in natural watermelon (about 1.0-1.2 g per serving) may be insufficient to induce a significant acute ergogenic effect in well-trained athletes, who frequently use higher doses of isolated citrulline (6-8 g) (Neves *et al*., 2022) [22]. The ergogenic effect was most evident in protocols involving muscle damage and metabolic fatigue, such as the Wingate test (reduction of the fatigue index) (Gonzalez *et al*., 2022) [16] and the squat protocol (increase in peak strength) (Martínez-Sánchez, Alacid, *et al*., 2017) [18], suggesting that watermelon may be more beneficial for high-intensity, short-duration exercises or for maintaining strength in exhaustive sessions.

The absence of effect in elite athletes (Al-Faruqi & Ichwan, 2021; Neves *et al*., 2022) [4, 22] may be attributed to the physiological "ceiling," where small improvements are difficult to detect. On the other hand, the potential for improvement in muscle endurance was observed in non-athletes (Rizal *et al*., 2019) [25], indicating that the magnitude of the effect may be dependent on the level of training. The training status of the participants may influence the magnitude of the observed responses, since trained individuals have less room for acute adaptations, which may contribute to the variability of the results.

4.4. Clinical Implications and Physiological Considerations

A relevant finding was the protective effect of watermelon juice on post-exercise blood pressure in women (Khasati *et al*., 2019) [17]. This effect, mediated by the NO pathway, suggests a potential cardiovascular benefit, especially in populations at higher risk of endothelial dysfunction. However, the finding of an increase in resting systolic blood pressure in a study with juice concentrate (Bailey *et al*., 2016) [6] raises an important consideration regarding the formulation, under the hypothesis that the high sugar content and excessive concentration of other components may, in some cases, negate the benefits of citrulline, reinforcing the need for caution in choosing the watermelon derivative.

Finally, the issue of gastrointestinal tolerance (Blohm *et al*., 2020) [7] should be considered in practical application. Although watermelon juice is a natural beverage, its high fructose content and the volume consumed may lead to discomfort, which may be a limiting factor in competitive contexts.

4.5. Limitations and recommendations for future research

Among the recurring limitations observed in the included studies, the following stand out: small sample size, short duration of many interventions, lack of standardized analytical quantification of administered L-citrulline content, and scarcity of studies in high-performance athletes. To advance in this area, we recommend: (I) standardizing the quantification of citrulline and the main phytochemicals in each formulation tested; (II) conducting larger trials with appropriately balanced parallel or crossover designs; (III) incorporating combined measures of bioavailability (plasma citrulline/arginine/nitrite), damage markers, and sensitive functional outcomes; and (IV) evaluating safety and gastrointestinal tolerability at practicable volumes for athletes. These measures will reduce heterogeneity and allow for clearer practical recommendations. From a practical point of view, the use of watermelon as a nutritional strategy presents high acceptability, low cost, and ease of incorporation into the diet, characteristics that reinforce its translational potential, despite limitations regarding dose standardization.

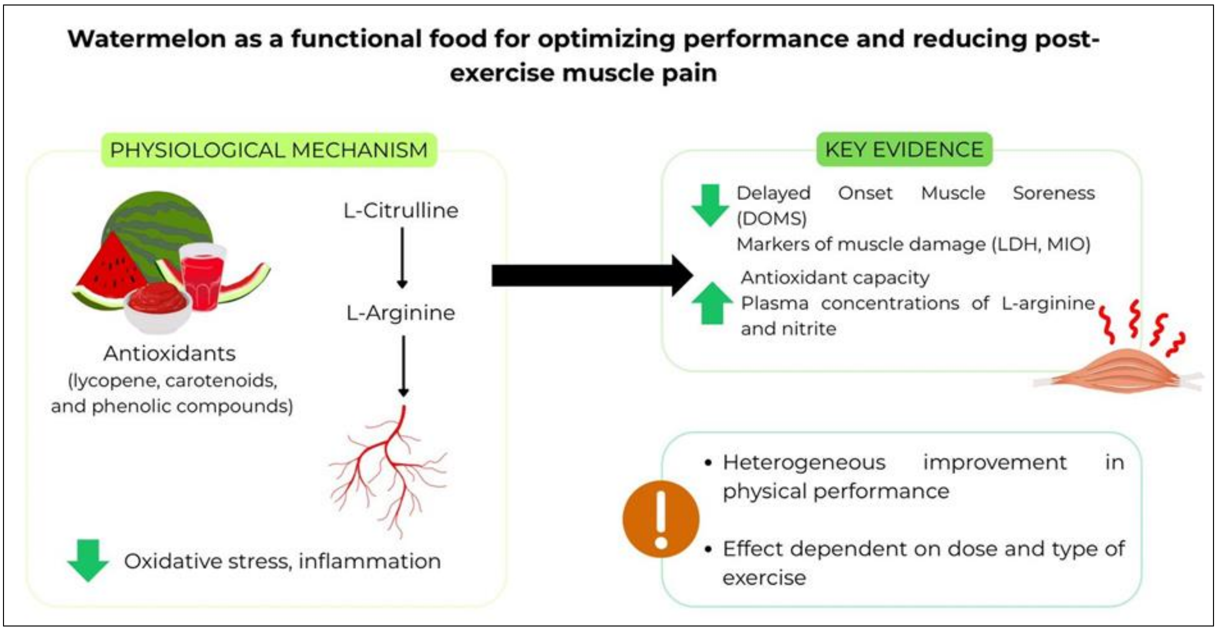

Fig 1: Watermelon as a functional food for optimizing performance and reducing post-exercise muscle pain

Table 1: Characteristics and main findings of the studies included

Study (year)	Population	Intervention	Dose/Duration	Exercise protocol	Key findings
Martínez-Sánchez et al. (2017) [18]	Corridors	Enriched watermelon juice	500 mL (0.45 g + 3 g de L-Cit)/ single dose	Half marathon	↔ perception of effort; ↓ DOMS 24-72h; ↓ lactate; ↑LDH;↑ arginine; Maintaining the height of SJ e CMJ
Shanely et al. (2016) [29]	Cyclists	Watermelon puree	980 mL/day × 2 weeks	75 km cycling	↑ citrulline, arginine, nitrate; ↑ TAC; no effect on time and average power
Martínez-Sánchez et al. (2017) [19]	Trained	Watermelon juice (WJ) Fortified watermelon juice (CWJ) Enriched watermelon juice + pomegranate concentrate (CWPJ)	200 mL (0.5 g de L-Cit) 200 mL (0.5 g + 3.3 g de L-Cit) 200 mL (0.5 g + 3.3 g de L-Cit + ellagitanins)	Squat + isokinetic test	WJ: ↔ peak force; ↔ potency; ↓ post-exercise isokinetic torque; ↑ fatigue; ↑ perception of effort; ↑ DOMS 24-48h; ↑ myoglobin; ↑↑AST; ↑LDH; ↔ plasma arginine CWJ: ↑ peak force; ↔ potency; ↓ post-exercise isokinetic torque; ↓ fatigue; ↓ perception of effort; ↓ DOMS 24-48h; ↓ myoglobin; ↓AST; ↓LDH; ↑↑ plasma arginine CWPJ: ↑ ↑ peak force; ↔ potency; ↔ post-exercise isokinetic torque; ↓ fatigue; ↓↓ perception of effort; ↓↓ DOMS 24-48h; ↓↓ myoglobin; ↓AST; ↓↓LDH; ↑↑ plasma arginine
Blohm et al. (2020) [7]	Healthy adults	Fortified watermelon juice	355 mL (+780 mg de L-Cit) / single dose	Submaximal cycle ergometer	No effect on performance (against the clock); prevented an increase in post-exercise blood pressure in women
Al-Faruqi & Ichwan (2021) [4]	Non-athletes	Watermelon rind juice	500 mL / single dose	Push-up	↑ muscular endurance (50% of participants)
Ahmadi et al. (2024) [21]	Teenagers	Natural Watermelon Juice	480 mL / single dose	Treadmill running	↔ anaerobic performance
Neves et al. (2022) [22]	Athletes	Natural watermelon juice	450 mL (~1.05g de L-Cit) / single dose	Cooper Test	↔ distance traveled; ↔ VO_2máx; prevention of increased blood pressure
Gonzalez et al. (2022) [16]	Trained	Concentrated watermelon juice	459 mL (~2,2 g de L-Cit) /d × 7 days	Supine + IMTP	↔ isometric force; ↔ velocity and power; ↔ total repetitions in RM

					sets; ↔ DOMS 24-48h
AghabeigiAmin et al. (2025) [1]	elite taekwondo athletes	Natural watermelon juice	500 mL / 6 weeks	Taekwondo training	↑ TAC; ↓ DOMS 24-48h
Cutrufello et al. (2015) [9]	Athletes from different sports	Natural watermelon juice vs. citrulline	710 mL (~1g L-Cit) / 710mL of a beverage containing 7.5% sucrose + 6 g de L-Cit	Supine + treadmill	↔ repetitions; ↔TTE; ↔ VO_2máx; ↔ workload
Rizal et al. (2019) [25]	Soccer players	Watermelon drink	500 mL / 7 days	Anaerobic sprint test based on running (RAST)	↓ fatigue index
Norouzzadeh et al. (2025) [23]	Non-athletes	Natural watermelon juice	710 mL (~1.65g de L-cit) × 8 weeks	Endurance training (Supine and Leg Press)	↑ muscle thickness; ↓ perception of effort
Bailey et al. (2016) [6]	recreationally active	Concentrated watermelon juice	300 mL (~3.4 g de L-cit) / 16 days	TTE test on a severe cycle ergometer	↑ citrulline, arginine, nitrite; ↑ BP; ↑ HR; ↑desconforto intestinal;
Omar et al. (2019)	Não atletas	Watermelon juice	250 mL / 8 weeks	Water exercises + 30-meter sprint + Flexibility test (Sit-and-reach) + sit-up + Cooper Test	↑ velocity; ↑ resistance (endurance); ↔Flexibility; ↔ sit-up;
Tarazona-Díaz et al. (2013) [33]	Atletas	Natural juice watermelon vs. fortified juice	500 mL (~1.17 g de L-Cit);/ 500 mL (+ 6 g de L-cit) Single dose	Cycle ergometer	↔ rotação por minuto (rpm); ↔ FC; ↔RPE; ↓ DMIT com os sucos contendo L-cit; ↔lactato sanguíneo

↓ - Reduction; ↑ - Increase; ↔ Neutral; PA - Blood Pressure; TAC - Total Antioxidant Capacity; TTE - Time to Exhaustion; + Added by; SJ - Squat Jump; CMJ - Countermovement Jump; RM - Repetition Maximum; RPE - Rate of Perceived Exertion; ~ - Approximately; IMTP - Mid-Thigh Isometric Pull-Up Test; BP - Blood Pressure; HR - Heart Rate

5. Conclusion

The evidence gathered in this review indicates that watermelon consumption exerts consistent physiological effects related to increased bioavailability of L-citrulline, L-arginine, and nitric oxide, modulation of oxidative stress, and attenuation of markers of muscle damage. Although the direct improvement in physical performance is heterogeneous and generally limited to specific protocols or less trained populations, the findings on recovery are more robust, with clear reductions in delayed onset muscle soreness and better preservation of function after exhaustive exercise. These effects appear to result not only from citrulline but also from the synergistic action of bioactive compounds present in the watermelon food matrix, which enhance NO stability and contribute to greater antioxidant capacity. However, methodological variability, lack of dose standardization, and the predominance of small samples limit the generalizability of the results. Taken together, the data suggest that watermelon represents a promising nutritional strategy to promote post-exercise recovery, with practical applicability in sports and recreational contexts. However, confirmation of its ergogenic potential requires studies with greater methodological rigor, standardization of formulations, and long-term interventions that allow for the evaluation of sustained effects on performance.

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