

Hakim Abdul Latif Rahman, Ambardini Rachmah Laksmi, Nugroho Wildan Alfia, Burhaein Erick. Dragon Fruit Giving Effect Against Malondealdehyde (MDA) Levels in Muay Thai Athletes With High Intensity Interval Traming (HIIT) Method. Journal of Education, Health and Sport. 2018;8(10):190-198. eISSN 2391-8306. DOI <http://dx.doi.org/10.5281/zenodo.1472727>  
<http://ojs.ukw.edu.pl/index.php/ohs/article/view/6224>  
<https://pbn.nauka.gov.pl/sedno-webapp/works/884951>

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).  
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

© The Authors 2018;

This article is published with open access at Licensee Open Journal Systems of Kazimierz Wielki University in Bydgoszcz, Poland  
Open Access. This article is distributed under the terms of the Creative Commons Attribution Noncommercial License which permits any noncommercial use, distribution, and reproduction in any medium, provided the original author (s) and source are credited. This is an open access article licensed under the terms of the Creative Commons Attribution Non commercial license Share alike.  
(<http://creativecommons.org/licenses/by-nc-sa/4.0/>) which permits unrestricted, non commercial use, distribution and reproduction in any medium, provided the work is properly cited.

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 01.10.2018. Revised: 25.10.2018. Accepted: 26.10.2018.

## Dragon Fruit Giving Effect Against Malondealdehyde (MDA) Levels in Muay Thai Athletes With High Intensity Interval Traming (HIIT) Method

Abdul Latif Rahman Hakim<sup>1</sup>, Rachmah Laksmi Ambardini<sup>2</sup>,  
Wildan Alfia Nugroho<sup>3</sup>, Erick Burhaein<sup>4</sup>

### Abstract

**Aim:** The aim of this research is to know how much the level of decline in MDA levels in muay thai athletes with HIIT Tabata training method.

**Methods:** This research using experimental method with eighteen times of treatments using *pretest-posttest control group design* with *true experimental lbortories* research. The subjects of this research are 20 muay thai athletes. The subject divided into two groups they are control group and experimental group (who consume dragon fruit). The way of collecting the data in this research is by taking the blood from sample's *ven ante cubiti*. Then the blood will be taken to the laboratory to measure the level of *Malondealdehyde* from control group, treatment group 1 and 2 by using TBARS method. The data analysis is using three steps of testing which is normal testing, homogeneity testing and hypothesis testing.

**Results:** The results obtained in this research are: 1) the data obtained from normality testing of significance score from every group  $>0,05$  so that the data were normally distributed; 2) the data obtained from homogeneity testing of significance score from every group  $>0,05$  so that the data were homogeneously distributed; 3) the different testing result obtained from control and treatment group is the significant point of  $0.752 >0.05$  so there are no significant different.

**Conclusion:** The conclusion that can be taken from the research are: 1) There is a high increase of MDA level in muay thai athlete who is given HITT training method ; 2) Giving the dragon fruit to the muay thai athlete which is given HIIT training method proven successfully decrease the level of their MDA; 3) There was no significant difference in effect between muay thai athletes who consumed dragon fruit and muay thai athletes who only practiced using the HIIT training method towards the decrease of MDA level within the blood.

### Keywords

MDA,  
HIIT,  
Dragon Fruit,

## INTRODUCTION

Muay thai is one of the self-defense sports which involving high intensity activity, with marked of high increase in lactate. (Crissafulli, 1:2009). Muay thai or Thai boxing is a martial art classified as interminent physical activity which needs aerob dan anaerob energy system, as shown in a present study in muay thai match. Muay thai as a high intensity activity, also marked by high cases injury within that sports. Injury data obtained from (IAMTF) *International Amateur Muay Thai Federation*

<sup>1</sup> **Corresponding Author:** Post Graduate Program, Sport Science, Universitas Negeri Yogyakarta, Indonesia, [abdul.latif2016@student.uny.ac.id](mailto:abdul.latif2016@student.uny.ac.id)  
ORCID ID: 0000-0002-8644-1995

<sup>2</sup> Faculty of Sport Science, Universitas Negeri Yogyakarta, Indonesia, [rachmah\\_la@uny.ac.id](mailto:rachmah_la@uny.ac.id) ORCID ID: 0000-0002-1931-9340

<sup>3</sup> Post Graduate Program, Sport Science, Universitas Negeri Sebelas Maret, Indonesia, [wildanalfian\\_nugroho@yahoo.com](mailto:wildanalfian_nugroho@yahoo.com) ORCID ID: 0000-0002-3531-868x

<sup>4</sup> Post Graduate Program, Sport Science, Universitas Negeri Yogyakarta, Indonesia, [erick.burhaein2016@student.uny.ac.id](mailto:erick.burhaein2016@student.uny.ac.id) ORCID ID: 0000-0003-4680-1682

shows that 42,5% injury on professional athlete, 31% on amateur athlete and 2,3% on the athlete in training session. Another injury data shows that 69,2% scratch on the body, 45,1% bone fracture, 44,2% injury on teeth and 6,7% is dislocated (Stephen, 79:2014). Besides the high of the injury, Athlete's training high intensity also affect the physical capacity ability of the athlete. One of the trainings to increase that physical capacity is using HIIT.

*High Intensity Interval Training (HIIT)* is a shape of training with the intensity of heart rate maximum (HRMax) from 85% up to 95% which is happening for 1 to 4 minutes and interspersed with break or recovery (Ciolac, 2012: 102). The effect from HIIT training itself is 18% increasement of VO<sub>2</sub>max and 14% increasement of *power output* (Foster, 2015: 747). Besides the increase of VO<sub>2</sub>Max and power, HIIT also has an impact on free radical formation. One of the training methods of HIIT that usually used within training is Tabatha. Tabatha training method itself is proven can increase the capacity of aerobik and anaerobic up to 28% (Emberts, 2013:612). System energy increasement which is happen in Tabata training method whether it is aerobic or anaerobic also followed by the increase of oxygen consumption. Along with the increase of oxygen consumption in the training, decrease of fat level, increasement of blood pressure, the sensitivity of insulin and glucose regulation also happen within relatively short time (Olson, 2014:17). The effect of Tabata high training intensity is the trigger that make the free radical formed within or outside the cell.

Free radical itself is a molecule which is lost one electron so that the bond become unbalance. That matter becomes clearer by Candrawati (2013: 456) that physical activity can give the effect towards free radical formation so that the oxidative stress is increasing. Li (2013: 169) explains that within physical training metabolism level is increasing, this thing can be seen from the oxygen that consumed and the heat production, that makes increasement of *Reactive Oxygen Species (ROS)*.

ROS is a depiction of free radical that centered to oxygen and non-radical reactive oxygen derivatives that produced from consecutively oxygen reduction through electron addition (Li, 2013: 169). Oxygen will increase in consumption especially when there is muscle contraction. The other effect of the training is the increase of electron leaking in mitochondrial that later becoming a ROS. The imbalance between ROS with the anti-oxidant activity like *free radical-scavenging activity*, can cause oxidative stress (Samichah dan Syauqy, 2014:501). Commonly, 2-5% from the oxygen that used in metabolism process within the body will turn into ion peroxide so when the heavy physical activity is happening the formation of free radical will increase (Jawi, 2008:66).

The previous research shows that free radical level is increasing after doing a physical activity (Kiyanto, 2009:155). Formation of free radical itself can be seen with the existence of *Malonedialdehyd (MDA)* especially when doing physical activity with high intensity. Exercise with high intensity causing the formation of *Malonedialdehyd (MDA)* more compared with the exercise with low intensity (Guzel *et al*, 2007:421).

George dan Osharechiren (2009:480) report that there is stress oxidative increasement in heavy exercise. MDA is the result of lipid peroxide within the body because the effect of free radical (Jawi dkk, 2008:66). MDA is a sign of Free radical that often used (Ambardini dkk, 2005:506). Free radical that found within human body can cause the damage of oxydative. Effect from MDA Increasement is the decrease or degeneration in body cells. Prevention of the body cells' degeneration can be anticipated by consuming the anti-oxidant. *Free adical-scavenging activity* anti-oxydant activity has linear correlation with anti-oxidant substance. The more level of anti-oxidant the higher anti-oxidant activity will be (Samh, 2013:48). Anti-oxidant can neutralize free radical through high anti-oxidant activity, so it can prevent various diseases (Samichah dan Syauqy, 2014:501). Development and utilization of natural antioxidants to increase antioxidant activity through functional food is currently being developed (Getoff, 2007:1577).

One of the natural food sources that usually consume, easy to get and contains of anti-oxidant compound are fruits and vegetables. Fruits and vegetables is the source of natural anti-oxidant which is contained vitamin A, C, E, Beta carotene, flavonoid and phenol (Syauqy dan Samichah, 2014:502). There are so many kinds of fruits and vegetables which has high vitamin C. Dragon fruit contains high vitamin C that functioned as natural anti-oxidant, and have potency becoming anti-oxidant needed by body (Arifin dkk, 2012:118). Vitamin C can inhibit the occurrence of lipid oxidation, protein and DNA that can cause mutation (Widianingsih, 2016:149). Vitamin C protects the body against free radical oxygen center and also to restore vitamin E, if oxidized, can be formed into something useful. In the certain phase vitamins C that oxidize can be restored with selenium-containing glutathione

peroxidase. Alpha lipoic acid can restore Vitamin C and E, also can protects glutathione. The amount that recommended in vitamin C consumption is 75 mg/day for women and 95mg/day for men. Vitamin C is polar and volatile which functions to protect cells or tissues from oxidative stress due to exposure to free radicals.

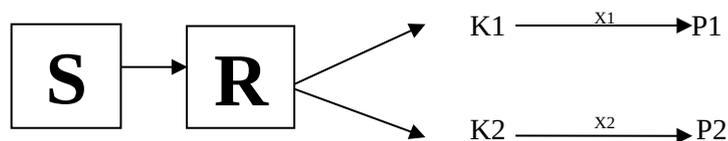
Fulfillment of consumption of vitamin C in men and women according to the need can be done by consuming extracts from dragon fruit which contain high vitamin C and high antioxidant compounds. Consuming dragon fruit can increase the supply of anti-oxidant to the body. Dragon fruit itself contains anti-oxidant compound such as Betalains, fenolat, gallic acid and *betacyanin*. Betalains has anti-oxidant efficacy which is useful for decreasing oxidation process (Glangkarn, 2015:203). Extracted betalain is safe to consume and act as micronutrient within the body (Khan, 2016:316).

So far the impact of high intensity physical training on free radical formation in Muay Thai athletes is still unknown, so it requires further research about the impact of high intensity training on free radical formation and exposure to antioxidant ingredients contained in dragon fruit. Based on the problem, the writer intend to do a research about the effect of giving antioxidants in the form of dragon fruit to the levels of *Malondialdehyd* (MDA) in high intensity exercise.

## MATERIAL & METHODOLOGY

### Types of Research

This research is an experimental research with test as the way of collecting the data. In this research, the writer wants to know the effect of dragon fruit juice giving toward the decrease in high intensity exercise. Kind of research that used in this research is *true experimental laboratories*. This research using *pre-test-post-test control group design* research. The design in this study is as follows:



Explanation:

S : Research sample

R : Sample randomization

K1 : Control group

K2 : *Treatment group*

X 1 : HIIT treatment

X2 : HII treatment + dragon fruit giving

P1 : control group Post-test

P2 : *treatment group* Post-test

### Research subject

Population in this research are 93 people and taking 20 people as a sample in Nataputra Muay Thai camp. Penentuan sampel ini mencakup semua atlet yang ada dan rutin berlatih di Nataputra MuayThai Camp the sample includes in this research are all existing athletes and the athlete who routinely practicing at Nataputra MuayThai Camp. The sample in this resarch must fullfil the requirement as follows:

1. Berusia 19-27 tahun19-27 years old
2. Man.
3. No smoking and drinking alcohol.
4. Already train for 6 months .
5. Train minimally three times a week.

The sampling partition is randomly chosen by lottery and divided into 2 groups, the control group and the treatment group.

### Data collection Tecnique

Data collecting in this study by taking blood from the ante cubiti vein of the sample. Then blood samples were taken to the laboratory to measure *malondialdehyde* levels in the control group, treatment group I and II using the TBARS method. TBARS is one of the very first lipid peroxidation indicators that used in research with a human or experimental animal. The measurement is using spectrofometer with a base of colour absorption that created from TBA and MDA reaction (Winasari, 2007:56).

### Data Analysis Technique

Data analysis technique used in this research is hypothesis test done by T test of two correlation samples using help of *SPSS 23 for Windows Evaluation Version*; test formula *Paired Sample T Test*. Within the test of *Paired Sample T-Test* there are 3 stages as follows:

1. Normality testing used *Kolmogorof-Smirnov* test, with a criteria that used to know whether normal or not one distribution is. If  $p > 0,05$  (5 %) the distribution in normal and if  $p < 0,05$  (5 %) the distribution is not normal.
2. Besides the test towards the data distribution that will be analyzed, it is necessary to do a homogeneity test to know the groups that created the sample is from the homogeneous population. Homogeneity testing used *leven's statistic* through *one way anova*. In homogeneity test criteria that used to know whether the test is homogeneous or not if  $p > 0,05$  and  $F_{hitung} < F_{tabel}$  test is homogeneous, if  $p < 0,05$  and  $F_{hitung} > F_{tabel}$  the test is inhomogeneous.
3. Hypothesis test is used for answering hypothesis from that data whether  $H_0$  is accepted or not by comparing t count and t table. T test done to know is there any difference between *pretest* and *post test* to the experiment groups. The t-test in this research using paired T-test (*paired sampel t-test*). The result of the analysis said there is a difference if the significance score less than 0,05 ( $P < 0,05$ ). Data obtained from the pre-test and post-test will be analysed on a descriptive statistics way using t test with SPSS computer program with 5% of significance level or 0,05. The purpose of this T test is to know there is an effect or not in the giving of dragon fruit juice towards the decrease of MDA. Increase percentage can be searched with a formula as follows (Purwanto, 2013:102) :

$$NP = \frac{R}{SM} NP = \frac{R}{SM} \times 100 \%$$

Explanation :

- NP : Acquisition percentage Value.  
R : Difference Value.  
SM : First score.  
100 : Fixed percentage.

## RESULTS and DISCUSSION

### Results

#### 1. Results of normality and homogeneity test

Normality and homogeneity tests are prerequisite tests for testing hypotheses. Normality test in this research is using Kolmogorof and Shapiro Wilk. While in homogeneity test used Levene Statistic.

**Table 1. Test of Normality**

Groups	Test	Kolmogorov- Smirnov	Shapiro-Wilk
		Sig	Sig
Treatment	Pre-Test	.117	.100
	Post-Test	.200*	.160
Control	Pre-Test	.200*	.280
	Post-Test	.200*	.394

Table above shows the size of significance value from pretest data in treatment group is  $0.100 > 0.05$  and posttest  $0.160 > 0.05$  so the data normally distributed. While in control group the size of significance pretest value is  $0.280 > 0.05$  dan posttest  $0.394 > 0.005$  so the data normally distributed. The significance value from every group is  $> 0.05$  so it can conclude that test done between pretest and posttest score from every groups research subject is normal.

**Table 2. Test of Homogeneity of Variance**

Kelompok	$\bar{X}$	Levene Statistic	df 1	df 2	Sig.
Treatment	$\bar{X}$	.122	1	18	.731
Kontrol	$\bar{X}$	.067	1	18	.799

Table 2 explained that the data from treatment groups have significance value of  $0.731 > 0.05$  so it can be said homogenous. In a control group the significance value that obtained is  $0.799 > 0.05$  so it can be said homogenous. Data from both groups is homogenous, this happen because significance from both groups is bigger than 0,05.

## 2. Group different test

Different test in determining the group from the whole research subject is using *independent sample test*.

**Table 3. Independent Samples Test**

	Levene's Test for Equality of Variances		t-test for Equality of Means					
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	
Pretest	Equal variances assumed	.103	.752	-1.424	18	.171	-.58100	.40787
	Equal variances not assumed			-1.424	17.617	.172	-.58100	.40787

In group taking different test, significance value that obtained is  $0.752 > 0.05$ . significance value that obtained showed there are no significant difference between control group and treatment group within the research that had been conducted.

## 3. Different test between groups

Different test used to analyze between group in pretest and posttest is *Paired Samples Test*.

**Table 4. Paired Samples Test Kelompok Treatment**

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pair 1	pre treatment - posttreatment	.30500	.38074	.12040	2.533	9	.032

Data in table 4 shows that there is a difference in result between pretest and posttest with significance value of  $0.032 < 0.05$ .

**Table 5. Paired Samples Test Control Group**

		Paired Differences					
		Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pair 1	pre control - post control	.52800	.65455	.20699	2.551	9	.031

Data from table 5 shows that there is a difference in result between pretest and posttest with the size of significance value  $0.031 < 0.05$ .

**Table 6. Independent Samples Test Antara Dua Kelompok**

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
value MDA	Equal variances assumed	.080	.781	-.975	18	.343	-.41200	.42272
	Equal variances not assumed			-.975	17.609	.343	-.41200	.42272

The data showed in table 6 shows the significance between treatment group and control group is higher than 0,05. The size of significance value between those group is 0.781. This thing shows that there is no difference in influence or difference between treatment group and control group.

## Discussion

The main purpose from this research is focused on the effect of Tabata HIIT and dragon fruit consumption on Muay thai athlete towards MDA level as the indicators of the existence of free radical. Fruit is the source of natural substances that contained high antioxidant. Compared with synthesis antioxidant, natural antioxidant contained within the fruit is safer to consume, so that it can increase the health degree in the body. Indonesia is one of 8 countries with plant genetic diversity in the world, especially tropical fruits that have the potential as a source of natural antioxidants (Febrianti et. al, 2015:6).

Dragon fruit is one of the fruits that contain variety of antioxidant substances. The consumption of dragon fruit in this research is proven can decrease the level of MDA in Muay Thai athlete that doing Tabata HIIT training. The result of this research supported by previous research that states dragon fruit can decrease free radical within the body. Dragon fruit meat contains phenolic compounds that act as antioxidants and inhibitors of melanoma cells (Wu et al. 2006:325). The content of dragon fruit that supports reducing levels of free radicals is also still a lot, including vitamin C, B2, B3, Triamine, and others.

Vitamin C contained within the daragon fruit have main role in order to prevent external pollution (exogenous antioxidant). Vitamin C in the dragon fruit in this research act as positive control, because already known as the main antioxidant. Many researches state that vitamin C consumption can decrease the fatigue and the muscle damage, but still there is no statement that oxidative stress can be measured specifically. The content of vitamin C in dragon fruit contains ascorbic compounds which trigger an emphasis on increasing ROS and breaking the chain of oxidants outside the nucleus. Ascorbic compounds in vitamin C alone Biochemically Vitamin C has the chemical formula  $C_6H_8O_6$  with a 6-carbon lactone ring structure that can be synthesized from glucose in mammalian liver, but not in humans, primates and guinea pigs. The cause of this is the absence of the ability to synthesize the gulonolactone oxidase enzyme in the liver and the coding of DNA to be synthesized is not there (Febrianti et. al, 2015:7). Ascorbic acid itself is easily dissolved in water and easily broken. The solubility level of ascorbic acid in the water was 33 g / 100 ml.

Ascorbic acid increases the proliferation of endothelium cells, stimulates type IV collagen synthesis, decreases LDL oxidation and adds protection from exposure to substances that cause oxidative stress. Aside from being an extracellular protector of oxidative stress, vitamin C also acts as an electron donor, which means as a reducing agent, consisting of a double bond between C-2 and C-3 of the 6-carbon lactone ring in it. Vitamin C can also prevent other compounds from oxidizing. Ascorbic acid contained within vitamin C has a function to protect the cell from extracellular oxidative stress.

Other roles of ascorbic acid itself include as coenzymes and electron donors in organic enzymatic reactions in neuro transmitter and synthesis of peptide hormones, noradrenaline, cholesterol, as well as amino acids in the body

The administration of vitamin C in this study was 200 mg which was consumed before exercise. Consumption of dragon fruit suppresses the suppression of MDA as a parameter of oxidative stress. Decreased MDA levels from the results of this study amounted to 18%. Other findings obtained from this study in addition to decreasing MDA levels after consuming 200 mg of vitamin C contained in red dragon fruit, a decrease was also obtained only with HIIT exercise adaptation in the research subject. Someone who exercises or exercises with high intensity also causes RONS production to decrease. When RONS occurs at low or moderate concentrations and involves a physiological role in immune processes, cellular signal pathways and mitogenic responses. RONS production is also accompanied by an increase in endogenous antioxidant defence. Direct proportion between training intensity and change the *total antioxidant capacity* (TAC) (Cipryan, 2017 : 140).

Increased TAC that occurs in someone who is trained can induce beneficial redox homeostasis changes (including an increase in TAC) and greater health benefits than sustained low to moderate intensity training (Cipryan, 2018 : 370).

In addition to the increase in TAC low levels of IL-6 in the blood circulation due to the HIIT method is one of the sign of increasing the threshold of the body's stimulation to stress stress, because IL-6 is a simulator potential against the hypothalamus in influencing the HPA-axis pathway that increases cortisol hormone (Hackney &Walz. 2013:8).

Stress level decrease that signed with the decrease of MDA within the blood on subject can be said no different. Significance level from the result of this research prove that there is no significant different decrease in two groups of research subjects with the significance level value of  $0.781 > 0,05$ .

## CONCLUSION

Based on the result that has been conducted, it can be concluded that:

1. The increase of MDA level In muay Thai athlete who given train with HIIT method is fairly high.

2. Dragon fruit giving proven successfully decreasing the MDA level on Muay Thai athlete who given the training with HIIT method.
3. There was no significant difference in effect between muay thai athletes who consumed dragon fruit and muay thai athletes who only practiced using the HIIT training method towards the decrease of MDA level within the blood.

## REFERENCES

- Aguirre, R., & May, J. M. (2008). Inflammation in the vascular bed: importance of vitamin C. *Pharmacology & therapeutics*, 119(1), 96-103.
- Ambardini, R. L. (2005). *Efek pemberian Panax Ginseng terhadap kadar malondialdehyde (MDA) dan Superoxide Dismutase (SOD) darah pada latihan fisik Aerobik intensitas sedang* (Doctoral dissertation, Universitas Gadjah Mada).
- Candrawati, S. (2015). Pengaruh Aktivitas Fisik Terhadap Stres Oksidatif. *MANDALA of Health*, 6(1), 454-461.
- Crisafulli, A., Vitelli, S., Cappai, I., Milia, R., Tocco, F., Melis, F., & Concu, A. (2009). Physiological responses and energy cost during a simulation of a Muay Thai boxing match. *Applied Physiology, Nutrition, and Metabolism*, 34(2), 143-150.
- Ciolac, E. G. (2012). High-intensity interval training and hypertension: maximizing the benefits of exercise?. *American journal of cardiovascular disease*, 2(2), 102.
- Cipryan, L. (2017). IL-6, antioxidant capacity and muscle damage markers following high-intensity interval training protocols. *Journal of human kinetics*, 56(1), 139-148.
- El Samh, M. M. A., Sherein, A. A. D., & Essam, H. H. (2013). Properties and antioxidant activity of probiotic yoghurt flavored with black carrot, pumpkin and strawberry. *International Journal of Dairy Science*, 8(2), 48-57.
- Emberts, T., Porcari, J., Doherty, S., Steffen, J., & Foster, C. (2013). Exercise intensity and energy expenditure of a tabata workout. *Journal of sports science & medicine*, 12(3), 612.
- Febrianti, N., Yudianto, I., & Dhaniaputri, R. (2015). Kandungan Antioksi dan Asam Askorbat pada Jus Buah-Buahan Tropis. *Jurnal Bioedukatika*, 3(1), 6-9.
- Foster, C., Farland, C. V., Guidotti, F., Harbin, M., Roberts, B., Schuette, J., ... & Porcari, J. P. (2015). The effects of high intensity interval training vs steady state training on aerobic and anaerobic capacity. *Journal of sports science & medicine*, 14(4), 747.
- George, B. O., & Osharechiren, O. I. (2009). Oxidative stress and antioxidant status in sportsmen two hours after strenuous exercise and in sedentary control subjects. *African Journal of Biotechnology*, 8(3).
- Getoff, N. (2007). Anti-aging and aging factors in life. The role of free radicals. *Radiation Physics and Chemistry*, 76(10), 1577-1586.
- Glangkarn, S. (2015). Antioxidant Activity in Red Dragon Fruit Jelly. *Food and Public Health*, 5(5), 203-206.
- Güzel, N. A., Hazar, S., & Erbas, D. (2007). Effects of different resistance exercise protocols on nitric oxide, lipid peroxidation and creatine kinase activity in sedentary males. *Journal of sports science & medicine*, 6(4), 417.
- Hackney, A. C., & Walz, E. A. (2013). Hormonal Adaptation And The Stress Of Exercise Training: The Role Of Glucocorticoids. *Trends In Sport Sciences*, 20(4), 165.
- Jawi, I. M., Suprpta, D. N., Dwi, S. U., & Wiwiek, I. (2008). Ubi jalar ungu menurunkan kadar MDA dalam darah dan hati mencit setelah aktivitas fisik maksimal. *Jurnal Veteriner Jurnal Kedokteran Hewan Indonesia*, 9(2), 65-72.
- Khan, M. I. (2016). Plant betalains: safety, antioxidant activity, clinical efficacy, and bioavailability. *Comprehensive Reviews in Food Science and Food Safety*, 15(2), 316-330.
- Kiyatno, K. (2009). Antioksidan Vitamin dan Kerusakan Otot pada Aktivitas Fisik Studi Eksperimen pada Mahasiswa JPOK-FKIP UNS Surakarta (Vitamin antioxidants administration toward muscle

- damage on exercise. An experimental study in students of FKIPâ JPOK Sebelas Maret University). *Media Medika Indonesiana*, 43(6), 277-281.
- Li, G. (2013). The positive and negative aspects of reactive oxygen species in sports performance. In *Current Issues in Sports and Exercise Medicine*. InTech.
- Olson, M. (2014). Tabata: It'sa Hiit!. *ACSM'S Health & Fitness Journal*, 18(5), 17-24.
- Purwanto, M. N. (2013). *Prinsip-prinsip dan teknik evaluasi pengajaran*. Remaja Rosdakarya.
- Samichah, S., & Syauqy, A. (2014). *Aktivitas Antioksidan Dan Penerimaan Organoleptik Yoghurt Sari Wortel (Daucus Carrota L)* (Doctoral dissertation, Diponegoro University).
- Sugiyono, P. D. (2013). *Metode Penelitian Manajemen*. Bandung: Alfabeta, CV.
- Widyaningsih, W. (2016). *Pengkajian Aktivitas Kardioprotektif, Antioksidan Dan Antiapoptosis Ekstrak Etanol Terstandar Melatonin Dari Ganggang Hijau (Ulva Lactuca L)* (Doctoral Dissertation, Universitas Gadjah Mada).
- Winarsi, H. (2007). *Natural antioxidants and free radicals*. Kanisius, Yogyakarta.
- Wu, L. C., Hsu, H. W., Chen, Y. C., Chiu, C. C., Lin, Y. I., & Ho, J. A. A. (2006). Antioxidant and antiproliferative activities of red pitaya. *Food Chemistry*, 95(2), 319-327.