Archives of Life Science and Nutritional Research
Review Article

Effects of Sulforaphane supplementation on exercise: A Review

Pedro Jose Gonzalez-Matarin

Professor and Researcher, Department of Education, University of Almería, Almería, Spain.

***Corresponding Author:** Pedro José González Matarín, Department of Education, University of Almeria, Almería, Spain. E-mail: pgm887@ual.es

Abstract

Sulforaphane (SFN) is a phytochemical present in cruciferous vegetables and is recognized for its anti-aging, anticancer, antidiabetic, antimicrobial and chemopreventive activity. The objective of this review is to carry out a broad and exhaustive analysis of the available scientific evidence on the role of SFN in performing physical exercise. The administration of SFN was analyzed in living beings performing an exercise protocol. In conclusion, we would like to comment that the intake of SFN has effects on physical exercise in improving the antioxidant capacity of skeletal muscle, greater protection against muscle damage, improving resistance capacity and contributing to the disappearance of delayed onset muscle soreness.

Keywords: Sulforaphane, physical exercise, inflammation, muscle damage.

Introduction

The consumption of cruciferous vegetables such as Brussels sprouts, cabbage and broccoli is associated with a low risk of developing chronic diseases including prostate, lung, colon and breast cancer. The non-nutritive bioactive compounds in cruciferous vegetables are also known as phytochemicals and have a protective function for our health [1].

Sulforaphane (SFN) is a phytochemical present in cruciferous vegetables and is a non-toxic compound recognized for its anti-aging, anticancer, antidiabetic, antimicrobial and chemopreventive activity. Administration of SFN (Figure 1) has been shown to reduce muscle inflammation, inhibit muscle atrophy, repair vascular smooth muscle cell dysfunction, and protect the body against aging [2].

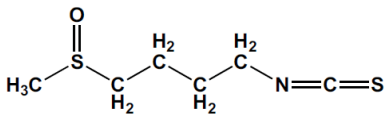

Figure 1. Structure of the SFN.

The edible portion of mature broccoli contains between 507–684 mcg/g (0.507–0.684 mg/g) of dry matter of SFN, while broccoli sprouts contain an SFN concentration of 1153 mg/100g (11.53 mg/g) of dry weight, so the part of the broccoli sprouts (Figure 2) has a high SFN content. Broccoli production has increased by around 400% in recent years due to its potential health-promoting effects [1].

Part of Broccoli	[SFN]
Mature broccoli	0,507–0,684 mg/g
Broccoli sprouts	11,53 mg/g

Figure 2. Content of SFN in brócoli.

Carrying out correctly structured physical exercise allows you to adequately maintain physical and mental well-being. However, its effects on general health and well-being depend on its intensity and duration. On the other hand, intense exercise can induce an increase in the production of pro-inflammatory cytokines such as interleukin 1 (IL-1) and 6 (IL-6), tumor necrosis factor (TNF-α) and reactive oxygen species (ROS), producing inflammation and oxidative stress. Inflammation characterized by fever, redness, pain, swelling and dysfunction, can cause cell proliferation and inhibition of apoptosis, consequently elevating the risk of cancer [3].

Furthermore, strenuous exercise causes structural damage to muscle cells, due to an increase in the plasma activity of the enzymes lactate dehydrogenase (LDH) and creatine phosphokinase (CPK), causing oxidative stress and muscle damage [4].

Furthermore, SFN activates nuclear factor erythroid 2 (NRF2) which reduces exercise-induced muscle fatigue by regulating cellular antioxidant mechanisms. SFN also decreases markers of muscle damage, such as CPK and LDH. Additionally, dietary supplementation with broccoli extract reduces exercise-induced delayed onset muscle soreness (DOMS) and markers of oxidative stress [5].

The objective of this review article is to carry out a broad and exhaustive analysis of the available scientific evidence on the role of SFN in performing physical exercise.

Material and Methods

A descriptive review study has been carried out with the objective of answering the following research question: What effects does SFN supplementation have on improving physical exercise performance?

To do this, a search was carried out in databases such as Pubmed and Google Scholar in March 2024. In order to find as many articles as possible, the following keywords were used: sulforaphane, physical exercise, inflammation, muscle damage.

For the selection of articles, inclusion criteria were used such as: articles published in english, articles where the ingestion of SFN is carried out in living beings, articles where an exercise protocol is carried out and articles where the research is carried out in vivo; The following exclusion criteria were established: articles that do not clearly show the intake of SFN in living beings during physical exercise, articles that do not refer to supplementation with SFN during physical exercise.

Results

Wang et al. evaluated the effect of SFN on the NRF2 mediated antioxidant capacity of skeletal muscle induced by 6-week interval high-intensity exercise in mice was evaluated. The results indicated that SFN treatment improved the antioxidant capacity of skeletal muscle in response to acute strenuous exercise by increasing the expression of mRNA and NRF2 and genes involved in the generation of antioxidants, resulting in a decrease in CPK [6]

Oh et al. conducted a study where aerobic capacity was evaluated in mice using a maximal progressive running test on a treadmill, measuring the expression of markers of oxidative stress and muscle damage. Mice receiving SFN had greater protection against muscle damage during intense exercise resulting in greater exercise

endurance capacity. These results provide new insights into SFN-induced NRF2 upregulation and its role in improving exercise performance. [7].

The authors Ruhee et al. conducted a study whose objective was to investigate the effects of SFN on acute organ damage induced by intense exercise and the mechanisms involved. The authors concluded that SFN can protect the liver from inflammation induced by strenuous exercise by inducing an antioxidant defense response through the activation of NRF2 [8].

In a study carried out by Malaguti et al. about the possible protective effects of SFN treatment on muscle damage and oxidative stress induced by strenuous exercise in rats were investigated. Acute exercise produced a significant increase in LDH and CPK. Treatment with SF produced a significant increase in total antioxidant capacity and a decrease in LDH and CPK levels. The results demonstrate that SFN acts as an indirect antioxidant in skeletal muscle and contributes to the prevention of muscle damage induced by strenuous exercise [4].

In a study conducted by Wang et al. performed in mice whose objective was to evaluate the effects of SFN on exercise resistance. To this end, SFN was administered before performing incremental treadmill exercise until exhaustion under hypoxic conditions. The results indicated that SFN administration improved exercise endurance under hypoxic conditions. Furthermore, SFN administration not only increased the expressions of antioxidant genes and the activity of antioxidant enzymes, but also significantly increased the mRNA and protein levels of MCT1 and CD147, so the activation of NRF2 may be a strategy to improve performance in performing exercise under hypoxic conditions [9].

Komine et al. evaluated the effect of SFN intake in humans with respect to DOMS after performing eccentric exercise. The participants performed 6 sets of 5 exercises eccentrically with the non-dominant arm performing elbow flexion with 70% maximum voluntary contraction. The results showed that participants who took SFN eliminated DOMS 2 days after performing eccentric exercise [10].

Sato et al. conducted a study whose objective was to assess the effects of continuous oral intake of SFN on the reduction of markers of muscle damage induced by resistance exercise in humans. Participants were subjected to 3 sets of 8 repetitions of bench press at 85% of 1RM. Participants received 30 mg/day of SFN 4 weeks prior to the exercise test. The results showed that SFN intake for 4 weeks decreased plasma levels of CPK and IL-6. Therefore, it was concluded that the continued use of SFN can be a nutritional strategy for the prevention of muscle damage in athletes who perform high-intensity exercise [11].

Conclusions and Future Directions

As conclusions of this review, it is highlighted that the intake of SFN has beneficial effects on physical exercise in improving the antioxidant capacity of skeletal muscle in response to strenuous exercise, greater exercise resistance capacity, and contributes to the prevention of muscle damage induced by strenuous exercise, improves resistance capacity when performing exercise under hypoxic conditions and favors the disappearance of DOMS two days after performing eccentric exercise.

The number of studies carried out with SFN in physical exercise is very limited in the scientific literature, so more studies are needed on the influence of SFN intake in people who perform different types of exercise.

Funding: This research received no external funding.

Conflicts of Interest: The author have no conflict of interest to declare.

References

1. Ruhee RT, Suzuki K. The Integrative Role of Sulforaphane in Preventing Inflammation, Oxidative Stress and Fatigue: A Review of a Potential Protective Phytochemical. *Antioxidants*. 2020; 9(6):521. doi:10.3390/antiox9060521.

2. Bose C, Alves I, Singh P, et al. Sulforaphane prevents age-associated cardiac and muscular dysfunction through Nrf2 signaling. *Aging Cell*. 2020; 19(11):e13261. doi:10.1111/acel.13261.

3. Ruhee RT, Suzuki K. The Immunomodulatory Effects of Sulforaphane in Exercise-Induced Inflammation and Oxidative Stress: A Prospective Nutraceutical. *Int J Mol Sci*. 2024; 25(3):1790. doi:10.3390/ijms25031790.

4. Malaguti M, Angeloni C, Garatachea N, et al. Sulforaphane treatment protects skeletal muscle against damage induced by exhaustive exercise in rats. *J Appl Physiol*. 2009; 107(4):1028-1036. doi:10.1152/japplphysiol.00293.2009

5. Saeidi A, Soltani M, Daraei A, et al. The Effects of Aerobic-Resistance Training and Broccoli Supplementation on Plasma Dectin-1 and Insulin Resistance in Males with Type 2 Diabetes. *Nutrients*. 2021;13(9):3144. doi:10.3390/nu13093144.

6. Wang Y, Xiang Y, Wang R, Li X, Wang J, Yu S, & Zhang, Y. (2022). Sulforaphane enhances Nrf2-mediated antioxidant responses of skeletal muscle induced by exhaustive exercise in HIIT mice. *Food Sci Hum Wellness*, 11(5), 1355-1361.

7. Oh S, Komine S, Warabi E, et al. Nuclear factor (erythroid derived 2)-like 2 activation increases exercise endurance capacity via redox modulation in skeletal muscles. *Sci Rep*. 2017; 7(1):12902. doi:10.1038/s41598-017-12926-y.

8. Ruhee RT, Ma S, Suzuki K. Protective Effects of Sulforaphane on Exercise-Induced Organ Damage via Inducing Antioxidant Defense Responses. *Antioxidants*. 2020; 9(2):136. doi:10.3390/antiox9020136.

9. Wang L, Zhu R, Wang J, Yu S, Wang J, Zhang Y. Nrf2 Activation Enhances Muscular MCT1 Expression and Hypoxic Exercise Capacity. *Med Sci Sports Exerc*. 2020; 52(8):1719-1728. doi:10.1249/MSS.0000000000002312.

10. Komine S, Miura I, Miyashita N, et al. Effect of a sulforaphane supplement on muscle soreness and damage induced by eccentric exercise in young adults: A pilot study. *Physiol Rep*. 2021; 9(24):e15130. doi:10.14814/phy2.15130.

11. Sato K, Kihara H, Kumazawa Y, Tatara K. Oral chronic sulforaphane effects on heavy resistance exercise: Implications for inflammatory and muscle damage parameters in young practitioners. *Nutrition*. 2021; 90:111266. doi:10.1016/j.nut.2021.111266.

Citation: Pedro José González-Matarín (2024), "**Effects of Sulforaphane Supplementation on exercise: a review**", Arch Lif Sci Nutr Res ; 8(1):1-5 .

DOI:10.31829/2765-8368/alsnr2024-8(1)-002