

Effect of Alkaline Fluids to Blood pH and Lactic Acid Changes on Sub Maximal Physical Exercise

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Abstract. Exercise was one of the physical stressors that can disrupt the acid-base balance in the body. One of the ways to prevent the fatigue due to physical activity caused by a buildup of lactate ions and H⁺ ion was used an alkaline pH 9. Consuming alkaline pH 9 was considered be able to neutralize the low pH conditions during physical activity. **Purpose:** to tested whether the used of alkaline pH 9 was able to inhibit the increasing of lactic acid, decreasing pH levels after sub maximal activity. **Method:** Pretest-posttest control group design used a random sample, which was totaling 15 samples of each group. **Results:** Were significant differences variable lactic acid values after it analyzed using different test (t-test), it was obtained p 0.000 < 0.05. The variable the pH, it had significant difference with value p 0.000 < 0.05 between the control group and the experimental group after the treatment with sub maximal physical activity. **Conclusion:** An alkaline fluid with pH 9 before sub maximal exercise inhibits the value of lactic acid and inhibits decreasing pH in the blood. The decreasing pH in was lower and the lactic acid level was higher when it compared with those not given lye.

Keywords: lactic acid, blood pH, alkaline fluids, submaximal, physical, exercises

1. Introduction

Physical exercise is one of the inhibiting factors or physical stressors that can disrupt the balance of the composition between acid and base in the body. Any physical exercise will generate a response from the organs of the body to the dose of exercise given. This is a self-improvement effort in the framework of maintaining the balance of the environment in order to remain stable called homeostasis [1]. Lactic acid in the body is the result of metabolites produced from the lactate system or anaerobic glycolysis due to imperfect glucose breakdown. Increased the levels of lactic acid in the body can lead to decreased blood pH which then can both lead to physical exhaustion and then will affect the physical performance. The formation of lactic acid was the result of high-intensity exercise activity and prolonged exercise [2]. Increased levels of lactic acid in muscle and blood will have an adverse effect on cell activity due to the disruption of the performance of a number of enzymes acting on neutral or base pH as catalysts in various metabolic processes. This of course will further disrupt the activity of cells in producing energy to support the body's activities [3]. Acid status in the blood (low pH) may cause interference with various cellular muscle mechanisms such as inhibiting the action of aerobic enzymes thereby decreasing aerobic endurance capacity, Inhibits the formation of creatine phosphate so as to interfere with the coordination in sports movement, The formation of small holes in the muscle tissue that can cause an increase in urea levels and can slow the oxidation of fat [4]. One of



the methods that can be used to slow down the occurrence of physical fatigue caused by the accumulation of lactate ions in the body during physical activity, is to provide alkaline liquids with pH 9, which is now widely found consumed by the athlete. Several literatures also explained that by consuming alkaline fluid pH 9 will be able to neutralize of pH level in low conditions in the blood during physical activity, so that the production process of lactic acid during the activity can be reduced. A strong base is a fast and strongly reacting base with H^+ as well as a NaOH liquid capable of rapidly removing the acid solution in solution [5]. An alkali is a molecule formed from the combination of one or more alkali metal-sodium, potassium, lithium and so on. The alkaline part of this molecule reacts quickly with H^+ to remove from the acidic solution. Body acidity or normal body fluid pH ranges from 7.35 to 7.45. If the pH is outside the range, the homeostasis mechanism will make repairs to the buffer process which will then change in pH [5]. Pre-exercise supplementation has been a fundamental component of the nutrition program in the sport [6]. According to Guyton and Hall [5] when pH is above 7.4, then the pH state is a high or alkaline pH, therefore, based on several studies conclude that beverages with a pH of 9 is one of a liquid containing high alkali, able to make the blood becomes alkaline pH at low pH or acidic. Alkaline liquids with pH 9 are commonly found and consumed by athletes. Consuming alkaline liquor pH 9 is one of the efforts to reduce the acidity of the body as a result of physical activity, especially in exercising, so that conditions that are too acidic or pH decrease can be sought as long as possible to delay the risk of fatigue in humans as early as possible caused by the accumulation of lactic ions And H^+ ions [7]. This study attempts to provide an attempt to inhibit the process of decreasing the pH in the blood and to reduce the level of lactic acid in the blood by providing intake of alkaline drink with pH 9 into the body before doing physical activity as an effort to minimize acidity in the body after doing the exercises.

2. Materials and methods

This type of research is experimental research using pretest-posttest control group design. Research probandus used were 30 male sports students (± 17.96 y.o), body height (± 171.03 cm), body mass index (± 21.60) and Resting Heart Rate (± 74.63 bpm), Maximum Heart Rate (± 202 bpm). The scheme of these study methods can be described as follows (figure 1):

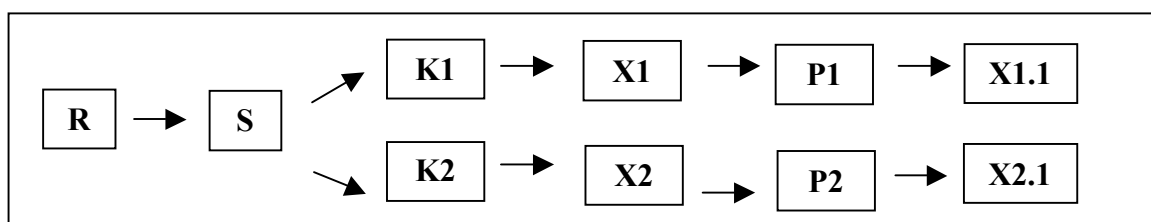


Figure 1. Design of study

Remarks :

- R = Randomization
- S = Subjek penelitian
- K1 = Group of one
- K2 = Group of two
- X1 = *Pretest of group* (500ml alkali)
- X2 = *Pretest of group* (500m no-alkali)
- P1 = Provide submaximal exercise (70-80% MHR)
- P2 = Provide submaximal exercise (70-80% MHR)
- X1.1 = *Posttest of group* (500ml alkali)
- X2.2 = *Posttest of group* (500ml no-alkali)

This study uses two groups (K). Group 1 (K1) is a group given alkaline liquids, while group 2 (K2) is a group not given alkaline liquids. Once the previously data was taken, each groups provide

submaximal exercises by range of 70-80% MHR. The research group in this study used two groups (K). Group 1 (K1) is a group given alkaline fluid prior to and during intervention, while group 2 (K2) is a group not given alkaline fluid either before or during the test. The test begins with initial data measurements related to the anthropometric aspect, initial pulse prior to physical activity, and initial blood pH checking using digital measurements of 1-STAT as well as lactate levels using a digital measuring instrument from Accu Check. Technically check lactate acid level is by using softel accu-check lactate pro by taking blood on ear leaf before and after doing physical activity. For the measurement of blood pH is done with the help of pH meter 1-STAT tool by taking blood twice as much as before and after doing the exercise with as much as one drop from the fingertips. Then the sample is divided into 2 groups with each number of 15 samples. Each group must perform submaximal tests with a 70-80% MHR limit using a monark ergometer, up to their respective capabilities. Alkali fluid administration in group 1 was given in every 5th minute of 250ml until the sample was no longer able to carry out the test. The next stage is the maximum pulse recording achieved when the sample does not have the test, then proceed with lactate taking at 5 minutes after submaximal test.

3. Results

The following is the distribution of data based on the mean and standard deviation of body weight, height, blood lactic acid level. The results of descriptive analysis of variables can be seen in the table 1 below.

Table 1. Descriptive Analysis

Variables	N	Means	Std. Deviation
Ages	30	17,96	0,80
Body Height	30	171,03	1,71
Body Mass	30	57,96	1,14
Body Mass Index	30	21,60	1,65
Resting Heart Rate (RHR)	30	74,63	1,17
Maximum Heart Rate (MHR)	30	202,03	0,65
Blood pH	30	7,35	1,22
Lactic Acid	30		

The table above can be seen that with the number of subjects as much as thirty, the age variable with the average value of 17.96 with Standard deviation 0.80. Value of body height with average of 171.03 cm, with Standard deviation 1.71, weight value with mean equal to 57.96 with deviation standard value equal to and for mean body mass index value equal to 21.60 with value of standard deviation 1.65. On the other hand, the mean value for RHR is 74.63 beats per minute with Std. Deviation of 3.17; the average value of MHR of 202.03 with a standard deviation of 0.65 and the mean value for blood pH is 7.35 with a standard deviation value of 1.22. The result of normality test value related to the subject and test parameters in this study can also be seen in the table 2 below.

Table 2. Result of Normality test

Variables	N	Signification	<i>p</i>
Ages	30	0.05	0.117
Body Height	30	0.05	0.289
Body Mass	30	0.05	0.330
Body Mass Index	30	0.05	0.201
Resting Heart Rate (RHR)	30	0.05	0.495
Maximum Heart Rate (MHR)	30	0.05	0.236
Blood pH	30	0.05	0.752
Lactic Acid	30		0.295

Based on the results of normality test above can be concluded that overall all data from age, height, body weight, body mass index, RHR, MHR and blood pH, all show a mean $p > 0,05$, which can be assumed as normal for all parameters. To ensure that both groups have similarities, then in this study also carried out homogeneity test on pre exercises. The value of homogeneity test can be seen in the following figure 2.

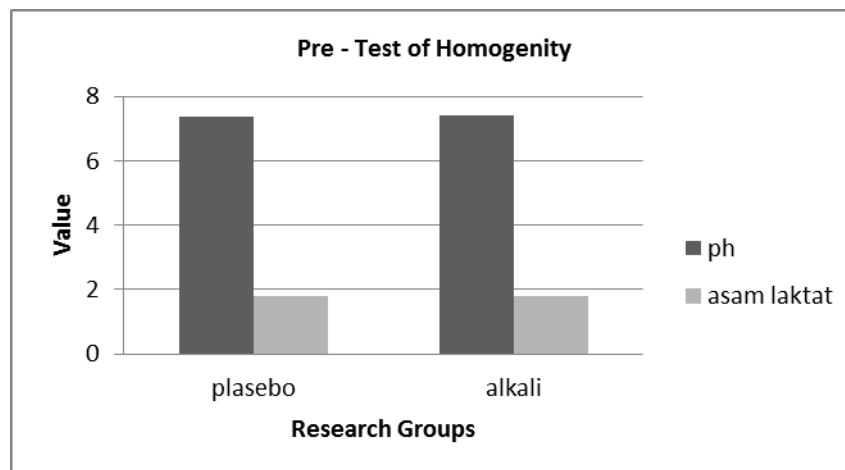
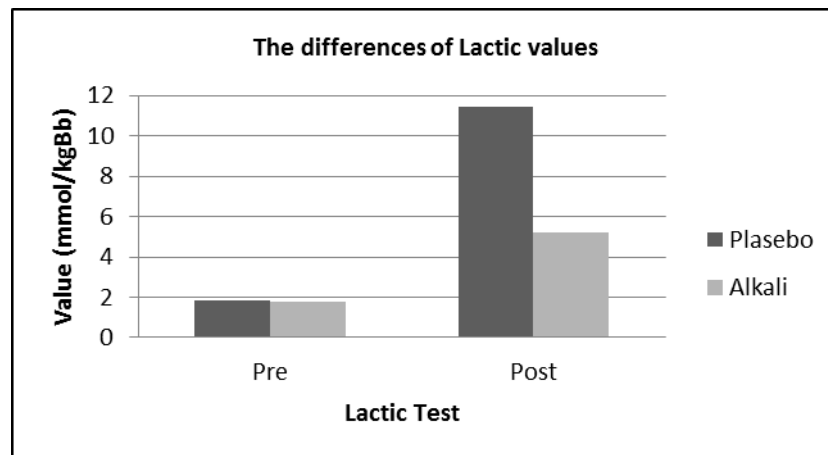
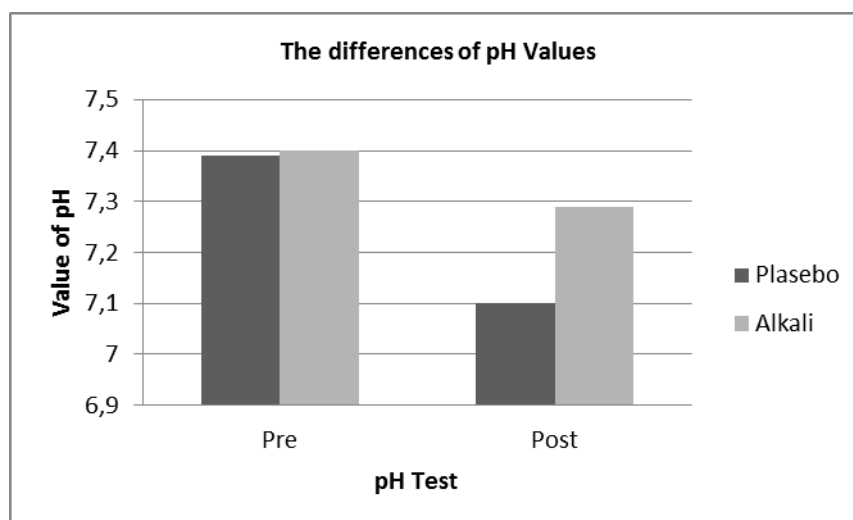


Figure 2. Value of homogeneity

Based on the above results it can be concluded that the blood pH value in the placebo group before the intervention was given was 7.39 mmol / kgBb while in the group given the alkaline fluid before the intervention showed the number 7.40 mmol / kgBb. This explains that the condition of blood pH before being given intervention in both groups shows in normal circumstances with the understanding that the blood pH of both groups is neither too acidic nor too alkaline. Similarly, preliminary lactate test results in both groups showed that the value of lactate content in blood in the placebo group was 1.81 mmol / kgBb, whereas the lactate content in blood in the trial group was 1.80 mmol / kgBb. This result also explains that the condition of lactate levels in both groups before being given intervention shows in a low state or under 4 mmol / kgBb with the understanding that lactate levels below the level of 4 mmol / kgBb indicate that the body condition is not in a state of tired or in a fit state. Based on the Pretest measurement of both groups of initial lactic acid content obtained p value of 0.926 with the assumption $p > 0.05$ then both groups are expressed to have the initial ability or lactic acid levels are the same or homogeneous. Likewise, the initial ability test of both groups on the measurement of initial blood pH obtained p value of 0.779 with the assumption $p > 0.05$ then both groups are expressed to have the ability of the beginning or blood pH is the same or homogeneous. Differences in blood levels of lactate before and after conducting submaximal tests can be seen from the figure 3.

**Figure 3 : Lactic Values**

The above results show a comparison of lactic acid levels in both groups. For the placebo group the mean value of lactate levels before the test was 1.81 mmol / kgBb, then increased to 11.42 mmol / kgBb. On the other hand, the difference in lactate levels in the group given the alkaline fluid prior to the submaximal test was 1.80 mmol / kgBb, then increased to 5.22 mmol / kgBb at the time after submaximal testing. Based on these differences, it can be concluded that lactate levels in the group given alkaline liquids proved to be significantly more capable of maintaining stable lactate conditions and were able to reduce the rate of elevated lactate levels in the blood, compared to groups not given alkaline liquids. At the same time, differences in blood pH values of both study groups were also exposed in figure 4.

**Figure 4 : pH Values**

The diagram shows that the ratio of blood pH value in both groups. For the placebo group the mean value of blood pH before the test was 7.39, then changed to 7.10 at the time after submaximal testing. On the other hand, the value of the difference in blood pH in the group given the alkaline fluid prior to submaximal test was 7.40, then changed to 7.29 at the time after submaximal test.

4. Discussion

High-intensity physical exercise stimulates the production of lactic acid in the blood and muscles that indicates the occurrence of fatigue. Lactic acid accumulation can occur during exercise at a high

intensity for a short time, this was due to lactic acid production was higher than the recovery process. In the resting state, the average value of the lactic acid levels of about 1 to 1.8 mmol / kg [8]. At the time of maximal exercise for 30-120 seconds, lactate levels can be increased up to 15-25 mmol / kg were measured 3-8 minutes after the exercise. This increase indicates that the process of ischemia and hypoxia in the muscles is underway, in which the state is a description of the process transforms glycogen into glucose, which will then be converted again into lactate. Increased lactate will cause a decrease in blood pH levels. This decrease in blood pH will interfere with the performance of a number of enzymes acting on neutral or alkaline pH, where they act as catalysts in the body's metabolic processes. With the disruption of some enzymes that function as a catalyst, it will give a less favorable effect because the metabolic process becomes slower. Conditions of lactic acid levels in excess of 6 mmol / kgBb, will make the state of sarcoplasm or muscle cells in a state of high acid. This will inhibit the release of Ca^{++} from the sarcoplasmic reticulum, which will result in the cessation of muscle contraction. This high lactate condition is also caused by the inability of the body system in supplying aerobic energy, so an anaerobic energy supply will dominate. If this high lactate state occurs continuously, it can cause disruption of the muscle cell work mechanism, interfere with the level of movement coordination and will be able to stop muscle contraction. The lactate ion has a not-so-great effect on the muscle contraction process, but the increase of H^+ ions present in lactate greatly affects the appearance of skeletal muscle fatigue. Ion H^+ greatly affects protein conformation. The increase of H^+ concentration derived from ATP hydrolysis and anaerobic glycolysis will cause the cell condition to acidosis which will eventually alter the structure and function of proteins that support contractions, such as actin, miosin or energy-forming enzymes [9]. Strong base is a base that reacts quickly and strongly with H^+ to form water (H_2O). Some theories explain that if a strong base such as NaOH is added to the buffer system, in this case OH^- is exposed by H_2PO_4 to form an amount of $\text{HPO}_4 + \text{H}_2\text{O}$, then added with $\text{NaOH} + \text{NaH}_2\text{PO}_4$, it will get a $\text{NaH}_2\text{PO}_4 + \text{H}_2\text{O}$ reaction. Some theories explain that if a strong base such as NaOH is added to the buffer system, in this case OH^- is exposed by H_2PO_4 to form an amount of $\text{HPO}_4 + \text{H}_2\text{O}$, then added with $\text{NaOH} + \text{NaH}_2\text{PO}_4$, it will get a $\text{NaH}_2\text{PO}_4 + \text{H}_2\text{O}$ reaction. Under such circumstances, a strong base of NaOH will then be exchanged for a weak base, then it will form NaHPO_4 , which will then increase blood pH, but the process of enhancement is not significant. The explanation of the reaction is NaHPO_4 will make the process of increasing blood pH to be slow, while the lactate content in high state. Thus, if there is an increase in lactate levels in the blood, which should also be followed by an increase in blood pH, but with the formation of the NaHPO_4 reaction in the body, it will result in an increase in blood pH to be slow, so that the blood pH conditions are still in alkaline or not acidic conditions Will interfere with the body's metabolic processes.

The amount of titrated acids in the urine is measured by titrating the urine with a strong base such as NaOH. This is done until the pH to 7.4, especially at normal plasma and a pH of glomerular filtration. This titration reverses events occurring in the tubular lumen when the tubular fluid is titrated by secreted H^+ . The amount of titrated acids in the urine is measured by titrating the urine with a strong base such as NaOH. This is done until the pH to 7.4, especially at normal plasma and a pH of glomerular filtration. This titration reverses events occurring in the tubular lumen when the tubular fluid is titrated by secreted H^+ . Therefore, the amount of the equivalent NaOH required to return the pH of the urine to 7.4 equals the number of equivalents of H^+ added to the tubular fluid that joins the phosphate and other organic buffers. Porses will form a new state, so that sodium bicarbonate is absorbed from the gastrointestinal tract into the blood and will raise the bicarbonate in bicarbonate buffer system, thereby increasing pH toward normal [5].

5. Conclusion

The conclusion of the study was that the administration of alkaline pH 9 fluid in the sample before sub maximal test was proven to inhibit the increase of lactic acid level of blood, thus increasing the lactic acid level to be slower, and can also decrease the blood pH level, so that the pH of blood remains at a normal level, when compared to the group who were not given alkaline liquids.

Acknowledgments

I wish to express my sincere gratitude to Mr. Didik Rilastiyo Budi, Head of Sports Laboratory for providing an opportunity to do my research in Department of Physical Education, Faculty of Health Science, University of Jenderal Soedirman. I sincerely thanks Mr. Prof Soewarto, Head of Research Institution and Community Services, University of Jenderal Soedirman who providing research grant to do this project. I also thanks to Mrs. Dr. Warsinah, M.Si.Apt, Dean of Faculty of Health Science, University of Jenderal Soedirman who support our research and to all respondent of my research who gave their precious time to accomplish the research. Lastly i would like to thank all those who helped me in anyway in my research.

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