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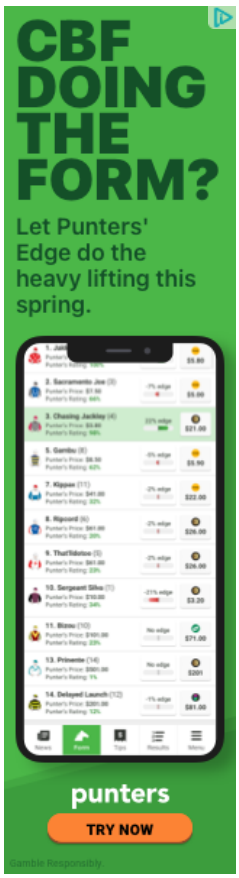

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Section	Pharmacology
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Effect of beetroot juice (*Beta vulgaris* L) supplementation on malondialdehyde levels and antioxidant status in athletes

Fajar Apollo Sinaga*, Rika Nailuvar Sinaga , Rosmaini Hasibuan

Faculty of sport science, Universitas Negeri Medan,
Jln Willem Iskandar, Psr V, Medan, Sumatera Utara

Submitted :..... Reviewed :..... Accepted:.....

ABSTRACT

Severe physical activity can cause lipid peroxidation marked by increased levels of malondialdehyde (MDA) and decreased levels of antioxidants which can reduce the performance and health of athletes. Lipid peroxidation can be prevented or reduced by antioxidant supplementation. Beetroot (*Beta vulgaris* L) contains various types of natural antioxidants but has not been investigated for its efficacy to reduce lipid peroxidation that is triggered by physical activity. The purpose of this study was to determine the effect of beetroot juice on malondialdehyde level and antioxidant status when performing maximum physical activity. This type of research is an experimental study with a randomized pre-test-post-test group design. The research sample was 30 students of Sports Science who met the criteria. Pretest is done by checking MDA levels, Total Antioxidant Capacity (TAC) and VO_2max. Furthermore the sample was divided into two groups: experimental (beetroot juice, n= 15) and control (placebo, n=15). Subjects trained for four weeks by consuming 250 mL of juice 1 hours prior to training. Then all samples performed maximum physical activity using bleep tests, and MDA, TAC and VO2max levels were re-examined. The results showed a decrease in MDA levels as well as an increase in TAC and VO_2max levels in the training group who were given 250ml beet juice compared with the control group ($p < 0.05$). The conclusion of the study was that the administration of beetroot juice during exercise could reduce MDA levels and increase athlete TAC and VO_2max levels.

Keywords: beetroot juice, malondialdehyde, antioxidants, maximum physical activity, exercise

Corresponding author:

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INTRODUCTION (11pt)

Exercise induces various physiological changes of different magnitude and direction, depending on the characteristics do exercises and at the level of fitness and training the subject. During strenuous exercise, oxygen flux can increased by 100-200-fold due to an increase in metabolism in the body (Joyner and Casey, 2015). Increased use of oxygen mainly by muscles contracting, causing an increase in electron leakage from the mitochondria which will become reactive oxygen compounds (Nemes, et al., 2018). Generally 2-5% of oxygen used in metabolic processes in the body will become superoxid ions so that during heavy physical activity an increase in free radical production occurs (Simioni, et al., 2018). When free radical production exceeds cellular defense antioxidants, oxidative stress can occur, where one of the contributing factors is physical activity (Daniel et al, 2010; Kawamura and Muraoka, 2018). Under conditions of oxidative stress, free radicals will oxidize lipids and damage the organization of cell membranes (Ayala, et al, 2014, Evans, 2000). Malondialdehyde (MDA) is one of the results of lipid peroxidation induced by free radicals during maximal physical exercise or endurance training with high intensity (Liu, et al., 2019; Bao, et al., 2016, Xu, et al., 2017) so that MDA is a general indicator used to determine the amount of free radicals and indirectly assess the body's oxidant capacity (Liu, et al., 2019)

The results showed that maximum physical activity can cause a decrease in the antioxidant levels of the enzyme superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione-S-transferase in the gastrocnemius muscle (Thirumalai, 2011). Meanwhile, Bulduk et al (2011) reported that volleyball athletes who run a 20 meter shuttle run can cause lipid peroxidation which is marked by an increase in MDA levels and a decrease in CAT and GPx antioxidant levels.

Decreased antioxidant levels and increased CK and lipid peroxidation due to maximum and sub-maximal physical activity can be prevented by optimizing nutrition, especially by increasing antioxidant content (Simioni, et al., 2018; Pingitore, et al., 2015; Kim, et al., 2017). Accordingly, Gomez (2008) said oxidative damage due to physical activity might be prevented by optimizing nutrition, especially by increasing the antioxidant content of food. According to Silalahi (2006) the efficacy of antioxidants will be more effective when consuming antioxidant-rich vegetables or fruits of various types rather than using a single antioxidant such as vitamin E. This may be due to the presence of other components and their interactions in vegetables and fruit those that play a positive role.

One alternative natural ingredient that has antioxidant content is red beetroot (*Beta vulgaris* L). Red beetroot is known to have betalains content which is a compound that has a very high antioxidant that is able to neutralize free radicals (Clifford, et al., 2015). Other compounds in red beetroots ~~(*Beta vulgaris* L.)~~ that function as antioxidants are betaine (Zhao, et al., (2018), vitamin C, carotenoids, phenolic acids such as and flavonoids (Georgiev, et al., 2010; Kujala, el., (2002); Wootton-Beard, et al., 2011). Phenolic acid compounds in red beetroots include ferulic acid, caffeic acid, p-coumaric acid, syringic acid, and vanillic acid (Chhikara, et al., 2019). A number of studies report that beetroot, in the form of a juice supplement, protects against oxidative damage to DNA, lipid and protein structures *in vitro* (Pietrzkowski et al., 2010; Kujawska et al., 2009; Winkler et al., 2005).

The specialty of redroot beet ~~(Beta vulgaris L.)~~ which has various types of antioxidants makes researchers feel interested and need to examine the antioxidant effect of red beetroot juice on MDA level and antioxidant status in maximum physical activity.

MATERIALS AND METHOD

Materials

Red beetroot (Beta vulgaris L) obtained from the Medan MMTC market, 1% EDTA solution, Aquadest, MDA Kit and TAC purchased from Shanghai Korain Biotech Co., Ltd (Shanghai, China).

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Methods

Participants

The study used 30 sports science students with criteria of having a good VO_2max level, male sex, age 20-22 years, having a good Body Mass Index (BMI), not smoking, not taking supplements and antioxidants 2 weeks before and during the study, willing to be the subject research and has received ethical clearance from the ethics committee of the Faculty of Medicine, University of North Sumatra

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Research Implementation

All subjects were subjected to hematological examination to measure MDA and TAC levels after the athlete had maximal physical activity by performing a beep test (pretest). Furthermore, athletes are divided into 2 groups: experimental (beetroot juice, n= 15) and control (placebo, n=15). Subjects trained for four weeks by consuming 250 mL of juice 1 hours prior to training. Then after one month, all athletes perform maximum physical activity by doing a beep test. Furthermore, a hematologic examination was performed again to measure MDA and TAC (posttest) levels.

MDA and TAC determination

Before and after treatment, blood (5 mL) was collected from the antecubital vein with a needle and placed in test tubes containing an anticoagulant substance. This was taken to the laboratory to measure the MDA and TAC. Serum MDA and TAC analysis was the enzyme-linked immunosorbent assay (ELISA) colorimetric method. Inspection procedures by following the procedures set out in each MDA and TAC kit.

Data Analysis

All data were analyzed using SPSS 25 Statistical Software. The Paired Sample t-test was used for comparison within groups and Independent Sample t-test was used for comparison between groups. Statistical significance (P) was set at 0.05.

RESULT AND DISCUSSION

The Effect of Beetroot Juice (Beta Vulgaris L) on Malondialdehyde Levels

Based on the results of the research, the pretest malondialdehyde (MDA) level in the treatment group was 1.98 ± 0.37 nmol/ml, while the control group was 2.11 ± 0.24 nmol/ml. The results of the analysis using the independent t test showed that there were no differences in pretest MDA levels between the treatment group and the control group. The results of measurement of MDA levels in the posttest treatment group were 5.75 ± 0.51 nmol/ml, while the control group obtained MDA levels 10.69 ± 0.97 nmol/ml. The results of the analysis using the Paired Sample t-test obtained differences in the levels of pre-test-post-test MDA treatment groups and control groups (p=0,000). Statistical test results with Independent Sample t-test obtained a significant difference in post-test MDA levels between the treatment and control groups (p = 0,000).

In the study obtained MDA levels in the group that was not given beetroot juice was greater than the group given beetroot juice. High levels of MDA in the group that were not given beetroot juice shows that during maximum physical activity will produce free radicals that oxidize cell membranes (Figure 1).

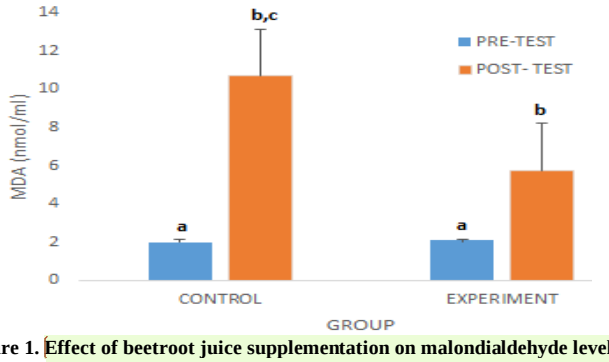

Figure 1. Effect of beetroot juice supplementation on malondialdehyde level. Data are mean ± SD for n = 15 in each group. Different letters indicate significant difference at $p < 0.05$ by paired samples-t test and independent sample t-test

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The results of this study are supported by several study results, that acute aerobic physical activity contributes to oxidative stress especially when exercising with high intensity. Two mechanisms that cause oxidative stress in high-intensity aerobic exercise are increased pro-oxidants through the effect of increasing oxygen consumption 10 to 15 times compared to rest and relatively insufficient antioxidants compared to pro-oxidants (Alessio, et al., 2000). Meanwhile according to Ji (1999), during maximum physical activity oxygen consumption throughout the body increases to 20 times, while oxygen consumption in muscle fibers is estimated to increase to 100 times. Under conditions of oxidative stress, free radicals will cause lipid peroxidation of cell membranes and damage the organization of cell membranes (Evans, 2000). Increased levels of MDA triggered by physical activity have been reported by many researchers including Moflehi, (2012) who examined the effect of aerobic exercise with different intensities (low intensity; moderate and high) on increasing levels of MDA and CK in people who are not athletes. The results of this study indicate that the higher the intensity of exercise the greater the MDA level. In this study, aerobic exercise for 20 minutes with an intensity of 80% can increase MDA levels compared to controls (9.09 ± 2.08 Vs 2.69 ± 1.32µmol/L). Meanwhile, research conducted by Bulduk, et al., (2011) reported that volleyball athletes who carried out a 20 meter shuttel run test with VO_2max levels of 41.78 ± 4.91ml/kg/min turned out to increase MDA levels from 1.41 ± 0.30 nmol/ml to 2.06 ± 0.08 nmol/ml, while non-athletes with VO_2max levels of 26.91 ± 3.67 ml/kg/min, MDA levels increased from 0.94 ± 0.24 ml/kg/min to 1.10 ± 0.21 ml/kg/min. Giving beetroot juice during exercise in this study can reduce MDA levels when athletes perform maximum physical activity when compared with MDA levels in the control group. The decrease in MDA levels is due to the antioxidant content found in beets (Beta Vulgaris L). It is known, beets contain antioxidants including phenolic compounds, flavonoids, vitamin C, carotenoids and betalains. Betalains contained in beets are betacyanin and betaxhantine (Ninfali and Angelino, 2013; Georgiev, et al., 2010; Kujala, 2002). Some in vitro research results show betalains pigments can protect cellular components from oxidative injury (Kanner, et al., 2001; Reddy, et al., 2005; Tesoriere, et al., 2008). For example, in the study by Kanner et al two betalains metabolites (betanin and betanidin) were shown to reduce linoleic damage caused by cytochrome C oxidase and lipid membrane oxidation induced by metmyoglobin-activated H_2O_2 and free iron (AA-Fe). The authors also report that betanine, the most abundant betalains found in beets (300-600 mg/kg), is the most effective inhibitor of lipid peroxidation. High antioxidant activity of betanin is thought to originate from its extraordinary electron donation capacity and ability to diffuse radicals that very reactive that targets cell membranes (Kanner, 2001) In addition, beets also contain NO_3

compounds (nitrates) which have been shown to suppress the formation of free radicals such as superoxide and hydrogen peroxide (Lundberg, et al., 2011; Wink, et al., 2001).

The Effect of Beet Juice (Beta Vulgaris L) on Total Antioxidant Capacity (TAC)

Based on the research results obtained pre-test TAC levels in the treatment group were 1.53 ± 0.06 U/ml, while the control group 1.50 ± 0.13 U/ml. The results of the analysis using the independent t-test showed that there were no differences in pre-test TAC levels between the treatment group and the control group. The results of the measurement of the TAC post-test of the treatment group were 3.39 ± 0.08 U/ml, while the control group obtained TAC levels of 2.46 ± 0.11 U/ml. The results of the analysis using the Paired Sample t-test obtained differences in pre-test-post-test TAC levels in the treatment group or in the control group (p = 0,000). Statistical test results with Independent Sample t-test obtained significant differences in posttest TAC levels between the treatment and control groups (p = 0,000).

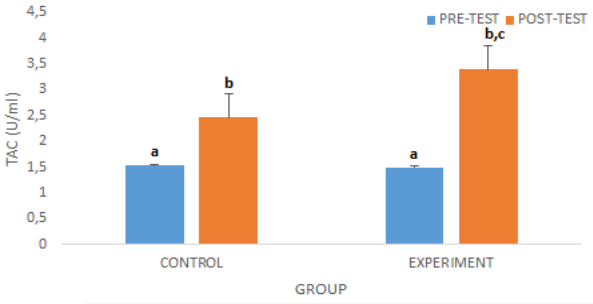

Figure 2. Effect of beetroot juice supplementation on TAC level. Data are mean ± SD for *n* = 15 in each group. Different letters indicate significant difference at *p* < 0.05 by paired samples-t test and independent samples t-test

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In Figure 2 shows the administration of beetroot juice can increase TAC levels when compared to the control group. Increased levels of TAC due to beetroot juice is due to the antioxidant content of beets such as betaine, phenol compounds, flavonoids, vitamin C, carotenoin and betalains. Betalains contained in beets are betacyanin and betaxhantine (Ninfali and Angelino, 2013; Georgiev, et al., 2010; Kujala, 2002). The results of this study are supported by research conducted by Kujawska, et al who investigated the potential protective effect of beet juice in an oxidative stress model induced by N-nitrosodiethylamine (NDEA) and carbon tetrachloride (CCl_4). In his study male Wistar rats were given beetroot juice per os, 8 mL kg/day for 28 days, and one by one dose of xenobiotics: 150 mg/kg NDEA or 2 ml/kg CCl_4. Simultaneously, two groups of mice that were not given juice were given each xenobiotic. The rate of microsomal lipid peroxidation in the liver, expressed as TBARS concentration, increased several-fold in mice given only NDEA or CCl_4. TBARS was reduced by 38% only in rats treated with beetroot juice before CCl_4 administration. Beetroot juice can also increase the antioxidant activity of superoxid dismutase (SOD), gluthation peroxidase (GPx), catalase (CAT) and glathatione reductase (Kujawska, et al., 2009). The results of the study were also supported by research conducted by Lu, et al., (2009). In his research investigated the radioprotective activity of betalains from red beetroots in rats irradiated by light (60) Co gamma (gamma) (6.0 Gy, at a dose of 1.5 Gy min (-1)). Rats were randomly divided into five groups, namely the control group and four experimental groups which were given one of four betalains concentrations of red beetroots (0, 5, 20 and 80 mg/kg for 30 days. The four groups of experimental mice were then exposed to gamma Co (ray) 60 and betalains was given from red beets for the next 3 days.The results of the study showed that administration of

betalains from red beetroots was radioprotective in mice irradiated by (60) Co in vivo. The underlying mechanism was thought to be mediated by the antioxidant activity of betalain from red beetroots and modulation immune system.

Effect of Giving Beet Juice (Beta Vulgaris L) on VO_2max

Based on the results of the study obtained levels of VO_2max pre-test in the treatment group was 47.59 ± 0.44 ml/kg/min, while the control group was 47.75 ± 0.53 ml/ kg/min. The results of the analysis using the independent samples t-test showed that there were no differences in pre-test VO_2max levels between the treatment group and the control group. The results of the measurement of VO_2max levels post-test of the treatment group were 52.95 ± 0.57 ml/kg/min, while the control group obtained VO_2max levels of 50.53 ± 0.87 ml/kg/min. The results of the analysis using the Paired Sample t-test obtained differences in the levels of VO_2max pre-test-post-test treatment group or control group (p = 0,000). Statistical test results with independent samples t-test obtained a significant difference in post-test VO_2max levels between the treatment and control groups (p=0,000).

In Figure 3 shows the administration of beetroots juice during exercise can increase VO_2max when compared to the control group. This increase in VO_2max occurs due to nitrate content and antioxidant content possessed by beetroots. The results showed 500 ml of beetroot juice containing nitrates as much as 5.1-6.2 mmol (Bailey, et al., 2009; Lansey, et al., 2011). Beet tubers have been shown to affect pulmonary oxygen uptake (VO_2). The results of research conducted on 7 adult men (19-38 years) mentioned the consumption of inorganic nitrates (5.1 mmol nitrate/day) in the form of 500 ml beetroot juice for 6 days can reduce pulmonary oxygen uptake (VO_2) in exercise intensity severe so that it can delay fatigue time (Bayley, et al., 2010).

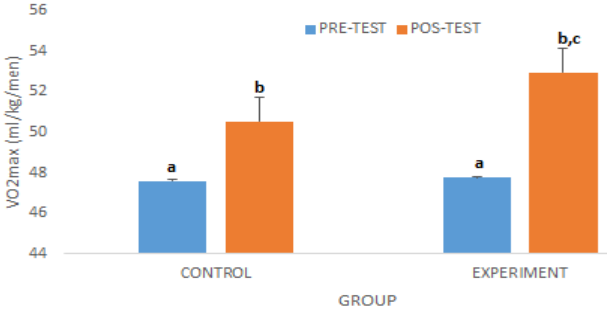

Figure 3. Effect of beetroot juice supplementation on VO_2max. Data are mean ± SD for n = 15 in each group. Different letters indicate significant difference at $p < 0.05$ by paired samples-t test and independent t-test

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The mechanism of action of nitrate (NO_3^-) to improve athlete's performance is as follows: Nitrate by bacteria in saliva will be reduced to nitrite (NO_2^-). Furthermore, in the stomach nitrite will be reduced to nitric oxide (NO) (Shiva, et al., 2007; Lunberg, et al., 2008). It is known that NO is an important signaling molecule with a key role in several physiological processes that can affect sports performance such as regulating tissue blood flow, muscle contraction, mitochondrial biogenesis, and muscle glucose absorption (Stamler, et al., 2001). In addition, the increased blood flow originating from NO synthesis can increase the recovery of tissue processes (Bloomer, 2010).

CONCLUSION

The conclusion of the study was that the administration of beetroots juice during exercise could reduce MDA levels and increase athlete TAC and VO2max levels..

REFERENCES

Alessio, H.M., Hagerman, A.E., Fulkerson, B.K., Ambrose, J., Rice, R.E., Wiley, R.L., 2000, Generation of reactive oxygen species after exhaustive aerobic and isometric exercise. *Med Sci Sports Exerc*,32(9):1576-1581

Algul,S., Seda,U., Mehmet, K., 2018, Comparative evaluation of MDA levels during aerobic exercise in young trained and sedentary male subjects, *East J Med.* 23(2):98–101.

Ayala, A., Munoz, M.F., Arguelles, S., 2014, Lipid Peroxidation: Production, Metabolism, and Signaling Mechanisms of Malondialdehyde and 4-Hydroxy-2-Nonenal. *Oxidative Medicine and Cellular Longevity*, Article ID 360438;1-31

Azlina M.F.N., Kamisah Y, Qodriyah M.S., 2018, Tocopherol And Tocotrienol: Therapeutic Potential In Animal Models of Stress, *Current Drug Targets*, 19(12):1456-1462

Baird, MF., Scott M. G., Julien S.B., Gordon F.B., 2012, Creatine-Kinase- and Exercise-Related Muscle Damage Implications for Muscle Performance and recovery, *Journal of Nutrition and Metabolism*, Article ID 960363;1-13.

Bao L., Cai X, Wang J., Zhang Y., Sun B, Li Y., 2016, Anti-Fatigue Effects of Small Molecule Oligopeptides Isolated from Panax ginseng C. A. Meyer in Mice, *Nutrients*,13(8):2-11

Bailey S.J., Winyard P., Vanhatalo A., et al., 2009, Dietary nitrate supplementation reduces the O2 cost of lowintensity exercise and enhances tolerance to hight intensity exercise in humans, *Journal of Applied Physiology*, 107(4): 1144-1155

Bailey S.J., Fulford J, Vanhatalo A., et al., 2010, Dietary nitrate supplementation enhances muscle contractile efficiency during knee-extensor exercise in humans, *Journal of Applied Physiology*, 109: 135-148.

Belviranli, M., Gokbel, H., Okudan, N., 2012, Basarali,K. Effects of grape seed extract supplementation on exercise-induced oxidative stress in rats, *British Journal of Nutrition.* 108: 249–256

Beshel,F.N., Beshel, J.A., Ante, E.E., 2018, The Ethanolic Extract of Beetroot (Beta Vulgaris) Ameliorates Some Red Cell Parameters In Phenylhydrazine-Induced Anaemic Rats. *IOSR Journal of Nursing and Health Science*, 7(4):27-30

Bloomer, R.J., 2010, Nitric oxide supplements for sports, *J Strength Cond Res*, 32 (2): 14-20

Bulduk, E.O., Ergene, N., Baltaci, A.K., Gumuş, H., 2011, Plasma antioxidant responses and oxidative stress following a 20 meter shuttle run test in female volleyball players, *International Journal of Human Sciences*, 8(2):510-526

Burton, G.W., Traber, M.G., 1990, Vitamin E: antioxidant activity, biokinetics and bioavailability. *Annual Review of Nutrition*, 10: 357–382.

Castrogiovanni,P., Imbesi,R., 2012, Oxidative Stress and Skeletal Muscle in Exercise, *Italian Journal of Anatomi and Embriology*, 117(2):107-116

Chevion S., Moran D. S., Heled Y., Shani Y., Regrev G., Abbou B., Berenshtein E., Stadtman E.R., Epstein Y., 2003, Plasma antioxidant status and cell injury after severe physical exercise, *Proc.Nati.Acad.Sci.USA*, 100(9):5119-5123.

Chhikara, N., Kushwaha, K., Sharma, P., Gat, Y., Panghal, A., 2019, Bioactive Compounds of Beetroot and Utilization in Food Processing Industry: A Critical Review. *Food Chem*, 272: 192–200.

Christopher, P.I., Wenke, J.C., Nofal, T., Armstrong, R.B., 2004, Adaptation to lenghthening contraction-induced injury in mouse muscle, *J.Appl.Physiol* 97:1067-76.

Clifford.T., Glyn,H., Daniel J., Emma J. S., 2015, The Potential Benefits of Red Beetroot Supplementation in Health and Disease, *Nutrients.* 7: 2801–2822.

Daniel, R.M., Stelian, S., Dragomir, C., 2010, The effect of acute physical exercise on the antioxidant status of the skeletal and cardiac muscle in the Wistar rat, *Romanian Biotechnological Letters*, 15(3):56-61.

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Dekany, M., Nemeskeri, V., Gyore, I., Ekes, E., Gogl, A., Szots, G., Petrekanits, M., Taylor, A.W., Berkes,I., Pucsok, J., 2008, Physical performance and antioxidant effects Iin triathletes, *Biology of Sport*, 25:101-114.

Eroglu, Y., Daglioglu, O., 2013, The effect of submaximal exercise on oxidant and antioxidant mechanisms in judokas and sedentary, *International Journal of Sport Studies*, 3(5):480-486

Evans, W. J., 2000, Vitamin E, vitamin C, and exercise, *Am J Clin Nutr*, 72: 647S-52S.

Figueira,T.G., Magosso,R.F., Neto J.C, Carli, J.P.C., Pires, C.M.R., 2017, Creatine Kinase Response of Physically Active Young Men to One- and Two-Legged Cycling, *Journal of Exercise Physiology online*, 20(3):168-176.

Funes L., Carrera-Quintanar L., Cerdan-Calero M., Ferrer M D., Drobnic F., Pons A., Roche E., Micol V., 2011, Effect of lemon verbena supplementation on muscular damage markers, proinflammatory cytokines release and neutrophils' oxidative stress in chronic exercise. *European Journal of Applied Physiology*, 111(4):695–705.

Gamal, A.A., Mansour S. A., Mohammad R., Mohammed A., Shaza M.A., Ajaz A., Mohamed H., Mohammed A., Omer A.B., Syed R., 2014, Beetroot (Beta vulgaris L .) Extract Ameliorates Gentamicin-Induced Nephrotoxicity Associated Oxidative Stress, Inflammation, and Apoptosis in Rodent Model, *Mediators of Inflammation.* 2014:1-13

Georgiev, V.G., Weber, J., Kneschke., E.M., Denev., P.N., Bley., T., Pavlov, A.I., 2010, Antioxidant activity and phenolic content of betalain extracts from intact plants and hairy root cultures of the red beetroot Beta vulgaris cv. Detroit dark red, *Plant Foods Hum. Nutr*. 65:105–111.

Gomez-Cabrera M.C., Domenech E., Vina J., 2008, Moderate exercise is an antioxidant: upregulation of antioxidant genes by training, *Free Radic Biol Med*. 44:126–131

Hanum, Z., Handono, D.K., Nurdiana., Sriwahyuni, E., 2018, Pengaruh Ekstrak Bit Merah (Beta vulgaris L.) Terhadap VEGF, dan Ketebalan Endometrium Pada Tikus (Rattus norvegicus) Dipapar Asap Rokok, *Window of Health : Jurnal Kesehatan*, 1(3):133-140.

Ighodaro, O.M., Akinloye, O.A, 2018, First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid, *Alexandria Journal of Medicine*. 54 (2018) 287–293

Ji, L.L.,1999, Antioxidants and Oxidative stress in exercise, *Society for Experimental Biology and Medicine*, 283: 292.

Jowko, E., Dlugolecka, B., Makaruk, B., Cieslinki, I., 2015, The effect of green tea extract supplementation on exercise-induced oxidative stress parameters in male sprinters. *European Journal of Nutrition*, 54(5):783–791.

Joyner, M.J., Casey, D.P., 2015, Regulation of Increased Blood Flow (Hyperemia) to Muscles During Exercise, *A Hierarchy of Competing Physiological Needs*, 95(2):549–601.

Kalpana, K., Kusuma, D.L., Lal, P.R., Khanna, G.L., 2012, Effect of Spirulina on Antioxidant Status and Exercise-Induced Oxidative Stress of Indian Athletes in Comparison to a Commersial Antioxidant, *Asia Journal of Exercise & Sports Science*, 9(2):36-48

Kan, N. W., Huang, W.C., Lin, W.T., Huang, C.Y., Wen, K.C., Chiang, H.M., Hsu, M.C., 2013, Hepatoprotective effects of Ixora parviflora extract against exhaustive exercise-induced oxidative stress in mice, *Molecules*, 18(9):10721–10732.

Kanner, J., Harel, S., Granit, R., 2001, Betalains A New Class of Dietary Cationized Antioxidants. J. Agric. *Food. Chem*, 49:5178–5185

Kawamura, T., Muraoka, I., 2018, Exercise-Induced Oxidative Stress and the Effects of Antioxidant Intake from a Physiological Viewpoint, *Antioxidants* 7(119):1-19 doi:10.3390/antiox7090119

Kim, S. H., Park, K.S., Chang, M.J., Sung, S.H., 2005, Effects of Panax ginseng extract on exercise-induced oxidative stress, *The Journal of sports medicine and physical fitness*, 45(2): 178–82.

Koch, A.J., Pereira, R., Machado, M., 2014, The creatine kinase response to resistance exercise. *J Musculoskelet Neuronal Interact.* 14(1):68-77

Kujala, T.S., Vienola, M.S., Klika, K.D., Loponen, J.M., Pihlaja, K., 2002, Betalain and phenolic compositions of four beetroot (Beta vulgaris) cultivars. *Eur. Food. Res. Technol*, 214: 505–510.

Kujawska, M., Ignatowicz, E., Ewertowska, M., Markowski, J., Jodynis-Liebert, J., 2011, Cloudy apple juice protects against chemical-induced oxidative stress in rat, *European Journal of Nutrition*, 50(1):53–60. doi: 10.1007/s00394-010-0114-y

Kujawska, M., Ignatowicz., E., Murias, M., Ewertowska, M., Mikolajczyk, K., Jodynis-Liebert, J., 2009, Protective effect of red beetroot against carbon tetrachloride- and N-nitrosodiethylamine-induced oxidative stress in rats, *J. Agric. Food Chem*, 57:2570-2575.

Kuzniak,V.K., Szaefer,H., EwaIgnatowicz., Adamska,T., Dubowska,W., 2012, Beetroot juice protects against *N*-nitrosodiethylamine-induced liver injury in rats. *Food and Chemical Toxicology*, 50(6):2027-2033

Lansley K. E., Winyard P. G., Bailey S.J., et al., 2011, Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance. *American College Sport of Medicine*. 43(6):1125-1131.

Lim,T.K., 2016, *Edible Medicinal and Non-Medicinal Plants*. Springer, Dordrecht.26-68

Liu, C.C., Huang,C.C., Lin,W.T., Hsieh,C.C., Lin,S.J., Yang,S.C., 2005, Lycopene supplementation attenuated xanthine oxidase and myeloperoxidase activities in skeletal muscle tissues of rats after exhaustive exercise. *British Journal of Nutrition*. (94):595-601

Liu,R., Wu, L., Du, Q., Ren, J.W., Chen, Q.H., Li, D., Mao, R.X., Liu, X.R. Li,Y., 2019, Small Molecule Oligopeptides Isolated from Walnut (Juglans regia L.) and Their Anti-Fatigue Effects in Mice. *Molecules*, 24(45):2-15

Liudong,F., Feng, Z.,Daoxing, S., Xiufang, Q., Xiaolong, F., Haipeng, L., 2011, Evaluation of antioxidant properties and anti- fatigue effect of green tea polyphenols. *Scientific Research and Essays*, 6 (13):2624-2629

Lu, X., Wang, Y., Zhang, Z., 2009, Radioprotective activity of betalains from red beets in mice exposed to gamma irradiation. *Eur. J. Pharmacol.* 615(1-2): 223–227

Lundberg, J.O., Carlstrom., M., Larsen, F.J., Weitzberg, E., 2011, Roles of dietary inorganic nitrate in cardiovascular health and disease. *Cardiovas Res*. 89: 525–532.

Mcfarlin, B.K., Adam S. V., Andrea L. H., Jill N. B., Kathryn P., Jakob L. Vingren., David W. H., 2016, Reduced in fl ammatory and muscle damage biomarkers following oral supplementation with bioavailable curcumin. *BBACLI* 5:72–78.

Moflehi, D., Kok, L.Y., Fadilah, T., Amri, S., 2013, Effect of Single-Session Aerobic Exercise with Varying Intensities on Lipid Peroxidation and Muscle-Damage Markers in Sedentary Males. *Global Journal of Health Science*, 4(4)48-54

Nemes, R., Koltai, E., Taylor, A.W., Suzuki, K., Gyori, F dan Radak, Z., 2018, Reactive Oxygen and Nitrogen Species Regulate Key Metabolic, Anabolic, and Catabolic Pathways in Skeletal Muscle. *Antioxidants*, 7(85):1-13. doi:10.3390/antiox7070085

Ninfali, P., Angelino, D., 2013, Nutritional and functional potential of Beta vulgaris cicla and rubra. *Fitoterapia*, 89: 188-199

Ostojic, S.M., Stojanovic, M.D., Djordjevic, B., Jourkesh, M., Vasiljevic, N., 2008, The Effect of a 4-Week Coffeberry Suplementation on Antioxidant Status, Endurance, and Anaerobic Performance in College Athletes. *Research in Sports Medicine*, 16: 281-294

Phaniendra, Jestadi, D.B., Periyasamy, L., 2015, Free Radicals: Properties, Sources, Targets, and Their Implication in Various Diseases, *Indian Journal of Clinical Biochemistry*

30(1):11–26.

Parisi, A., Trachita, E., Duranti, G., Ciminelli, E., Quaranta, F., Ceci, R., Cerulli, C., Sabatini, S., 2010, Effects of chronic rhodiola rosea supplementation on sport performance and antioxidant capacity in trained male. *Journal of Sports Medicine and Physical Fitness*, 50(1):57–63.

Pietrzkowski, Z., Nemzer, B., Sprna, A., Stalica, P., Tresher, W., Keller, R, Jiminez, R., Michalowski, T., Wybraniec, S., 2010, Influence of betalinrich extracts on reduction of discomfort associated with osteoarthritis, *New Med*, 1:12-17

Pingitore, A., Lima, G.P.P., Mastorci, F., Quinones, A., Iervasi, G. Vassalle, C., 2015, Exercise and oxidative stress: Potential effects of antioxidant dietary strategies in sports." *Nutrition* 31(7–8):916–22

Qazi, M.A., Molvi,K.I., 2018, Free Radicals and their Management. *Am. J. Pharm Health Res*. 6(04);1-13

Rosidi, A., Khomsan, A., Setiawan, B., Riyadi, H and Briawan, D., 2013, Effect of Temulawak (Curcumin xanthorrhiza Roxb) Extract on Reduction Of MDA (Malondialdehyde) Levels of Football Athletes, *Pakistan Journal of Nutrition.* 12 (9):842-850

Santos-Silva, A., Rebelo, M.I., Castro, E.M., Belo, L., Guerra, A., Rego, C., Quintanilha, A. 2001, Leukocyte activation, erythrocyte damage, lipid profile and oxidative stress imposed by high competition physical exercise in adolescents, *Clin. Chim. Acta*, 306, 119-126.

Shiva S., Huang Z., Grubina R., Sun J., Ringwood L.A, MacArthur P.H., Xu, X., Murphy, E., Darley-Usmar, V.M., Gladwin M. T., 2007, Deoxymyoglobin is a nitrite reductase that generates nitric oxide and regulates mitochondrial respiration. *Circ Res*. 100:654–61.

Silalahi, J. (2006). *Makanan Fungsional*, Penerbit Kanisius Yogyakarta. 38-56

Simioni, C., Zauli, G., Martelli, A.M., Vitale, M., Sacchetti, G., Gonelli, A., Neri, L.M., 2018, Oxidative stress: role of physical exercise and antioxidant nutraceuticals in adulthood and aging, *Oncotarget* 9(24):17181–98.

Sinaga, F.A., 2012, Pengaruh Pemberian Vitamin E Terhadap Kadar Malondialdehid, Hemoglobin dan VO_2Max Selama Latihan Pada Atlet Sepakbola FIK UNIMED. *Jurnal Penelitian Saintika*, 12(2):153-164

Sinaga, F.A., 2013, Pengaruh Pemberian *Virgin Coconut Oil* (VCO) Terhadap Parameter Hematologi, Kadar Malondialdehid dan Daya Tahan Tikus (*Rattus Norvegicus Galur Sprague Dawley*) Pada Aktifitas Fisik Maksimal. *Proceeding, International Scientific Seminar On Sport And Sportsciences*, 978-602-98603-9-9: 226-238

Sinaga, F.A., 2015, The Effect of red fruit oil on rat's malondialdehide at maximal physical avtivity. *Proceeding international conference of ASEAN Council of Physical Education and Sports (ACPES) 2015.* ISBN 978-979-1964-4-2:379-385

Sinaga, F. A., Risfandi,M., Mesanan., Jumadin, I.P., 2017, The Effect of Red Fruit Oil on Hematological Parameters and Endurance Performance at the Maximal Physical Activity. *International Journal of Science and Research (IJSR)*, 6 (5):155-158

Sinaga, F.A., Susanti,N., 2018, The influence of red fruit (*Pandanus conoideus* Lam.) Oil on glutathione peroxidase level at maximum physical activity, *Asian J Pharm Clin Res*, 11(1)103-106

Sinaga, F.A., Purba, P., 2018, The Influence of Red Fruit Oil on Creatin Kinase Level at Maximum Physical Activity. *Journal of Physics*: Conf. Series 970: 012007.

Sinaga, F.A., Harahap, U., Silalahi, J., Sipahutar, H., 2019, Antioxidant and hepatoprotective effect of virgin coconut oil at physical maximum activity. *Asian J Pharm Clin Res*, 12(3);272-276

Stankovic, M., Radovanovic, D. ,2012, Oxidative Stress and Physical Activity, *SportLogia*, 8(1):1-20

Taju, G., Jayanthi, M., Majeed, S.A., 2011, Evaluation of Hepatoprotective and Antioxidant

activity of Psidium Guajava Leaf Extract against Acetaminophen Induced Liver Injury in Rats, *International Journal of Toxicology and Applied Pharmacology*. 1(2):13-20

Tesoriere, L., Fazzari, M., Angileri, F., Gentile, C., Livrea, M.A., 2008, In vitro digestion of betalainic foods. Stability and bioaccessibility of betaxanthins and betacyanins and antioxidative potential of food digesta, *J. Agric. Food. Chem.* 56: 10487-10492

Thirumalai, T., Viviyan T. S., Elumalai, E.K., David, E., 2011, Intense and exhaustive exercise induce oxidative stress in skeletal muscle, *Asian Pacific Journal of Tropical Disease* 63-66

Urso, M.L., Clarkson, P.M., 2003, Oxidative stress, exercise, and antioxidant supplementation, *Toxicology*, 189(1-2):41-54

Vyas, N., Tailang, M., Gavatia, N.P., Gupta, B.K., 2010, Antioxidant Potential Of Psidium Guajava Linn. International Journal of PharmTech Research, 2(1):417-419

Vina J, Gomez-Cabrera M.C., Lloret A., Marquez, R., Minana, J.B., Pallardo, F.V., 2000, Free radicals in exhaustive physical exercise: mechanism of production and protection by antioxidants. *IUBMB Life*, 50: 271–7.

Wink, D.A., Miranda, K.M., Espey., M.G., Pluta, R.M., Hewett, S.J., Colton, C., Vitek, M., Feelisch, M., Grisham, M.B., 2001, Mechanisms of the antioxidant effects of nitric oxide, *Antioxid. Redox Signal*, 3: 203–213

Winkler, C., Wirleitner, B., Schroecksnadel, K., 2005, In vitro effects of beet root juice on stimulated and unstimulated peripheral blood mononuclear Cells, *Am. J. Biochem. Biotechnol*, 1:180.

Wootton-Beard, P.C., Ryan, L., 2011, A beetroot juice shot is a significant and convenient source of bioaccessible antioxidants. *J. Funct. Foods* 3, 329–334.

Xu, M, Liang, R., Li, Y., Wang, J., 2017, Anti-fatigue effects of dietary nucleotides in mice, *Food & Nutrition Research* 61(1):1334485.

Yavari, A., Javadi, M., Mirmiran, P., Bahadoran, Z., 2015, Exercise-Induced Oxidative Stress and Dietary Antioxidants, *Asian J Sports Med.* 6(1):1-7

Zhao, G., He, F., Wu, C., Li, P., Li, N., Deng, J., Zhu, G., Ren, W., Peng,Y., 2018, Betaine in inflammation: Mechanistic Aspects and Applications, *Frontiers in Immunology*, 9(1070):1-13

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Effect of beetroot juice (*Beta vulgaris* L) supplementation on malondialdehyde levels and antioxidant status in athletes

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ABSTRACT

Severe physical activity can cause lipid peroxidation marked by increased levels of malondialdehyde (MDA) and decreased levels of antioxidants which can reduce the performance and health of athletes. Lipid peroxidation can be prevented or reduced by antioxidant supplementation. Beetroot (Beta vulgaris L) contains various types of natural antioxidants but has not been investigated for its efficacy to reduce lipid peroxidation that is triggered by physical activity. The purpose of this study was to determine the effect of beetroot juice on malondialdehyde level and antioxidant status when performing maximum physical activity. This type of research is an experimental study with a randomized pre-test-post-test group design. The research sample was 30 students of Sports Science who met the criteria. Pretest is done by checking MDA levels, Total Antioxidant Capacity (TAC) and VO_2max. Furthermore the sample was divided into two groups: experimental (beetroot juice, n= 15) and control (placebo, n=15). Subjects trained for four weeks by consuming 250 mL of juice 1 hours prior to training. Then all samples performed maximum physical activity using bleep tests, and MDA, TAC and VO2max levels were re-examined. The results showed a decrease in MDA levels as well as an increase in TAC and VO_2max levels in the training group who were given 250ml beet juice compared with the control group ($p < 0.05$). The conclusion of the study was that the administration of beetroot juice during exercise could reduce MDA levels and increase athlete TAC and VO_2max levels.

Keywords: beetroot juice, malondialdehyde, antioxidants, maximum physical activity, exercise

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INTRODUCTION (11pt)

Exercise induces various physiological changes of different magnitude and direction, depending on the characteristics do exercises and at the level of fitness and training the subject. During strenuous exercise, oxygen flux can increased by 100-200-fold due to an increase in metabolism in the body (Joyner and Casey, 2015). Increased use of oxygen mainly by muscles contracting, causing an increase in electron leakage from the mitochondria which will become reactive oxygen compounds (Nemes, et al., 2018). Generally 2-5% of oxygen used in metabolic processes in the body will become superoxid ions so that during heavy physical activity an increase in free radical production occurs (Simioni, et al., 2018). When free radical production exceeds cellular defense antioxidants, oxidative stress can occur, where one of the contributing factors is physical activity (Daniel et al, 2010; Kawamura and Muraoka, 2018). Under conditions of oxidative stress, free radicals will oxidize lipids and damage the organization of cell membranes (Ayala, et al, 2014, Evans, 2000). Malondialdehyde (MDA) is one of the results of lipid peroxidation induced by free radicals during maximal physical exercise or endurance training with high intensity (Liu, et al., 2019; Bao, et al., 2016, Xu, et al., 2017) so that MDA is a general indicator used to determine the amount of free radicals and indirectly assess the body's oxidant capacity (Liu, et al., 2019)

The results showed that maximum physical activity can cause a decrease in the antioxidant levels of the enzyme superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and glutathione-S-transferase in the gastrocnemius muscle (Thirumalai, 2011). Meanwhile, Bulduk et al (2011) reported that volleyball athletes who run a 20 meter shuttle run can cause lipid peroxidation which is marked by an increase in MDA levels and a decrease in CAT and GPx antioxidant levels.

Decreased antioxidant levels and increased CK and lipid peroxidation due to maximum and sub-maximal physical activity can be prevented by optimizing nutrition, especially by increasing antioxidant content (Simioni, et al., 2018; Pingitore, et al., 2015; Kim, et al., 2017). Accordingly, Gomez (2008) said oxidative damage due to physical activity might be prevented by optimizing nutrition, especially by increasing the antioxidant content of food. According to Silalahi (2006) the efficacy of antioxidants will be more effective when consuming antioxidant-rich vegetables or fruits of various types rather than using a single antioxidant such as vitamin E. This may be due to the presence of other components and their interactions in vegetables and fruit those that play a positive role.

One alternative natural ingredient that has antioxidant content is red beetroot (*Beta vulgaris L*). Red beetroot is known to have betalains content which is a compound that has a very high antioxidant that is able to neutralize free radicals (Clifford, et al., 2015). Other compounds in red beetroots that function as antioxidants are betaine (Zhao, et al., (2018), vitamin C, carotenoids, phenolic acids such as and flavonoids (Georgiev, et al., 2010; Kujala, el., (2002); Wootton-Beard, et al., 2011). Phenolic acid compounds in red beetroots include ferulic acid, caffeic acid, p-coumaric acid, syringic acid, and vanillic acid (Chhikara, et al., 2019). A number of studies report that beetroot, in the form of a juice supplement, protects against oxidative damage to DNA, lipid and protein structures *in vitro* (Pietrzkowski et al., 2010; Kujawska et al., 2009; Winkler et al., 2005).

The specialty of redroot beet which has various types of antioxidants makes researchers feel interested and need to examine the antioxidant effect of red beetroot juice on MDA level and antioxidant status in maximum physical activity.

MATERIALS AND METHOD

Materials

Red beetroot (Beta vulgaris L) obtained from the Medan MMTC market, 1% EDTA solution, Aquadest, MDA Kit and TAC purchased from Shanghai Korain Biotech Co., Ltd (Shanghai, China).

Tool

Spectrophotometer (Shimadzu), glassware, spuit, juicer, marking cones, measuring tape (≥20m), multistage fitness test audio CD or MP3, CD or MP3 player with loud speaker (volume of speaker is particularly important), performance recording sheet

Methods

Participants

The study used 30 sports science students with criteria of having a good VO_2max level, male sex, age 20-22 years, having a good Body Mass Index (BMI), not smoking, not taking supplements and antioxidants 2 weeks before and during the study.

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Research Implementation

All subjects were subjected to hematological examination to measure MDA and TAC levels after the athlete had maximal physical activity by performing a beep test (pretest). Furthermore, athletes are divided into 2 groups: experimental (beetroot juice, n= 15) and control (placebo, n=15). Subjects trained for four weeks by consuming 250 mL of juice 1 hours prior to training. Then after one month, all athletes perform maximum physical activity by doing a beep test. Furthermore, a hematologic examination was performed again to measure MDA and TAC (posttest) levels.

MDA and TAC determination

Before and after treatment, blood (5 mL) was collected from the antecubital vein with a needle and placed in test tubes containing an anticoagulant substance. This was taken to the laboratory to measure the MDA and TAC. Serum MDA and TAC analysis was the enzyme-linked immunosorbent assay (ELISA) colorimetric method. Inspection procedures by following the procedures set out in each MDA and TAC kit.

Data Analysis

All data were analyzed using SPSS 25 Statistical Software. The Paired Sample t-test was used for comparison within groups and Independent Sample t-test was used for comparison between groups. Statistical significance (P) was set at 0.05.

RESULT AND DISCUSSION

The Effect of Beetroot Juice (Beta Vulgaris L) on Malondialdehyde Levels

Based on the results of the research, the pretest malondialdehyde (MDA) level in the treatment group was 1.98 ± 0.37 nmol/ml, while the control group was 2.11 ± 0.24 nmol/ml. The results of the analysis using the independent t test showed that there were no differences in pretest MDA levels between the treatment group and the control group. The results of measurement of MDA levels in the posttest treatment group were 5.75 ± 0.51 nmol/ml, while the control group obtained MDA levels 10.69 ± 0.97 nmol/ml. The results of the analysis using the Paired Sample t-test obtained differences in the levels of pre-test-post-test MDA treatment groups and control groups (p=0,000). Statistical test results with Independent Sample t-test obtained a significant difference in post-test MDA levels between the treatment and control groups (p = 0,000).

In the study obtained MDA levels in the group that was not given beetroot juice was greater than the group given beetroot juice. High levels of MDA in the group that were not given beetroot juice shows that during maximum physical activity will produce free radicals that oxidize cell membranes (Figure 1).

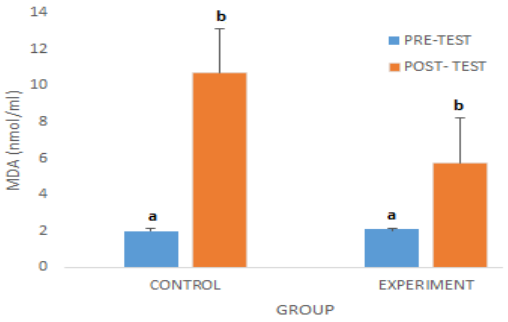

Figure 1. Effect of beetroot juice supplementation on malondialdehyde level. Data are mean ± SD for *n* = 15 in each group. Different letters indicate significant difference at $p < 0.05$ by paired samples-t test.

The results of this study are supported by several study results, that acute aerobic physical activity contributes to oxidative stress especially when exercising with high intensity. Two mechanisms that cause oxidative stress in high-intensity aerobic exercise are increased pro-oxidants through the effect of increasing oxygen consumption 10 to 15 times compared to rest and relatively insufficient antioxidants compared to pro-oxidants (Alessio, et al., 2000). Meanwhile according to Ji (1999), during maximum physical activity oxygen consumption throughout the body increases to 20 times, while oxygen consumption in muscle fibers is estimated to increase to 100 times. Under conditions of oxidative stress, free radicals will cause lipid peroxidation of cell membranes and damage the organization of cell membranes (Evans, 2000). Increased levels of MDA triggered by physical activity have been reported by many researchers including Moflehi, (2012) who examined the effect of aerobic exercise with different intensities (low intensity; moderate and high) on increasing levels of MDA and CK in people who are not athletes. The results of this study indicate that the higher the intensity of exercise the greater the MDA level. In this study, aerobic exercise for 20 minutes with an intensity of 80% can increase MDA levels compared to controls (9.09 ± 2.08 Vs 2.69 ± 1.32µmol/L). Meanwhile, research conducted by Bulduk, et al., (2011) reported that volleyball athletes who carried out a 20 meter shuttel run test with VO_2max levels of 41.78 ± 4.91ml/kg/min turned out to increase MDA levels from 1.41 ± 0.30 nmol/ml to 2.06 ± 0.08 nmol/ml, while non-athletes with VO_2max levels of 26.91 ± 3.67 ml/kg/min, MDA levels increased from 0.94 ± 0.24 ml/kg/min to 1.10 ± 0.21 ml/kg/min. Giving beetroot juice during exercise in this study can reduce MDA levels when athletes perform maximum physical activity when compared with MDA levels in the control group. The decrease in MDA levels is due to the antioxidant content found in beets (Beta Vulgaris L). It is known, beets contain antioxidants including phenolic compounds, flavonoids, vitamin C, carotenoids and betalains. Betalains contained in beets are betacyanin and betaxhantine (Ninfali and Angelino, 2013; Georgiev, et al., 2010; Kujala, 2002). Some in vitro research results show betalains pigments can protect cellular components from oxidative injury (Kanner, et al., 2001; Reddy, et al., 2005; Tesoriere, et al., 2008). For example, in the study by Kanner et al two betalains metabolites (betanin and betanidin) were shown to reduce linoleic damage caused by cytochrome C oxidase and lipid membrane oxidation induced by metmyoglobin-activated H_2O_2 and free iron (AA-Fe). The authors also report that betanine, the most abundant betalains found in beets (300-600 mg/kg), is the most effective inhibitor of lipid peroxidation. High antioxidant activity of betanin is thought to originate from its extraordinary electron donation capacity and ability to diffuse radicals that very reactive that targets cell membranes (Kanner, 2001) In addition, beets also contain NO_3

compounds (nitrates) which have been shown to suppress the formation of free radicals such as superoxide and hydrogen peroxide (Lundberg, et al., 2011; Wink, et al., 2001).

The Effect of Beet Juice (Beta Vulgaris L) on Total Antioxidant Capacity (TAC)

Based on the research results obtained pre-test TAC levels in the treatment group were 1.53 ± 0.06 U/ml, while the control group 1.50 ± 0.13 U/ml. The results of the analysis using the independent t-test showed that there were no differences in pre-test TAC levels between the treatment group and the control group. The results of the measurement of the TAC post-test of the treatment group were 3.39 ± 0.08 U/ml, while the control group obtained TAC levels of 2.46 ± 0.11 U/ml. The results of the analysis using the Paired Sample t-test obtained differences in pre-test-post-test TAC levels in the treatment group or in the control group (p = 0,000). Statistical test results with Independent Sample t-test obtained significant differences in posttest TAC levels between the treatment and control groups (p = 0,000).

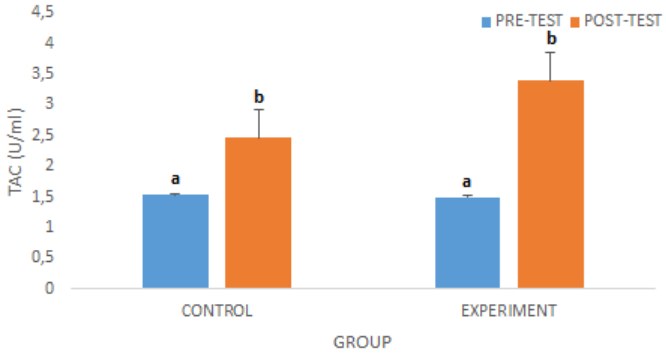

Figure 2. Effect of beetroot juice supplementation on TAC level. Data are mean ± SD for *n* = 15 in each group. Different letters indicate significant difference at *p* < 0.05 by paired samples-t test.

In Figure 2 shows the administration of beetroot juice can increase TAC levels when compared to the control group. Increased levels of TAC due to beetroot juice is due to the antioxidant content of beets such as betaine, phenol compounds, flavonoids, vitamin C, carotenoin and betalains. Betalains contained in beets are betacyanin and betaxhantine (Ninfali and Angelino, 2013; Georgiev, et al., 2010; Kujala, 2002). The results of this study are supported by research conducted by Kujawska, et al who investigated the potential protective effect of beet juice in an oxidative stress model induced by N-nitrosodiethylamine (NDEA) and carbon tetrachloride (CCl_4). In his study male Wistar rats were given beetroot juice per os, 8 mL kg/day for 28 days, and one by one dose of xenobiotics: 150 mg/kg NDEA or 2 ml/kg CCl_4. Simultaneously, two groups of mice that were not given juice were given each xenobiotic. The rate of microsomal lipid peroxidation in the liver, expressed as TBARS concentration, increased several-fold in mice given only NDEA or CCl_4. TBARS was reduced by 38% only in rats treated with beetroot juice before CCl_4 administration. Beetroot juice can also increase the antioxidant activity of superoxid dismutase (SOD), gluthation peroxidase (GPx), catalase (CAT) and glathatione reductase (Kujawska, et al., 2009). The results of the study were also supported by research conducted by Lu, et al., (2009). In his research investigated the radioprotective activity of betalains from red beetroots in rats irradiated by light (60) Co gamma (gamma) (6.0 Gy, at a dose of 1.5 Gy min (-1)). Rats were

randomly divided into five groups, namely the control group and four experimental groups which were given one of four betalains concentrations of red beetroots (0, 5, 20 and 80 mg/kg for 30 days. The four groups of experimental mice were then exposed to gamma Co (ray) 60 and betalains was given from red beets for the next 3 days.The results of the study showed that administration of betalains from red beetroots was radioprotective in mice irradiated by (60) Co in vivo. The underlying mechanism was thought to be mediated by the antioxidant activity of betalain from red beetroots and modulation immune system.

Effect of Giving Beet Juice (Beta Vulgaris L) on VO_2max

Based on the results of the study obtained levels of VO_2max pre-test in the treatment group was 47.59 ± 0.44 ml/kg/min, while the control group was 47.75 ± 0.53 ml/ kg/min. The results of the analysis using the independent samples t-test showed that there were no differences in pre-test VO_2max levels between the treatment group and the control group. The results of the measurement of VO_2max levels post-test of the treatment group were 52.95 ± 0.57 ml/kg/min, while the control group obtained VO_2max levels of 50.53 ± 0.87 ml/kg/min. The results of the analysis using the Paired Sample t-test obtained differences in the levels of VO_2max pre-test-post-test treatment group or control group (p = 0,000). Statistical test results with independent samples t-test obtained a significant difference in post-test VO_2max levels between the treatment and control groups (p=0,000).

In Figure 3 shows the administration of beetroots juice during exercise can increase VO_2max when compared to the control group. This increase in VO_2max occurs due to nitrate content and antioxidant content possessed by beetroots. The results showed 500 ml of beetroot juice containing nitrates as much as 5.1-6.2 mmol (Bailey, et al., 2009; Lansey, et al., 2011). Beet tubers have been shown to affect pulmonary oxygen uptake (VO_2). The results of research conducted on 7 adult men (19-38 years) mentioned the consumption of inorganic nitrates (5.1 mmol nitrate/day) in the form of 500 ml beetroot juice for 6 days can reduce pulmonary oxygen uptake (VO_2) in exercise intensity severe so that it can delay fatigue time (Bayley, et al., 2010).

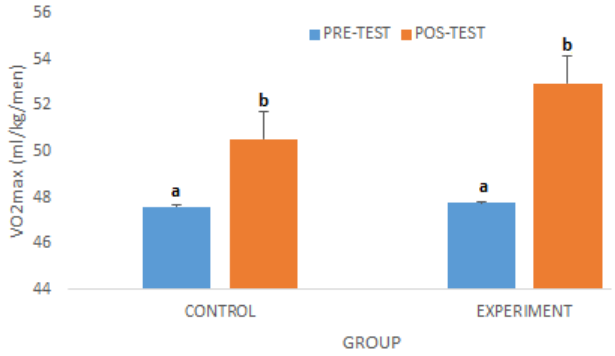

Figure 3. Effect of beetroot juice supplementation on VO_2max. Data are mean ± SD for n = 15 in each group. Different letters indicate significant difference at $p < 0.05$ by paired samples-t test.

The mechanism of action of nitrate (NO_3^-) to improve athlete's performance is as follows: Nitrate by bacteria in saliva will be reduced to nitrite (NO_2^-). Furthermore, in the stomach nitrite will be reduced to nitric oxide (NO) (Shiva, et al., 2007; Lunberg, et al., 2008). It is known that NO is an important signaling molecule with a key role in several physiological processes that can affect

sports performance such as regulating tissue blood flow, muscle contraction, mitochondrial biogenesis, and muscle glucose absorption (Stamler, et al., 2001). In addition, the increased blood flow originating from NO synthesis can increase the recovery of tissue processes (Bloomer, 2010).

CONCLUSION

The conclusion of the study was that the administration of beetroots juice during exercise could reduce MDA levels and increase athlete TAC and VO2max levels.

Tambahkan Acknowledgment

REFERENCES

Alessio, H.M., Hagerman, A.E., Fulkerson, B.K., Ambrose, J., Rice, R.E., & Wiley, R.L. (2000). Generation of reactive oxygen species after exhaustive aerobic and isometric exercise. *Med Sci Sports Exerc*,32(9):1576-1581

Algul,S., Seda,U., & Mehmet, K. (2018). Comparative evaluation of MDA levels during aerobic exercise in young trained and sedentary male subjects, *East J Med.* 23(2):98–101.

Ayala, A., Munoz, M.F., & Arguelles, S. (2014). Lipid Peroxidation: Production, Metabolism, and Signaling Mechanisms of Malondialdehyde and 4-Hydroxy-2-Nonenal. *Oxidative Medicine and Cellular Longevity*, Article ID 360438;1-31

Azlina M.F.N., Kamisah Y., & Qodriyah M.S. (2018). Tocopherol And Tocotrienol: Therapeutic Potential In Animal Models of Stress, *Current Drug Targets*, 19(12):1456-1462

Baird, MF., Scott M. G., Julien S.B., & Gordon F.B. (2012). Creatine-Kinase- and Exercise-Related Muscle Damage Implications for Muscle Performance and recovery, *Journal of Nutrition and Metabolism*, Article ID 960363;1-13.

Bao L., Cai X, Wang J., Zhang Y., & Sun B, Li Y. (2016). Anti-Fatigue Effects of Small Molecule Oligopeptides Isolated from Panax ginseng C. A. Meyer in Mice, *Nutrients*,13(8):2-11

Bailey S.J., Winyard P., & Vanhatalo A., et al. (2009). Dietary nitrate supplementation reduces the O2 cost of lowintensity exercise and enhances tolerance to hight intensity exercise in humans, *Journal of Applied Physiology*, 107(4): 1144-1155

Bailey S.J., Fulford J., & Vanhatalo A., et al. (2010). Dietary nitrate supplementation enhances muscle contractile efficiency during knee-extensor exercise in humans, *Journal of Applied Physiology*, 109: 135-148.

Belviranli, M., Gokbel, H., & Okudan, N. (2012). Basarali,K. Effects of grape seed extract supplementation on exercise-induced oxidative stress in rats, *British Journal of Nutrition.* 108: 249–256

Beshel,F.N., Beshel, J.A., & Ante, E.E. (2018). The Ethanolic Extract of Beetroot (Beta Vulgaris) Ameliorates Some Red Cell Parameters In Phenylhydrazine-Induced Anaemic Rats. *IOSR Journal of Nursing and Health Science*, 7(4):27-30

Bloomer, R.J. (2010). Nitric oxide supplements for sports, *J Strength Cond Res*, 32 (2): 14-20

Bulduk, E.O., Ergene, N., Baltaci, A.K., & Gumuş, H. (2011). Plasma antioxidant responses and oxidative stress following a 20 meter shuttle run test in female volleyball players, *International Journal of Human Sciences*, 8(2):510-526

Burton, G.W., & Traber, M.G. (1990). Vitamin E: antioxidant activity, biokinetics and bioavailability. *Annual Review of Nutrition*, 10: 357–382.

Castrogiovanni,P., & Imbesi,R. (2012). Oxidative Stress and Skeletal Muscle in Exercise, *Italian Journal of Anatomi and Embriology*, 117(2):107-116

Chevion S., Moran D. S., Heled Y., Shani Y., Regrev G., Abbou B., Berenshtein E., Stadtman E.R., & Epstein Y. (2003). Plasma antioxidant status and cell injury after severe physical exercise, *Proc.Nati.Acad.Sci.USA*, 100(9):5119-5123.

Commented [_2]: Sitasi dan penulisan referensi mohon dituliskan dengan Mendeley style APA

Chhikara, N., Kushwaha, K., Sharma, P., Gat, Y., & Panghal, A. (2019). Bioactive Compounds of Beetroot and Utilization in Food Processing Industry: A Critical Review. *Food Chem*, 272: 192–200.

Christopher, P.I., Wenke, J.C., Nofal, T., & Armstrong, R.B. (2004). Adaptation to lenghthening contraction-induced injury in mouse muscle, *J.Appl.Physiol* 97:1067-76.

Clifford.T., Glyn,H., Daniel J., & Emma J. S. (2015). The Potential Benefits of Red Beetroot Supplementation in Health and Disease, *Nutrients.* 7: 2801–2822.

Daniel, R.M., Stelian, S., & Dragomir, C. (2010). The effect of acute physical exercise on the antioxidant status of the skeletal and cardiac muscle in the Wistar rat, *Romanian Biotechnological Letters*, 15(3):56-61.

Dekany, M., Nemeskeri, V., Gyore, I., Ekes, E., Gogl, A., Szots, G., Petrekanits, M., Taylor, A.W., Berkes,I., & Pucsok, J. (2008). Physical performance and antioxidant effects Iin triathletes, *Biology of Sport*, 25:101-114.

Eroglu, Y., & Daglioglu, O. (2013). The effect of submaximal exercise on oxidant and antioxidant mechanisms in judokas and sedentary, *International Journal of Sport Studies*, 3(5):480-486

Evans, W. J. (2000). Vitamin E, vitamin C, and exercise, *Am J Clin Nutr*, 72: 647S-52S.

Figueira,T.G., Magosso,R.F., Neto J.C, Carli, J.P.C., & Pires, C.M.R. (2017). Creatine Kinase Response of Physically Active Young Men to One- and Two-Legged Cycling, *Journal of Exercise Physiology online*, 20(3):168-176.

Funes L., Carrera-Quintanar L., Cerdan-Calero M., Ferrer M D., Drobnic F., Pons A., Roche E., & Micol V. (2011). Effect of lemon verbena supplementation on muscular damage markers, proinflammatory cytokines release and neutrophils' oxidative stress in chronic exercise. *European Journal of Applied Physiology*, 111(4):695–705.

Gamal, A.A., Mansour S. A., Mohammad R., Mohammed A., Shaza M.A., Ajaz A., Mohamed H., Mohammed A., Omer A.B., & Syed R. (2014). Beetroot (Beta vulgaris L .) Extract Ameliorates Gentamicin-Induced Nephrotoxicity Associated Oxidative Stress, Inflammation, and Apoptosis in Rodent Model, *Mediators of Inflammation.* 2014:1-13

Georgiev, V.G., Weber, J., Kneschke., E.M., Denev., P.N., Bley., T., & Pavlov, A.I. (2010). Antioxidant activity and phenolic content of betalain extracts from intact plants and hairy root cultures of the red beetroot Beta vulgaris cv. Detroit dark red, *Plant Foods Hum. Nutr*. 65:105–111.

Gomez-Cabrera M.C., Domenech E., & Vina J. (2008). Moderate exercise is an antioxidant: upregulation of antioxidant genes by training, *Free Radic Biol Med*. 44:126–131

Hanum, Z., Handono, D.K., Nurdiana., & Sriwahyuni, E. (2018). Pengaruh Ekstrak Bit Merah (Beta vulgaris L.) Terhadap VEGF, dan Ketebalan Endometrium Pada Tikus (Rattus norvegicus) Dipapar Asap Rokok, *Window of Health : Jurnal Kesehatan*, 1(3):133-140.

Ighodaro, O.M., & Akinloye, O.A. (2018). First line defence antioxidants-superoxide dismutase (SOD), catalase (CAT) and glutathione peroxidase (GPX): Their fundamental role in the entire antioxidant defence grid, *Alexandria Journal of Medicine.* 54 (2018) 287–293

Ji, L.L. (1999). Antioxidants and Oxidative stress in exercise, *Society for Experimental Biology and Medicine*, 283: 292.

Jowko, E., Dlugolecka, B., Makaruk, B., & Cieslinki, I. (2015). The effect of green tea extract supplementation on exercise-induced oxidative stress parameters in male sprinters. *European Journal of Nutrition*, 54(5):783–791.

Joyner, M.J., & Casey, D.P. (2015). Regulation of Increased Blood Flow (Hyperemia) to Muscles During Exercise, *A Hierarchy of Competing Physiological Needs*, 95(2):549–601.

Kalpana, K., Kusuma, D.L., Lal, P.R., & Khanna, G.L. (2012). Effect of Spirulina on Antioxidant Status and Exercise-Induced Oxidative Stress of Indian Athletes in Comparison to a Commersial Antioxidant, *Asia Journal of Exercise & Sports Science*, 9(2):36-48

Kan, N. W., Huang, W.C., Lin, W.T., Huang, C.Y., Wen, K.C., Chiang, H.M., & Hsu, M.C. (2013). Hepatoprotective effects of Ixora parviflora extract against exhaustive exercise-induced oxidative stress in mice, *Molecules*, 18(9):10721–10732.

Kanner, J., Harel, S., & Granit, R. (2001). Betalains A New Class of Dietary Cationized Antioxidants. J. Agric. *Food. Chem*, 49:5178–5185

Kawamura, T., & Muraoka, I. (2018). Exercise-Induced Oxidative Stress and the Effects of Antioxidant Intake from a Physiological Viewpoint, *Antioxidants* 7(119):1-19 doi:10.3390/antiox7090119

Kim, S. H., Park, K.S., Chang, M.J., & Sung, S.H. (2005). Effects of Panax ginseng extract on exercise-induced oxidative stress, *The Journal of sports medicine and physical fitness*, 45(2): 178–82.

Koch, A.J., Pereira, R., & Machado, M. (2014). The creatine kinase response to resistance exercise. *J Musculoskelet Neuronal Interact.* 14(1):68-77

Kujala, T.S., Vienola, M.S., Klika, K.D., Loponen, J.M., & Pihlaja, K. (2002). Betalain and phenolic compositions of four beetroot (Beta vulgaris) cultivars. *Eur. Food. Res. Technol*, 214: 505–510.

Kujawska, M., Ignatowicz, E., Ewertowska, M., Markowski, J., & Jodynis-Liebert, J. (2011). Cloudy apple juice protects against chemical-induced oxidative stress in rat, *European Journal of Nutrition*, 50(1):53–60. doi: 10.1007/s00394-010-0114-y

Kujawska, M., Ignatowicz., E., Murias, M., Ewertowska, M., Mikolajczyk, K., & Jodynis-Liebert, J. (2009). Protective effect of red beetroot against carbon tetrachloride- and N-nitrosodiethylamine-induced oxidative stress in rats, *J. Agric. Food Chem*, 57:2570-2575.

Kuzniak,V.K., Szaefer,H., EwaIgnatowicz., Adamska,T. & Dubowska,W. (2012). Beetroot juice protects against *N*-nitrosodiethylamine-induced liver injury in rats. *Food and Chemical Toxicology*, 50(6):2027-2033

Lansley K. E., Winyard P. G., & Bailey S.J., et al. (2011). Acute Dietary Nitrate Supplementation Improves Cycling Time Trial Performance. *American College Sport of Medicine*. 43(6):1125-1131.

Lim,T.K. (2016). *Edible Medicinal and Non-Medicinal Plants*. Springer, Dordrecht.26-68

Liu, C.C., Huang,C.C., Lin,W.T., Hsieh,C.C., Lin,S.J., & Yang,S.C. (2005). Lycopene supplementation attenuated xanthine oxidase and myeloperoxidase activities in skeletal muscle tissues of rats after exhaustive exercise. *British Journal of Nutrition*. (94):595-601

Liu,R., Wu, L., Du, Q., Ren, J.W., Chen, Q.H., Li, D., Mao, R.X., Liu, X.R. & Li,Y. (2019). Small Molecule Oligopeptides Isolated from Walnut (Juglans regia L.) and Their Anti-Fatigue Effects in Mice. *Molecules*, 24(45):2-15

Liudong,F., Feng, Z.,Daoxing, S., Xiufang, Q., Xiaolong, F., & Haipeng, L. (2011). Evaluation of antioxidant properties and anti- fatigue effect of green tea polyphenols. *Scientific Research and Essays*, 6 (13):2624-2629

Lu, X., Wang, Y.,& Zhang, Z. (2009). Radioprotective activity of betalains from red beets in mice exposed to gamma irradiation. *Eur. J. Pharmacol.* 615(1-2): 223–227

Lundberg, J.O., Carlstrom., M., Larsen, F.J., & Weitzberg, E. (2011). Roles of dietary inorganic nitrate in cardiovascular health and disease. *Cardiovas Res*. 89: 525–532.

Mcfarlin, B.K., Adam S. V., Andrea L. H., Jill N. B., Kathryn P., Jakob L. Vingren., & David W.H. (2016). Reduced in fl ammatory and muscle damage biomarkers following oral supplementation with bioavailable curcumin. *BBACLI* 5:72–78.

Moflehi, D., Kok, L.Y., Fadilah, T., & Amri, S. (2013). Effect of Single-Session Aerobic Exercise with Varying Intensities on Lipid Peroxidation and Muscle-Damage Markers in Sedentary Males. *Global Journal of Health Science*, 4(4)48-54

Nemes , R., Koltai, E., Taylor, A.W., Suzuki, K., Gyori, F & Radak, Z. (2018). Reactive Oxygen and Nitrogen Species Regulate Key Metabolic, Anabolic, and Catabolic Pathways in Skeletal Muscle. *Antioxidants*, 7(85):1-13. doi:10.3390/antiox7070085

Ninfali, P., & Angelino, D. (2013). Nutritional and functional potential of Beta vulgaris cicla and rubra. *Fitoterapia*, 89: 188-199

Ostojic, S.M., Stojanovic, M.D., Djordjevic, B., Jourkesh, M., & Vasiljevic, N. (2008). The Effect of a 4-Week Coffeberry Suplementation on Antioxidant Status, Endurance, and Anaerobic Performance in College Athletes. *Research in Sports Medicine*, 16: 281-294

Phaniendra, Jestadi, D.B., & Periyasamy, L. (2015). Free Radicals: Properties, Sources, Targets, and Their Implication in Various Diseases, *Indian Journal of Clinical Biochemistry* 30(1):11–26.

Parisi, A., Trachita, E., Duranti, G., Ciminelli, E., Quaranta, F., Ceci, R., Cerulli, C., & Sabatini, S. (2010). Effects of chronic rhodiola rosea supplementation on sport performance and antioxidant capacity in trained male. *Journal of Sports Medicine and Physical Fitness*, 50(1):57–63.

Pietrzkowski, Z., Nemzer, B., Sprna, A., Stalica, P., Tresher, W., Keller, R, Jiminez, R., Michalowski, T., & Wybraniec, S. (2010). Influence of betalinrich extracts on reduction of discomfort associated with osteoarthritis, *New Med*, 1:12-17

Pingitore, A., Lima, G.P.P., Mastorci, F., Quinones, A., Iervasi, G. & Vassalle, C. (2015). Exercise and oxidative stress: Potential effects of antioxidant dietary strategies in sports." *Nutrition* 31(7–8):916–22

Qazi, M.A., & Molvi,K.I. (2018). Free Radicals and their Management. *Am. J. Pharm Health Res*. 6(04);1-13

Rosidi, A., Khomsan, A., Setiawan, B., Riyadi, H & Briawan, D. (2013). Effect of Temulawak (Curcumin xanthorrhiza Roxb) Extract on Reduction Of MDA (Malondialdehyde) Levels of Football Athletes, *Pakistan Journal of Nutrition.* 12 (9):842-850

Santos-Silva, A., Rebelo, M.I., Castro, E.M., Belo, L., Guerra, A., Rego, C., & Quintanilha, A. (2001). Leukocyte activation, erythrocyte damage, lipid profile and oxidative stress imposed by high competition physical exercise in adolescents, *Clin. Chim. Acta*, 306, 119-126.

Shiva S., Huang Z., Grubina R., Sun J., Ringwood L.A, MacArthur P.H., Xu, X., Murphy, E., Darley-Usmar, V.M., & Gladwin M. T. (2007). Deoxymyoglobin is a nitrite reductase that generates nitric oxide and regulates mitochondrial respiration. *Circ Res.* 100:654–61.

Silalahi, J. (2006). *Makanan Fungsional*, Penerbit Kanisius Yogyakarta. 38-56

Simioni, C., Zauli, G., Martelli, A.M., Vitale, M., Sacchetti, G., Gonelli, A., & Neri, L.M. (2018). Oxidative stress: role of physical exercise and antioxidant nutraceuticals in adulthood and aging, *Oncotarget* 9(24):17181–98.

Sinaga, F.A. (2012). Pengaruh Pemberian Vitamin E Terhadap Kadar Malondialdehid, Hemoglobin dan VO_2Max Selama Latihan Pada Atlet Sepakbola FIK UNIMED. *Jurnal Penelitian Saintika*, 12(2):153-164

Sinaga, F.A. (2013). Pengaruh Pemberian *Virgin Coconut Oil* (VCO) Terhadap Parameter Hematologi, Kadar Malondialdehid dan Daya Tahan Tikus (*Rattus Norvegicus Galur Sprague Dawley*) Pada Aktifitas Fisik Maksimal. *Proceeding, International Scientific Seminar On Sport And Sportsciences*, 978-602-98603-9-9: 226-238

Sinaga, F.A. (2015). The Effect of red fruit oil on rat's malondialdehide at maximal physical avtivity. *Proceeding international conference of ASEAN Council of Physical Education and Sports (ACPES) 2015.* ISBN 978-979-1964-4-2:379-385

Sinaga, F. A., Risfandi,M., Mesanan., & Jumadin, I.P. (2017). The Effect of Red Fruit Oil on Hematological Parameters and Endurance Performance at the Maximal Physical Activity. *International Journal of Science and Research (IJSR)*, 6 (5):155-158

Sinaga, F.A., & Susanti,N. (2018). The influence of red fruit (*Pandanus conoideus* Lam.) Oil on glutathione peroxidase level at maximum physical activity, *Asian J Pharm Clin Res*, 11(1)103-106

Sinaga, F.A., & Purba, P. (2018). The Influence of Red Fruit Oil on Creatin Kinase Level at Maximum Physical Activity. *Journal of Physics*: Conf. Series 970: 012007.

Sinaga, F.A., Harahap, U., Silalahi, J., & Sipahutar, H. (2019). Antioxidant and hepatoprotective effect of virgin coconut oil at physical maximum activity. *Asian J Pharm Clin Res*, 12(3);272-276

Stankovic, M., & Radovanovic, D. (2012). Oxidative Stress and Physical Activity, *SportLogia*, 8(1):1-20

Taju, G., Jayanthi, M., & Majeed, S.A. (2011). Evaluation of Hepatoprotective and Antioxidant activity of Psidium Guajava Leaf Extract against Acetaminophen Induced Liver Injury in Rats, *International Journal of Toxicology and Applied Pharmacology*. 1(2):13-20

Tesoriere, L., Fazzari, M., Angileri, F., Gentile, C., & Livrea, M.A. (2008). In vitro digestion of betalainic foods. Stability and bioaccessibility of betaxanthins and betacyanins and antioxidative potential of food digesta, *J. Agric. Food. Chem.* 56: 10487-10492

Thirumalai, T., Viviyan T. S., Elumalai, E.K., & David, E. (2011). Intense and exhaustive exercise induce oxidative stress in skeletal muscle, *Asian Pacific Journal of Tropical Disease* 63-66

Urso, M.L., & Clarkson, P.M. (2003). Oxidative stress, exercise, and antioxidant supplementation, *Toxicology*, 189(1-2):41-54

Vyas, N., Tailang, M., Gavatia, N.P., & Gupta, B.K. (2010). Antioxidant Potential of Psidium Guajava Linn. International Journal of PharmTech Research, 2(1):417-419

Vina J, Gomez-Cabrera M.C., Lloret A., Marquez, R., Minana, J.B., & Pallardo, F.V. (2000). Free radicals in exhaustive physical exercise: mechanism of production and protection by antioxidants. *IUBMB Life*, 50: 271–7.

Wink, D.A., Miranda, K.M., Espey., M.G., Pluta, R.M., Hewett, S.J., Colton, C., Vitek, M., Feelisch, M., & Grisham, M.B. (2001). Mechanisms of the antioxidant effects of nitric oxide, *Antioxid. Redox Signal*, 3: 203–213

Winkler, C., Wirleitner, B., & Schroecksnadel, K. (2005). In vitro effects of beet root juice on stimulated and unstimulated peripheral blood mononuclear Cells, *Am. J. Biochem. Biotechnol*, 1:180.

Wootton-Beard, P.C., & Ryan, L. (2011). A beetroot juice shot is a significant and convenient source of bioaccessible antioxidants. *J. Funct. Foods* 3, 329–334.

Xu, M, Liang, R., Li, Y., & Wang, J. (2017). Anti-fatigue effects of dietary nucleotides in mice, *Food & Nutrition Research* 61(1):1334485.

Yavari, A., Javadi, M., Mirmiran, P., & Bahadoran, Z. (2015). Exercise-Induced Oxidative Stress and Dietary Antioxidants, *Asian J Sports Med.* 6(1):1-7

Zhao, G., He, F., Wu, C., Li, P., Li, N., Deng, J., Zhu, G., Ren, W., & Peng,Y. (2018). Betaine in inflammation: Mechanistic Aspects and Applications, *Frontiers in Immunology*, 9(1070):1-13