

novita

by Novita Sari Harahap

Submission date: 14-Apr-2021 08:00AM (UTC+0700)

Submission ID: 1558598734

File name: novita.pdf (966.87K)

Word count: 2702

Character count: 15197

PAPER • OPEN ACCESS

HSP70 (heat shock protein 70) expression and antioxidant as a protective against oxidative stress triggered by sub-maximal physical activity

To cite this article: N S Harahap *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **713** 012051

View the [article online](#) for updates and enhancements.



The Electrochemical Society
Advancing solid state & electrochemical science & technology

240th ECS Meeting ORLANDO, FL

Orange County Convention Center Oct 10-14, 2021

Abstract submission deadline extended: April 23rd

SUBMIT NOW

HSP70 (heat shock protein 70) expression and antioxidant as a protective against oxidative stress triggered by sub-maximal physical activity

N S Harahap^{1*}, R Amelia², A Sibuea³, N Manalu⁴ and N Novita⁵

¹ Department of Sports Sciences, Faculty of Sports Sciences, Universitas Negeri Medan, Medan, North Sumatra, Indonesia.

² Department of Community Medicine, Public Health, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatra, Indonesia.

³ Surgery Division, Dr. T. Mansyur Tanjung Balai Hospital, Tanjungbalai, North Sumatra, Indonesia.

⁴ Department of Physical Education and Health Recreation, Faculty of Sports Sciences, Universitas Negeri Medan, Medan, North Sumatra, Indonesia.

⁵ Department of Sports Coaching Education, Faculty of Sports Sciences, Universitas Negeri Medan, Medan, North Sumatra, Indonesia

*E-mail : novitahrp74@gmail.com

Abstract. Sub-maximal physical activity will interfere with the ROS and antioxidants balance, so oxidative stress occurs. Oxidative stress can induce increased expression of HSP70 in cells to produce a cytoprotective effect. Red dragon fruit in biological systems can neutralize free radicals, because it contains flavonoid compounds and polyphenols. There were 20 participants, male, athletes, non-smokers and 2 weeks before and during the study, no consumption of supplements and antioxidants. Participants were randomly divided into 2 teams. Team A had sub-maximal activity and no red dragon fruit given. Team B had activity sub-maximal and was given red dragon fruit juice. Study found that HSP70 expression was lower in the team B than in team A. There was significant difference between team A and team B in expression of HSP70. We concluded that, HSP70 expression and antioxidants can be the protective function against oxidative stress triggered by sub-maximal physical activity.

1. Introduction

Human muscles can adapt to broad capacities in response to stress caused by physiological and mechanical changes in physiology. Physical activity accompanied by mechanical and metabolic disorders can be a stressor. When skeletal muscle experiences physiological stress, it adapts to changes in the cellular mechanism. An important protein produced by cells in response to the stress conditions is HSP (Heat Shock Protein) [1].

The mechanism for the creation of free radicals during submaximal physical activity starts with muscle contractions during explosive power movements. At the time of the explosive power movement, ischemic to the muscle will occur, Alternating muscle relaxation followed. This muscle motion hampers the blood flow due to muscle contraction. Then, as blood vessels relax easily flow, ischemia-reperfusion occurs, which causes the release of an electron from the respiration chain to form free radicals or known as ROS (Reactive Oxidative Species) [2,3].



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

Submaximal physical activity can interfere with the balance between ROS and antioxidants, thereby producing oxidative stress. Oxidative stress often has many parameters in biological systems including an increased production of free radicals and other oxidants and reduced enzyme antioxidants. Like catalase, superoxide dismutase (SOD), and glutathione peroxidase (GPx). An imbalance of redox reactions in cells can also cause oxidative damage to cell components, such as fat, protein, and DNA [4]. Another indicator of cell damage is increased expression of the HSP70 protein due to oxidizing stress. Consequently, oxidative stress can increase HSP70 expression through the formation of reactive oxygen species (ROS).

HSP70 expression is a highly essential protein molecule for cell recovery and homeostasis maintenance. HSP70 is a protein that is strongly induced after stress, such as oxidative stress [5]. Oxidative stress can induce an increase in HSP70 expression in cells to provide a cytoprotective effect. When cells are ischemic, HSP70 expression helps prevent cell death by binding proteins which play a role in cell necrosis inhibition [6]. Self-care behavior and the relationship with exercise can be influence metabolic control [7].

Oxidative damage due to physical exercise can be prevented by increasing the antioxidant content of food [8]. Therefore, the body must have optimal antioxidant defenses to protect against free radicals. Many athletes believe that consuming antioxidants can reduce muscle damage and increasing defenses and fatigue so that it will improve their performance [9].

Red dragon fruit (*Hylocereus polyrhizus*), which belongs to the cactus category, is a nowadays very common and cultivated fruit, especially in Indonesia. Red dragon fruit is considered natural antioxidant. Numerous studies demonstrated the possible antioxidant of red fruit extract.

Red dragon fruit is known to have the ability to serve as a natural antioxidant. Many studies have shown that the extract from red dragon fruit had antioxidant possible [10-12]. The ability of red dragon fruit as an antioxidant in biological systems will neutralize free radicals because it contains flavonoid compounds and polyphenols [13]. This research aims to find out the protective role of HSP70 and antioxidants against oxidative stress, based on the description above.

2. Methods

2.1. Ethical clearance

Universitas Sumatera Utara (no.59/KEP/USU/2020) of the Committee on Ethics for the Implementation of Scientific Research in the Faculty of Medicine approved this work ethically.

2.2. Subjects

The participants were 20 persons, male, who were qualified as athletes, non-smokers and no consumption of vitamins and antioxidants 2 weeks before and throughout the research. The subjects were split into two teams, randomly. Team A had activity sub-maximal and no red dragon fruit given. Team B had activity sub-maximal and obtained juice from red dragon fruit. Blood is obtained for evaluation of HSP70 expression before and after diagnosis.

2.3. Activity sub-maximal protocol

The subject warms for 3-5 minutes. Perform physical activity by running on treadmill on intensity 80-85% of maximum heart rate, no incline, 11-12 speed stage, 30 minutes length and then cooling down for 3-5 minutes. Treadmill was done for 3 days/week, for 4 weeks. Red dragon fruit drink, 4 weeks a day. The treadmill is done at Physical Laboratory Universitas Negeri Medan.

2.4. HSP70 expression evaluation

Examination of HSP70 expression was carried out with spectrophotometric, the Enzyme-Linked Immunosorbent Assay (ELISA) method Examination and Human Heat Shock Protein 70 (HSP70) reagents ELISA Kit, Catalog Number MBS012990.

3. Results and Discussion

The means of HSP70 expression in team A increased significantly, while team B decreased significantly as shown in Table 1. The expression of HSP70 in team B was lower than in team A as shown in Table 2. Team A and Team B differed significantly in HSP70 speech.

Table 1. Means HSP70 expression on teams

Teams	Pre-test	Post-test	p
	Mean±sd	Mean±sd	
A	16.15±3.20	25.95±7.63	0.02*
B	19.22±5.11	10.42±3.26	0.000*

Note: team A = control; team B = treatment; sd = standar deviation; * = significant

Table 2. Difference in HSP70 expression on team

Teams	Mean	sd	P
A	25.95	7.63	0.000*
B	10.42	3.26	

Note: team A = control; team B = treatment; sd = standar deviation; * = significant

HSP70 expression after submaximal physical exercise increase because it is triggered by oxidative stress, which induced increased production of HSP70 in cells. HSP (Heat Shock Protein) is a protein molecule that plays a role in maintaining the structure and function of cell homeostasis in normal and stressful situations [14]. HSP's anti-apoptotic influence, which repairs damaged cells so that they can return to normal. Thus, an increase in HSP70 levels is compensation for the ischemia state and increased production of ROS due to submaximal physical activity [15]. Research by Nugroho et al. (2020) states that an increase in HSP70 expression triggered by oxidative stress is followed by a decrease in catalase and SOD [16].

The increase in HSP70 expression due to submaximum physical activity is consistent with research by Stranes et al. (2003) [17], who recorded exercise on the treadmill can increase expression of HSP70 in rat muscles. An increase in HSP70 expression functions as a protection against cells that prevents oxidative damage and repairs damaged proteins by balancing the state of ischemia and increasing production of free radicals [18].

HSP70 expression decreased in the submaximum physical activity group given red dragon fruit antioxidants because the antioxidants found in red dragon fruit, such as flavonoids and polyphenols, function to eliminate ROS so that it can suppress HSP70 expression. The findings of this research are consistent with prior Harahap et al. (2019) studies [19], who reported the effect of giving red dragon fruit extract in rats given a heavy physical exercise to decrease HSP70 and cortisol expression.

HSP response is related to training intensity because HSP70 expression is known to be higher after high-intensity exercise compared to the mild and moderate-intensity training [20-21]. Thus, the HSP response is also related to metabolic stress due to increased ROS [22]. Oxidative stress is known to cause an increase in the development of stress protein (HSP), which is an essential component of the cellular protective response and can protect cells from potential oxidative stress damage [23-24].

Red dragon fruit antioxidants are important to prevent protein and other components from being damaged by exercise or ischemia during oxidative stress. HSP70 expression reaction is to help recovery by preventing denatured protein aggregation [25]. Kassaf et al. (2003) research [26] notes that increasing tissue levels of vitamin C can suppress oxidants that are caused by submaximum physical activity. This represents the likelihood of antioxidants and HSP70 defending against oxidative stress [27].

4. Conclusions

Red dragon fruit antioxidants are important to prevent protein and other components from being damaged by exercise or ischemia during oxidative stress. The results showed HSP70 expression decreased with red dragon fruit juice for sub-maximal physical activity. Therefore, it can be concluded of HSP70 expression and antioxidants can be the protective function against oxidative stress triggered by submaximal physical activity.

References

- [1] Folkesson M, Mackey AL, Langberg H, et al. 2013 The expression of heat shock protein in human skeletal muscle: effects of muscle fibre phenotype and training background *Acta Physiol (Oxf)*. 209(1): 26–33reference
- [2] Liu JF, Chang WY, Chan KH, Tsai WY, Lin CL, Hsu MC, et al. 2005 Blood lipid peroxides and muscle damage increased following intensive resistance training of female weightlifter', *Annals of the New York Academy of Science*, 1042:255-261.
- [3] Sahlin K, Shabalina IG, Mattsson CM, Linda B, Fernstrom M, Rozhdestvenskaya, Z, et al. 2010 Ultraendurance exercise increases the production of reactive oxygen species in isolated mitochondria from human skeletal muscle *Journal Appl Physiol*. 08:780-787.
- [4] Dekany M, Nemeskeri V, Gyore I, Ekes E, Golg A, Szots,G, Petrekanits M., Taylor, A.w., Berkes, J., & Pucso, J. (2008). Physical performance and antioxidants effects in triathletes. *Biology of Sport*, 25(2), 101-114. <https://www.researchgate.net/publication/47508243>
- [5] Lanneau D, Brunet M, Frisan E, Solary E, Fontenay M, Garrido C. Heat shock proteins: essential proteins for apoptosis regulation. *Journal Cell. Mol. Med*,12(3):743-761.
- [6] Mathur S, Walley KR, Wang Y, Indrambarya T, Boyd JH 2011 Extracellular heat shock protein 70 induces cardiomyocyte inflammation and contractile dysfunction via TLR2. *Circ J* 75: 2445-2452.
- [7] Amelia R. 2018 The model of self care behaviour and the relationship with quality of life, metabolic control and lipid control of type 2 diabetes mellitus patients in Binjai city, Indonesia. *Open Access Maced J Med Sci* 6(9):1762-1767.
- [8] Gomez-Cabrera MC, Domenech E, & Vina, J. 2008 Moderate exercise is an antioxidant: Upregulation of antioxidant genes by training, *Free Radical Biology & Medicine*, 44(2), 126–131. <https://doi.org/10.1016/j.freeradbiomed.2007.02.001>
- [9] Braakhuis AJ, & Hopkins WG 2015. Impact of dietary antioxidants on sport performance: A *Review Sports Med.*, 45(7), 939-55. doi: 10.1007/s40279-015-0323-x.
- [10] Stintzing FC, Sheiber A, & Carler R 2006. Betacyanins In fruit from red-purple pitaya *hylocereus polyrhizus* (weber) britton and rose. *Jurnal Food Chemistry*, 77(1),101-106. [https://doi.org/10.1016/S0308-8146\(01\)00374-0](https://doi.org/10.1016/S0308-8146(01)00374-0)
- [11] Helmi A, Welli N, & Elisma E. 2012. Pengaruh pemberian jus buah naga *hylocereus undatus* (haw.) Britton & Rose terhadap jumlah hemoglobin, eritrosit dan hematokrit pada mencit putih betina. *Jurnal Sains Dan Teknologi Farmasi*, 17(1), 118-125.
- [12] Minh NP 2014 Various Factory Influencing to Red Dragon Fruit (*Hylocereus Polyrhizus*) Wine Fermentation. *International Journal of Multidisciplinary Research and Development*, 1 (5), 94-98.
- [13] Mahattanatawee K, Manthey JA,uzio, G, Talcott ST, Goodner K, & Baldwin E.A. 2006 Total antioxidant activity and fiber content of select florida-grown tropical fruits. *Journal Agricultural and Food Chemistry*, 54(19), 7355-7363. DOI: 10.1021/jf060566s
- [14] Snoeck LHEH, Comelussen RN, Van Nieuwenhoven FA, Reneman RS, Van der Vusse AGJ 2001 Heat Shock Protein and Cardiovascular Pathophysiology. *Physiological Rev.* 81(4): 1461-85.
- [15] Christians ES, Liang-Jun Y, Benjamin IJ 2002 Heat shock factor 1 and heat shock proteins:

- Critical partners in protection against acute cell injury. *Critical Care Medicine* 30(1): S43-S50.
- [16] Nugroho J, Darius C, Probahoecodo MY and Ghea C. 2020 The Relationship of Hsp-70 with Calcineurin, SOD and Catalase PostAcute Myocardial Infarction in Wistar Rats Model. *Journal of Cardiovascular Diseases & Diagnosis*. 8(2):1-4.
- [17] Starnes JW, Choilawala AM, Taylor RP, Nelson MJ, Delp MD 2005 Myocardial heat shock protein 70 expression in young and old rats after identical exercise programs. *The Journals of Gerontology*. 60(8):963-969. [10.1093/gerona/60.8.963](https://doi.org/10.1093/gerona/60.8.963)
- [18] Krause M, Heck TG, Bittencourt A, Scorzazon SP, Newsholme P, Curi R, et al. 2015 The chaperone balance hypothesis: The importance of the extracellular to intracellular HSP70 ratio to inflammation-driven type 2 diabetes, the effect of exercise, and the implications for clinical management. *Mediators Inflamm*
- [19] Harahap NS, Lelo A, Purba A, Sibuea A, Amelia R, Zulaini Z. 2019 The effect of red-fleshed pitaya (*Hylocereus polyrhizus*) on heat shock protein 70 and cortisol expression in strenuous exercise induced rats. *F1000Research*. 8:130
- [20] Liu Y, Gampert L, Nething K, et al. 2006 Response and function of skeletal muscle heat shock protein 70. *Front Biosci*. 11: 2802-27.
- [21] Yamada P, Amorim F, Moseley P, Schneider S 2008 Heat shock protein 72 response to exercise in humans. *Sports Med* 38: 715-733.
- [22] Khassaf M, Child RB, McArdle A, Brodie DA, Esanu C, Griffiths RD & Jackson MJ 2001 Time course of responses of human skeletal muscle to exercise-induced oxidative stress. *J Appl Physiol* 90, 1031-1036.
- [23] Samali A, Robertson JD, Peterson E, Manero F, van Zeijl L, Paul C, Cotgreave IA, Arrigo AP & Orrenius S. 2001 Hsp27 protects mitochondria of thermotolerant cells against apoptotic stimuli. *Cell Stress Chaperones* 6, 49-58.
- [24] Ogawa K, Seta R, Shimizu T, Shinkai S, Calderwood SK, et al. 2011 Plasma adenosine triphosphate and heat shock protein 72 concentrations after aerobic and eccentric exercise. *Exerc Immunol Rev* 17: 136-149.
- [25] Latchman DS. 2001 Heat shock proteins and cardiac protection. *Cardiovasc Res*. 51:637-646.
- [26] Khassaf M, McArdle A, Esanu C, et al. 2003 Effect of vitamin C supplements on antioxidant defence and stress proteins in human lymphocytes and skeletal muscle. *J Physiol*. 549(Pt 2): 645-52.
- [27] Harahap NS, Sunarno A, N Simatupang N and Suprayitno. 2020. The Effect of Red Dragon Fruit Juice Towards Cholesterol Level and Maximum Aerobic Capacity (VO₂max) on Sport Science Students Treated with Heavy Physical Exercise. *Journal of Physics: Conf. Series* 1462 (2020) 012030. doi:10.1088/1742-6596/1462/1/012030

ORIGINALITY REPORT

14%

SIMILARITY INDEX

7%

INTERNET SOURCES

9%

PUBLICATIONS

8%

STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

3%

★ Submitted to California State University,
Sacramento

Student Paper

Exclude quotes On

Exclude matches Off

Exclude bibliography On