2024, Retos, 58, 1112-1116

Rhodiola Rosea: a plant from the Crassulaceae family that has the potential to reduce muscle pain and increase range of motion during exercise-induced muscle damage

Rhodiola Rosea: una planta de la familia de las crasuláceas que tiene el potencial de reducir el dolor muscular y aumentar el rango de movimiento durante el daño muscular inducido por el ejercicio

*Novadri Ayubi, **Anton Komaini, ***Mohammed Aljunaid, ****Procopio B. Dafun Jr., **Ilham, **Deby Tri Mario
*Universitas Negeri Surabaya (Indonesia), **Universitas Negeri Padang (Indonesia), ***University of Taiz (Yemen), ****Mariano Marcos State University (Philippines)

Abstract. This study aims to analyze the potential of rhodiola rosea in reducing muscle pain and increasing ROM during EIMD. This experimental research uses a pre- and post-control group design. Research subjects were selected using a purposive sampling technique, then the subjects were divided into 2 groups, namely group (K1) which was given placebo and group (K2) which was given rhodiola rosea at a dose of 500 mg. A total of 18 healthy men aged between 19-25 years participated in this study. Data collection began on the first day by collecting data on subject characteristics. After that, they were asked to warm up. Physical activity is carried out afterward. These activities include high-intensity activities, such as walking lunges, good mornings, and leg extensions. This exercise is done in 4 sets with a 1-minute break (recovery) between sets. Exercise intensity is monitored using a Polar H9 Heart Rate Sensor. On day 2 or 24 hours after training, subjects took pre-test data to measure muscle soreness and ROM. Subjects were then given placebo or rhodiola rosea treatment, depending on the group assigned. On the 3rd day or 48 hours after training, post-test data was collected again. Muscle intensity was measured using a Visual Analog Scale (VAS) and ROM was measured at the knee joint using a goniometer. After the data was obtained, the data were analyzed using the IBM SPSS version 26 application. The results of this study reported that the K1 group given placebo did not significantly reduce muscle pain and increase ROM during EIMD, while the K2 group given rhodiola rosea at a dose of 500 mg significantly reduced pain. muscle and increase ROM during EIMD. Considering that pain management and ROM are very necessary to support body function, we recommend the use of rhodiola rosea for sports enthusiasts to support physical performance.
Keywords: Rhodiola Rosea, Muscle Pain, Range of Motion, Exercise-Induced Muscle Damage, Inflammation, Healthy lifestyle

Resumen. Este estudio tiene como objetivo analizar el potencial de la rhodiola rosea para reducir el dolor muscular y aumentar el ROM durante EIMD. Esta investigación experimental utiliza un diseño de grupo de control previo y posterior. Los sujetos de investigación se seleccionaron utilizando una técnica de muestreo intencional, luego los sujetos se dividieron en 2 grupos, a saber, el grupo (K1) al que se le administró placebo y el grupo (K2) al que se le administró rhodiola rosea en una dosis de 500 mg. En este estudio participaron un total de 18 hombres sanos de entre 19 y 25 años. La recolección de datos comenzó el primer día con la recopilación de datos sobre las características de los sujetos. Después de eso, se les pidió que calentaran. Posteriormente se realiza actividad física. Estas actividades incluyen actividades de alta intensidad, como caminatas, buenos días y extensiones de piernas. Este ejercicio se realiza en 4 series con un descanso (recuperación) de 1 minuto entre series. La intensidad del ejercicio se controla mediante un sensor de frecuencia cardíaca Polar H9. El día 2 o 24 horas después del entrenamiento, los sujetos tomaron datos previos a la prueba para medir el dolor muscular y el ROM. Luego, los sujetos recibieron placebo o tratamiento con rhodiola rosea, según el grupo asignado. Al tercer día o 48 horas después del entrenamiento, se recopilaron nuevamente los datos posteriores a la prueba. La intensidad muscular se midió mediante una escala visual analógica (EVA) y el ROM se midió en la articulación de la rodilla mediante un goniómetro. Una vez obtenidos los datos, los datos se analizaron utilizando la aplicación IBM SPSS versión 26. Los resultados de este estudio informaron que el grupo K1 que recibió placebo no redujo significativamente el dolor muscular ni aumentó el ROM durante EIMD, mientras que el grupo K2 que recibió rhodiola rosea en una dosis de 500 mg redujo significativamente el dolor. músculo y aumentar el ROM durante EIMD. Teniendo en cuenta que el control del dolor y el ROM son muy necesarios para respaldar la función corporal, recomendamos el uso de rhodiola rosea a los entusiastas del deporte para respaldar el rendimiento físico.
Palabras clave: Rhodiola Rosea, dolor muscular, rango de movimiento, daño muscular inducido por el ejercicio, inflamación, Estilo de vida saludable

Fecha recepción: 23-06-24. Fecha de aceptación: 19-07-24
Novadri Ayubi
novadriayubi@unesa.ac.id

Introduction

Exercise at high intensity will cause muscle damage (Nanavati *et al.*, 2022). This is called exercise-induced muscle damage (EIMD). (Jamurtas, 2018). During EIMD, inflammation will increase and is also closely related to increased muscle pain and decreased Range of Motion (ROM) (Fernández-Lázaro *et al.*, 2020). Our previous research has reported that proinflammatory cytokines such as Tumor Necrosis Factor-alpha (TNF-a) are believed to be the main cause of muscle pain during inflammatory processes (Novadri Ayubi *et al.*, 2022). The muscle pain that occurs is related to a decrease in ROM (Fernández-Lázaro et al., 2020). Decreased ROM has been reported to reduce performance in carrying out daily activities (Howatson et al., 2012). In this regard, to relieve muscle pain, various types of medicine are actually available on the market (Ezike *et al.*, 2023). One of them is non-steroidal anti-inflammatory drugs (NSAIDs) which have been proven to be effective in reducing inflammation and pain (Mahesh, Anil Kumar, & Reddanna, 2021). Currently, it has been reported that as many as 30 million people worldwide use NSAIDs for pain management (N Ayubi *et al.*, 2022). In fact, continuous consumption of this drug can affect health and cause drug

dependence (Tsagareli *et al.*, 2012).

Therefore, alternative medicine is needed to overcome this problem. Of these alternative treatments, one of the plants that comes from the Crassulaceae family and grows in the highlands is Rhodiola rosea (Ivanova Stojcheva and Quintela, 2022). Laboratory studies show that this plant has anti-cancer, anti-oxidant and anti-inflammatory properties (Li *et al.*, 2017; Bernatoniene, Jakstas and Kopustinskiene, 2023). Apart from that, another study reported that rhodiola rosea given to mice for 2 weeks was able to improve fatigue caused by exercise (Lu *et al.*, 2022). Currently rhodiola rosea is not widely used in sports. In addition, its effect on muscle pain factors and ROM is unknown.

This study aims to analyze the potential of Rhodiola rosea in reducing muscle pain and increasing ROM during EIMD.

Research Methods

Study Design

This experimental research uses a pre and post control group design. Research subjects were selected using random sampling techniques, then the subjects were divided into 2 groups, namely group (K1) which was given a placebo and group (K2) which was given rhodiola rosea at a dose of 500 mg. Rhodiola rosea is given in supplementation capsule form.

Subjects

A total of 18 healthy men participated in this study (subject characteristics are shown in table 1). Inclusion and exclusion criteria were determined to identify whether potential subjects could meet the requirements of this study. Inclusion criteria included students aged between 18 and 25 years with a normal Body Mass Index (BMI). Apart from that, students should also not do sports regularly. Furthermore, the exclusion criteria in this study were those who were under 18 years of age and had abnormal blood pressure before training. Finally, subjects were excluded (eliminated) if they were taking non-steroidal anti-inflammatory drugs (NSAIDs).

Research Instruments

Some of the instruments used in this research were fitness equipment, data collection sheets, writing instruments, tensimeters, visual analogue scales (VAS), goniometers, rhodiola rosea, and placebo capsules.

Procedure

Data collection in this research went through several stages. Before starting, subjects go through a screening process. The process is based on certain criteria that allow data to be included or excluded from analysis. They also provided informed consent indicating their approval of this research project. They are grouped into two groups. One group was the placebo group, and the other group was the treatment group receiving Rhodiola rosea. The placebo group took empty capsules, while the treatment group took Rhodiola rosea at a dose of 500mg. Rhodiola rosea is given in supplementation capsule form.

Data collection began on the first day by collecting data on subject characteristics. After that, they were asked to warm up. Physical activity is carried out afterwards. These activities include high-intensity activities, such as walking lunges, good mornings, and leg extensions. This exercise is done in 4 sets with a 1 minute break (recovery) between sets. Exercise intensity is monitored using a Polar H9 Heart Rate Sensor. On day 2 or 24 hours after training, subjects took pre-test data to measure muscle soreness and ROM. Subjects were then given placebo or Rhodiola rosea treatment, depending on the group assigned. On the 3rd day or 48 hours after training, post-test data was collected again. Muscle intensity was measured using a Visual Analog Scale (VAS) and ROM was measured at the knee joint using a goniometer. Finally, researchers analyze the data and make a written report as a form of accountability.

CONSORT flowchart

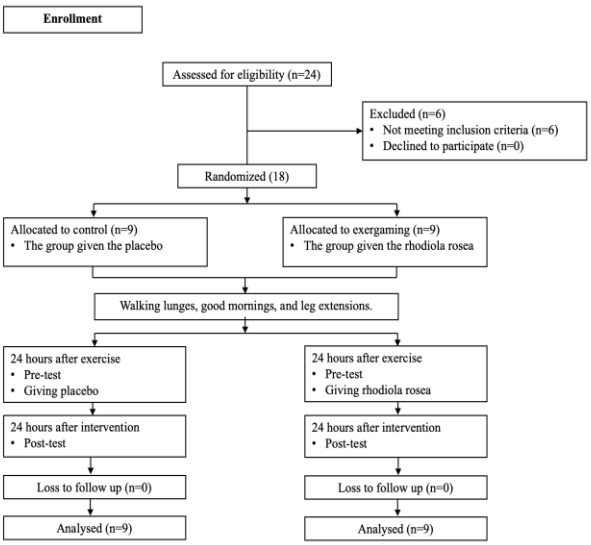

Figure 1. The CONSORT flowchart

Statistical analysis

After collecting the data, a statistical analysis was carried out using the SPSS software. The data were analyzed descriptively to obtain the mean and standard error. Further, the study performed a normality test was carried out using the Shapiro-Wilk. If the data spread normally, a difference test was calculated using the paired t-test method. However, if the results showed differently, the data were examined using the Wilcoxon signed-rank test.

Ethics

Prior to data collection, we have received ethical approval from the Health Research Ethics Committee of Medical Faculty, Ciputra University, with registration No.103/EC/KEPK/FKUC/III/2024.

Results

This section presents the data and provides information about the general characteristics of the participants in Table 1. This data allows us to better understand the characteristics of each group. Data are presented as mean ± standard error. The first analysis produced a t-test value where no significant difference was found between K1 and K2 ($p \geq 0.05$).

Table 1.
Characteristics of research subjects

Data	Group K1	Group K2	P value
Age (y)	19.55±0.24	19.44±0.24	0.739
Height (cm)	168.33±1.79	169.66±2.30	0.563
Weight (kg)	61.17±3.51	62.57±2.35	0.932
BMI (kg/m^2)	21.76±0.92	22.14±0.98	0.953
Systolic (mmHg)	110.44±3.18	119.00±4.66	0.123
Diastolic (mmHg)	68.88±2.30	72.00±1.70	0.721

Table 2.
Normality test results

Data	Group	Shapiro-Wilk	
		n	P-value
Muscle Pain Levels (Pre-test)	K1	9	0.014
	K2	9	0.028
Muscle Pain Levels (Post-test)	K1	9	0.122
	K2	9	0.290
ROM Levels (Pre-test)	K1	9	0.761
	K2	9	0.905
ROM Levels (Post-test)	K1	9	0.401
	K2	9	0.100

Based on the normality test in Table 2, the pre-test and post-test data for muscle pain in K1 and K2 are not normally distributed ($p<0.05$).

The results of the analysis of muscle pain and ROM between pre-test and post-test in each group are presented in Figure 2.

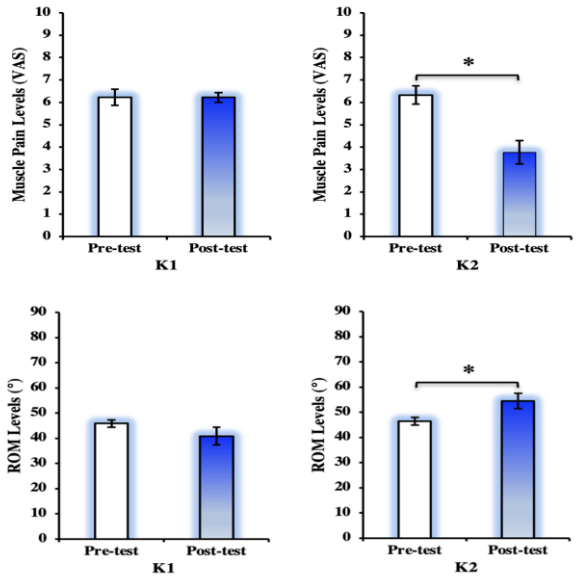

Figure 2. Analysis of Muscle Pain and ROM levels between pre-test and post-test

Information:

The K2 group given rhodiola rosea during EIMD was able to reduce muscle pain and increase ROM significantly (*$p<0.05$). Meanwhile, the K1 group which was given a placebo during EIMD could not reduce muscle pain and increase ROM significantly ($p>0.05$).

Table 3.
Results of Pain Intensity and ROM t-test

Different Test Methods	Group (pre-test and post-test)	P-value
Muscle Pain Levels	K1	0.931
	K2	*0.004
ROM Levels	K1	0.100
	K2	*0.027

Information:
* There was a significant difference (*$p<0.05$)

Discussion

The aim of this study was to analyze the potential of rhodiola rosea in reducing muscle pain and increasing ROM during EIMD. The results of our study showed that the K1 group given placebo did not significantly reduce muscle pain and increase ROM during EIMD, while the K2 group given rhodiola rosea at a dose of 500 mg significantly reduced muscle pain and increased ROM during EIMD.

In cases of EIMD, histological studies show that neutrophils enter the muscle and accumulate in the damaged area from 1 to 24 hours after exercise (Paulsen *et al.*, 2010). In addition, EIMD is characterized by muscle ultrastructural disturbances that increase the release of inflammatory cytokines by macrophages (Nanavati *et al.*, 2022). Neutrophils and pro-inflammatory cytokines interact with each other to control the pro-inflammatory response when muscle damage occurs (Hody *et al.*, 2019). On the other hand, when pro-inflammatory cytokines increase, macrophages also release anti-inflammatory cytokines that contribute to muscle recovery and regeneration (Nonnenmacher and Hiller, 2018). Our previous study reported that the main cause of muscle pain is the uncontrolled increase in pro-inflammatory cytokines such as TNF-a during EIMD (Novadri Ayubi *et al.*, 2022). Increased inflammatory response and muscle pain then result in decreased ROM (Fernández-Lázaro *et al.*, 2020). Another investigation points out that anti-inflammation affects Rhodiola rosea by potentially reducing the pro-inflammatory cytokines, such as TNF-a, IL-1 β, and IL-6 (Lee *et al.*, 2013). Furthermore, our previous research also reported that omega 3 supplementation, which is known for its anti-inflammatory properties, can reduce TNF-a levels after weight training (Novadri Ayubi *et al.*, 2022). The findings of this study were confirmed by a study which reported that rhodiola rosea has therapeutic potential for the treatment of inflammation and neurodegenerative diseases (Lee *et al.*, 2013). Supported by clinical trials which have proven that curcumin is able to reduce inflammatory mediators (Drafi *et al.*, 2023).

We believe that reducing pain intensity and increasing ROM are necessary to support body function. A study re-

ported that ROM correlated with tissue hardness and decreased muscle strength correlated with increased pain intensity (Konrad *et al.*, 2022). Accelerating recovery after EIMD can maximize the value of exercise regarding hypertrophy and muscle strength gains. On the other hand, the limitations of our study were not analyzing muscle strength and inflammatory biomarkers that cause muscle pain. We strongly recommend further research to analyze the effects of rhodiola rosea on muscle strength and inflammatory biomarkers. We hereby report that administration of rhodiola rosea during EIMD is highly recommended to reduce muscle pain and increase ROM.

Conclusion

Giving rhodiola rosea at a dose of 500 mg during EIMD can reduce muscle pain and increase ROM. Considering that pain management and ROM are very necessary to support body function, we recommend the use of rhodiola rosea for sports enthusiasts to support physical performance. Future research could be aimed at testing whether Rhodia rosea also affects inflammatory biomarkers, such as IL-10 and IL-1 β, and muscle damage biomarkers, such as creatine kinase.

Acknowledgment

The author would like to thank the support from Universitas Negeri Surabaya, Universitas Negeri Padang, University of Taiz, dan Mariano Marcos State University.

References

Ayubi, N., Yuniarti, E., Kusnanik, NW., Herawati, L., Indika, PM., Putra RY., Komaini, A. (2022). Acute effects of n-3 polyunsaturated fatty acids (PUFAs) reducing tumor necrosis factor-alpha (TNF-a) levels and not lowering malondialdehyde (MDA) levels after anaerobic exercise. *Journal of Biological Regulators and Homeostatic Agents*, 36(1); 7-11 https://doi.org/10.23812/21-468-A.

Ayubi, N., Purwanto, B., Rejeki, PS., Kusnanik, NW., Herawati, L., Komaini, A., Mutohir, TC., Nurhasan, N., Al Ardha, MA., & Firmansyah, A. (2022). Effect of acute omega 3 supplementation reduces serum tumor necrosis factor-alpha (TNF-a) levels, pain intensity, and maintains muscle strength after high-intensity weight training. *Retos*, 46; 677–682. https://doi.org/10.47197/retos.v46.93720.

Bernatoniene, J., Jakstas, V., Kopustinskiene, DM. (2023). Phenolic Compounds of Rhodiola rosea L. as the Potential Alternative Therapy in the Treatment of Chronic Diseases. *International Journal of Molecular Sciences*, 24(15); 12293. https://doi.org/10.3390/ijms241512293.

Drafi, F., Bauerova, K., Chrastina, M., Taghdisiesfejír, M., Rocha, J., Direito, R., Figueira, ME., Sepodes, B., Ponist, S. (2023). Rhodiola rosea L. Extract, a Known Adaptogen, Evaluated in Experimental Arthritis. Molecules, 28(13); 5053. https://doi.org/10.3390/molecules28135053.

Ezike, TC., Okpala, US., Onoja, UL., Nwike, CP., Ezeako, EC., Okpara, OJ., Okoroafor, CC., Eze, SC., Kalu, OL., Odoh, EC., Nwadike, UG., Ogbodo, JO., Umeh, BU., Ossai, EC., & Nwanguma, BC. (2023). Advances in drug delivery systems, challenges and future directions. Heliyon, 9(6); e17488. https://doi.org/10.1016/j.heliyon.2023.e17488.

Fernández-Lázaro, D., Mielgo-Ayuso, J., Seco Calvo, J., Córdova Martínez, A., Caballero García, A., & Fernandez-Lazaro, C. I. (2020). Modulation of Exercise-Induced Muscle Damage, Inflammation, and Oxidative Markers by Curcumin Supplementation in a Physically Active Population: A Systematic Review. Nutrients, 12(2); 501. https://doi.org/10.3390/nu12020501.

Hody, S., Croisier, JL., Bury, T., Rogister, B., & Leprince, P. (2019). Eccentric Muscle Contractions: Risks and Benefits. Frontiers in physiology, 10; 536. https://doi.org/10.3389/fphys.2019.00536.

Ivanova Stojcheva, E., & Quintela, J. C. (2022). The Effectiveness of Rhodiola rosea L. Preparations in Alleviating Various Aspects of Life-Stress Symptoms and Stress-Induced Conditions-Encouraging Clinical Evidence. Molecules (Basel, Switzerland), 27(12); 3902. https://doi.org/10.3390/molecules27123902.

Konrad, A., Kasahara, K., Yoshida, R., Yahata, K., Sato, S., Murakami, Y., Aizawa, K., & Nakamura, M. (2022). Relationship between Eccentric-Exercise-Induced Loss in Muscle Function to Muscle Soreness and Tissue Hardness. Healthcare (Basel, Switzerland), 10(1); 96. https://doi.org/10.3390/healthcare10010096.

Lee, Y., Jung, JC., Jang, S., Kim, J., Ali, Z., Khan, IA., & Oh, S. (2013). Anti-Inflammatory and Neuroprotective Effects of Constituents Isolated from Rhodiola rosea. Evidence-based complementary and alternative medicine : eCAM, 2013; 514049. https://doi.org/10.1155/2013/514049.

Li, Y., Pham, V., Bui, M., Song, L., Wu, C., Walia, A., Uchio, E., Smith-Liu, F., & Zi, X. (2017). Rhodiola rosea L.: an herb with anti-stress, anti-aging, and immunostimulating properties for cancer chemoprevention. Current pharmacology reports, 3(6); 384–395. https://doi.org/10.1007/s40495-017-0106-1.

Lu, Y., Deng, B., Xu, L., Liu, H., Song, Y., & Lin, F. (2022). Effects of Rhodiola Rosea Supplementation on Exercise and Sport: A Systematic Review. Frontiers in nutrition, 9; 856287. https://doi.org/10.3389/fnut.2022.856287.

Mahesh, G., Anil Kumar, K., & Reddanna, P. (2021). Overview on the Discovery and Development of Anti-Inflammatory Drugs: Should the Focus Be on Synthesis

or Degradation of PGE2?. Journal of inflammation research, 14; 253–263. https://doi.org/10.2147/JIR.S2785144.

Nanavati, K., Rutherfurd-Markwick, K., Lee, SJ., Bishop, NC., & Ali, A. (2022). Effect of curcumin supplementation on exercise-induced muscle damage: a narrative review. European journal of nutrition, 61(8); 3835–3855. https://doi.org/10.1007/s00394-022-02943-7.

Nonnenmacher, Y., & Hiller, K. (2018). Biochemistry of proinflammatory macrophage activation. Cellular and molecular life sciences : CMLS, 75(12); 2093–2109. https://doi.org/10.1007/s00018-018-2784-1.

Paulsen, G., Crameri, R., Benestad, HB., Fjeld, JG., Mørkrid, L., Hallén, J., & Raastad, T. (2010). Time course of leukocyte accumulation in human muscle after eccentric exercise. Medicine and science in sports and exercise, 42(1); 75–85. https://doi.org/10.1249/MSS.0b013e3181ac7adb.

Tsagareli, M. G., Tsiklauri, N., Nozadze, I., & Gurtskaia, G. (2012). Tolerance effects of non-steroidal anti-inflammatory drugs microinjected into central amygdala, periaqueductal grey, and nucleus raphe: Possible cellular mechanism. Neural regeneration research, 7(13); 1029–1039. https://doi.org/10.3969/j.issn.1673-5374.2012.13.010.

Datos de los/as autores/as y traductor/a:

Novadri Ayubi	novadriayubi@unesa.ac.id	Autor/a
Anton Komaini	antonkomaini@fik.unp.ac.id	Autor/a
Mohammed Aljunaid	mohammed.aljunaid90@gmail.com	Traductor/a
Procopio B. Dafun Jr.	pbdafun@mmsu.edu.ph	Traductor/a
Ilham Ilham	ilhamf@fik.unp.ac.id	Autor/a
Deby Tri Mario	debytrimario@unp.ac.id	Autor/a
Procopio B. Dafun Jr.	pbdafun@mmsu.edu.ph	Traductor/a