Effect of Mangosteen Peel Supplementation on Erythrocytes and Hemoglobin in Male Students after Heavy Physical Exercise

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Abstract. Oxidative stress due to heavy physical exercise can cause damage to the cell body of one of several erythrocytes and hemoglobin. Natural antioxidant consumption is a way to overcome the effect of oxidative stress. One of the natural antioxidants is mangosteen peel with high content of antioxidants. The aim of this study is to understand the effect of mangosteen peels on erythrocytes and hemoglobin in male students after heavy physical exercise. This is a true experimental study with a pretest-posttest control group design with 21 male students which were divided into two groups. The first group was given placebo while the other groups were given mangosteen peels supplementation with dosage of 550 mg for two weeks. Physical exercise with an intensity of 75%-85% using a treadmill is done three times a week for all groups. Erythrocytes and hemoglobin were measured before and after treatment. Erythrocytes levels decreased significantly in the control group and increased insignificantly in the treatment group. Hemoglobin levels decreased significantly in the control group and increased significantly in the treatment group. From this study, it can be concluded that mangosteen peel supplementation acts as antioxidant to erythrocytes and hemoglobin in male students after heavy physical exercise.

1. Introduction
Exercise can be categorized as the most important part of life which contributes both positive and negative impacts on the body. Furthermore, an exercise that is performed regularly could prevent chronic diseases. However, an over heavy exercise could lead to oxidative stress due to the production of free radicals, exceeding the amount of antioxidants in the body [1,2]. In this condition, free radicals will result a lipid peroxidation of cell membranes and damage cell membranes organization [3]. One cell that is susceptible to oxidative stress in erythrocytes, which also affect hemoglobin.

Several results of the research have been performed to observe the effect of exercise on erythrocytes and hemoglobin. Strength exercise could significantly reduce erythrocyte and hemoglobin levels [4]. In addition, red blood cells and hemoglobin decrease significantly for 60 minutes after experiencing aerobic and anaerobic exercise [5]. In fact, oxidative stress due to exercise contributes to the reduction of erythrocytes in untrained mice [6].

Oxidative stress can be overcome by administering both synthetic and natural antioxidants. The advantages of employing natural antioxidants are that they have smaller and affordable side effects, resulting in various studies towards antioxidant-rich medicinal plants to prevent oxidative stress from physical activity. Some of the studies that have been carried out were including red dragon fruit and red fruit oil [7,8]. One of the plants that contain natural antioxidants is the mangosteen, especially on its skin. Mangosteen rind contains antioxidants, such as Xanthones and Procyanidin [9,10]. Based on several studies that have been carried out, mangosteen peel has been proven as an anticancer, antimicrobial, antidiabetic, and antioxidant [11,12,13,14]. However, research that concerns the efficacy of mangosteen rind in the field of sports is still limited.
2. Materials and Methods

This study is an experimental study with a Pretest-Posttest with control group design. As many as 21 students in the faculty of sports at Universitas Negeri Medan (UNIMED) who met the criteria were chosen as sample. The sample criteria were male, healthy, not smoking, willing to be a sample, and not taking other supplements during the study. The sample is 19-22 years old and has a normal body mass index (22.42-23.00 kg/m²). This research has received "Ethical clearance" from the ethics committee of the Faculty of Medicine, Universitas Sumatera Utara (USU), Indonesia (approval number 186/TGL/KEPK FK USU-RSUP HAM/2019). Furthermore, the research was carried out at the UNIMED Physiology Laboratory, the UNIMED Physical Laboratory and the USU Faculty of Medicine Integrated Laboratory.

The sample consisted of 2 groups. The first group was control group which only received an exercise program while the second group received an exercise program and supplements of mangosteen rind extract. The exercise program was running on a Treadmill with an intensity of 75-85%, duration of 60 minutes, and frequency of 3 times a week for 2 weeks. Lastly, as much as 1 capsule @ 550 mg of mangosteen rind extract supplement was given half an hour before exercise.

Erythrocyte and hemoglobin levels were measured before and after the treatment. Blood for examination is taken from veins as much as 10 ml. Erythrocyte and Hemoglobin levels were measured using the Hematology Analyzer method. Data were analysed by using SPSS 22.0 with Wilcoxon test, Mann-Whitney and Paired t-test. Also, the decision of the statistical test was taken as $P <0.05$ which was considered significant.

3. Result

The aim of this study is to understand the effect of mangosteen peels on erythrocytes and hemoglobin in male students after heavy physical exercise. From the results of the study, the differences in erythrocyte and hemoglobin levels before and after exercise were obtained and shown in Table 1 and 3. In detail, the differences in erythrocyte and hemoglobin levels after exercise were described in Table 2 and 4.

Table 1. The difference of erythrocyte levels towards pre- and post- heavy physical activity on students

| Erythrocyte Parameter $\times 10^{12}$/l | Average ± SD | p value |
|-----------------------------------------|--------------|--------|
| Pretest P1                              | 5.39 ± 0.50  |        |
| Posttest P1                             | 5.05 ± 0.62  | 0.012* |
| Pretest P2                              | 4.64 ± 1.56  |        |
| Posttest P2                             | 4.83 ± 1.62  | 0.153  |

P1 (Control); P2 (Treatment); * $p < 0.05$.

Table 2. The difference of erythrocyte levels towards post heavy physical activity on students

| Parameter $\times 10^{12}$/l | Group     | p value |
|------------------------------|-----------|---------|
|                              | P1 (Average ± SD) | P2 (Average ± SD) |
| Erythrocyte Posttest         | 5.05 ± 0.62  | 4.83 ± 1.62 | 0.029* |

P1 (Control); P2 (Treatment); * $p < 0.05$.

Based on table 1, it can be seen that the average erythrocyte level decreased significantly in the control group ($p<0.05$). In contrast to the control group, the average erythrocyte level increased insignificantly ($p>0.05$) in the treatment group. On the other hand, table 2 indicates the average posttest of erythrocyte levels of the two groups decreased significantly ($p <0.05$).
Table 3. The difference of hemoglobin levels towards pre- and post- heavy physical activity on students

| Parameter | Average ± SD | p value |
|-----------|--------------|---------|
| Pretest P1| 15.55 ± 0.86 | 0.035*  |
| Posttest P1| 14.67 ± 1.49 |         |
| Pretest P2| 13.74 ± 4.61 | 0.015*  |
| Posttest P2| 14.32 ± 4.78 |         |

P1 (Control); P2 (Treatment); * p < 0.05.

Table 4. The difference of hemoglobin levels towards post heavy physical activity on students

| Parameter | Group          | p value |
|-----------|----------------|---------|
| Hb Postest (g/dl) | P1 (Average ± SD) | P2 (Average ± SD) |         |
|           | 14.67 ± 1.49   | 14.32 ± 4.78 | 0.029*  |

P1 (Control); P2 (Treatment); * p < 0.05.

Based on table 3, it can be seen that the average hemoglobin level decreased significantly in the control group (p<0.05). In contrast to the control group, the average hemoglobin level increased significantly (p<0.05) in the treatment group. On the other hand, table 4 indicates the average posttest of hemoglobin levels of the two groups decreased significantly (p <0.05).

4. Discussion

An acute and chronic exercise can affect the human cardiovascular system including blood. Moreover, this change depends on the type, intensity, and duration of exercise [15]. In this study, it is indicated that heavy physical exercise significantly reduced erythrocyte and hemoglobin levels. Several hypotheses towards the effect of physical exercise on erythrocytes and hemoglobin are still in debate. For example, some studies discovered that during physical exercise, the destruction of erythrocytes can cause anemia [16,17,18]. Oxidative stress due to physical exercise is responsible for the process of destroying erythrocytes. On the other hand, another study found that physical exercise can stimulate the process of erythropoiesis and increase red blood cell mass and plasma volume; an increase in erythropoiesis occurs due to stimulation of the bone marrow [19]. Red blood cells and hemoglobin increase immediately after performing an acute high-intensity training interval and the levels begin to fall 3 hours after the exercise [20].

Based on the results of this study, it was found that erythrocyte levels increased insignificantly while hemoglobin levels increased significantly in the group receiving mangosteen rind extract supplements. Mangosteen rind has great potential as an antioxidant by the existence of Xanthones and Procyanidin compounds. These compounds can ward off some free radicals. Also, Xanthones extract from mangosteen can protect red blood cells from severe H₂O₂ stress [21]. Relevant research has described that mangosteen rind extract did not significantly increase the number of erythrocytes but significantly increase hemoglobin in mice exposed to cigarette smoke [22]. Lastly, antioxidant supplements could fight oxidative stress and improve hematological status, including red blood cells and hemoglobin on runners [23].

Another antioxidant that can affect erythrocytes is spirulina which can improve the physiological conditions of erythrocyte membrane fluidity so as to prevent the adverse effects of oxidative stress [24]. Antioxidants can counteract oxidative stress, intravascular hemolysis and prevent erythrocyte damage [6].

5. Conclusion

This study has concluded that heavy physical exercise can affect the number of erythrocytes and hemoglobin. Also, this study has discovered that mangosteen rind supplementation increased the number of erythrocytes and hemoglobin in male students who were treated with heavy physical exercise.
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