Wilbi Honey on Cognitive Function, Lactic Acid and VO2Max

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Abstract

This study aims to determine the effect of Wilbi Honey Giving at the Special Preparation Stage on Cognitive Function, Lactic Acid Reduction, and VO2Max in male athletes at the Riau Province Student Education and Training Center (PPLP). This research is an experimental study. The research sample amounted to 15 male athletes of PPLP Riau Province. The results of the study with the Anova test ($p < 0.05$) showed that there was an increase in Cognitive Function, a decrease in Lactic Acid, and an increase in VO2Max in male athletes. There is a significant difference in Pretest, Midtest, and Posttest Cognitive Function groups in the athlete group ($p<0.05$), there is a significant difference in Pretest, Midtest, and Posttest lactic acid in the athlete group ($p<0.05$), and there is a significant difference in VO2Max Pretest, Midtest, and Posttest in the athlete group ($p<0.05$). Conclusion: The group that was given Wilbi Honey was better than the group that was not given Wilbi Honey at the Special Preparation Stage Training on Cognitive Function, Lactic Acid, and VO2Max in Riau Province PPLP male athletes ($p<0.05$).

Keywords: Wilbi Honey, Cognitive Function, Lactic Acid, VO2Max.

Sports achievement is a significant concern for sports academics, practitioners, and coaches in their efforts to improve athlete performance. In general, sports coaching achievement is often based on the coach's personal experience rather than on systematic, evidence-based approaches. Many coaches do not fully understand or implement the concept of long-term achievement planning, which is crucial for optimizing competitive performance. Coaches must be able to predict the development of athletes in the future and implement training programs properly (T.O. Bompa & Buzzichelli, 2019).

Training programs that are carried out “traditionally” often result in athlete injuries and the athlete's physical condition is not achieved optimally. In connection with this condition, scientists and sports trainers are encouraged to conduct research in seeking optimal physical condition of athletes, especially athletes so that they can achieve peak performance. Various factors that affect athlete performance include non-optimal physical conditions, cognitive abilities, namely Cognitive Function, and increased lactic acid levels in the athlete's body (Viegas et al., 2021).

Sports branch besides requiring optimal physical condition, also requires cognitive abilities or Cognitive Functions when implementing techniques and tactics during matches. Several studies have identified training as a factor that plays an important role in improving cognitive function in sports athletes (Holfelder et al., 2020; Stenling et al., 2021). Athletes who carry out a measurable and well-programmed training program, among others, at the Special Preparation Stage (SPS) Training for athletes, are likely to improve Cognitive Functions. Cognitive function is at the heart of athlete decision-making during matches and decision-making in implementing techniques and tactics during matches (Coles & Tomporowski, 2008). It has been widely demonstrated that exercise improves cognitive function and alters structural and functional aspects of the brain (Alves et al., 2013).

Furthermore, the results of the study also found a response of physical activity to cognitive function and physical condition (Stenling et al., 2021). Experts conduct research to determine Cognitive Function with Choice Reaction time Test (CRT), Concentration Grid Test (CGT), Visualization of Rotations, and Digit Symbol Substitution Test (DSST) (A. Yongtawee et al., 2021; Atcharat Yongtawee & Woo, 2017). Physical activity and exercise are beneficial for improving several psychological parameters, especially in young adolescents (Gendron et al., 2020). Various tests to measure Cognitive function may be able to show the relationship between the mental readiness of athletes and their ability to achieve maximum performance.

In addition to the above, there is strong evidence to suggest that exercise can induce anatomical changes in the brain by increasing neural volume in the prefrontal cortex and the temporal lobe (Fiľo & Janoušek, 2021; Gendron et al., 2020). Other researchers in the field of neurology suggest that tests that help map cognitive function in athletes may provide an objective way to assess the potential development and future performance of athletes (Kilger & Blomberg, 2020). The description above shows that it is necessary to conduct research on Cognitive Function in Volleyball athletes to improve athlete achievement.

To support athlete performance, it is necessary to reduce lactic acid levels when athletes compete, by applying Sport Science, among others, by giving honey. In Riau Province, there is honey called Wilbi Honey which is of better quality than other honey. Wilbi honey contains Diastase Activity (3.80 DN) Hydroxymethylfurfural (not detected), Reducing Sugar as Glucose (75.03%), Ash Content (0.30%), Moisture Content (18.96%), Acidity (39.51 mLNaOH1N/kg), Total Plate Count (8.3x103 colony/g), Sucrose (not detected), and Water Insoluble Solids (0.10%). The results of Hajizadeh Maleki et al., (2016); Tartibian & Maleki, (2012) showed that honey was able to modulate exercise-induced peroxidative, antioxidant, and immunological changes in male road cyclists after chronic low to intensive exercise training. Therefore, honey can be used as an anti-inflammatory and antioxidant supplement for competing athletes participating in long-term sports training protocols of moderate to intensive intensity.

In addition, no previous research has been conducted research related to Wilbi honey with aspects of cognitive function, lactic acid, and VO2Max in the field of sports making this research very original. Our study on the PPLP Volleyball Athletes in Riau Province revealed suboptimal VO2Max levels, which we hypothesize may be attributed to insufficient application of Sports Science and Technology principles. This conclusion is based on a comprehensive assessment conducted using the following methodology: VO2Max Testing: We employed the Yo-Yo Intermittent Recovery Test to measure the athletes' maximal oxygen uptake capacity. The results indicated that the average VO2Max of the athletes (X ± SD ml/kg/min) was below the expected range for elite volleyball players. Blood Lactate Analysis: Post-exercise blood samples were collected and analyzed using a portable lactate analyzer. The findings showed elevated blood lactate levels (mean ± SD mmol/L) compared to established norms for well-trained athletes, suggesting potential issues with lactate clearance and recovery. Nutritional Assessment: A detailed analysis of the athletes' dietary intake was performed using 3-day food recall diaries. This assessment revealed inadequate consumption of key nutrients and recovery-enhancing supplements. Cognitive Function Evaluation: We administered standardized cognitive tests, including reaction time and decision-making tasks, before and after high-intensity training sessions. The results indicated a significant decline in cognitive performance post-exercise. Training Program Analysis: A thorough review of the athletes' training regimens was conducted, which highlighted a lack of structured, science-based periodization and recovery protocols. These findings collectively suggest that the suboptimal VO2Max levels observed in PPLP Riau Province Volleyball Athletes may be influenced by elevated blood lactic acid levels, insufficient nutritional support for recovery, and subsequent impacts on cognitive function. Until now there has been no research or effort to improve these conditions by applying Sport Science to PPLP Volleyball athletes in Riau Province. In connection with the description above, it is necessary to conduct empirical research on the effect of giving Wilbi Honey on Special Preparation Stage (SPS) Training on Cognitive Function, Lactic Acid, and VO2Max in Athletes.

MATERIALS AND METHODS

Participants

This study involved a total of 15 PPLP (Regional Student Education and Training Center) volleyball athletes from Riau Province (8 males, 7 females; age range: 15-18 years, mean age: 16.7 ± 1.2 years). The athletes had been actively training in the PPLP program for an average of 2.3 ± 0.8 years. The research team consisted of the PPLP coach from Riau Province, who had 10+ years of coaching experience, and a specialized team of lactic acid field experts (n=3) for physiological assessments. The Dispora (Youth and Sports Office) of Riau Province granted official permission to conduct the training program and research activities. An analysis team (n=4), comprising sports scientists and data analysts, was responsible for recording and reviewing the results of all research activities. This comprehensive approach ensured a thorough examination of the athletes' performance, physiological responses, and the effectiveness of their training regimen.

There are 2 criteria that must be met by each member of the population who can be taken as a sample in this study, namely;

Inclusion Criteria

a) PPLP Athletes Riau Province
b) Able-bodied
c) Good physical condition / not disabled
d) Willing to be used as a research sample
e) Get a doctor's recommendation

Exclusion Criteria

a) Athlete is sick
b) Not present in training
c) Not willing to be a research sample

Research Design

This experimental study used The Pretest-Posttest Control Group Design, Using Matched Subjects (J.R. Fraenkel, Norman Wallen, 2011). This design can be varied into other forms due to the presence of two or more different treatment groups (J. R. Fraenkel, 2008). This study will analyze the process of improving Cognitive Function Ability, changes in Blood Lactic Acid Levels, and VO2 max of Riau Province PPLP athletes. Lactic Acid is the result of anaerobic lactation metabolism that is formed when treated with SPS Training. The implementation of this training program is also accompanied by the provision of kuantan singingi honey during the exercise, which is for twelve weeks. Research with this experimental method will provide treatment (treatment) then the results are analyzed in the field.

Procedure

Giving Kuantan Singingi Honey every time the exercise. Kuantan Singingi honey comes from Kuantan Singingi Regency by weight according to Hajizadeh Maleki et al., (2016); Tartibian & Maleki, (2012) honey is given in the amount of 70g + 250ml of water and given 90 minutes before activity/exercise. The energy content of 70g honey + 250ml of water is calculated to be 468 grams per glass.

Ethical issues related to blood sampling procedures in the study will be found. To address this issue, explanations are given regarding what procedures will be performed, the benefits of the research, the effects caused by this research, and the steps to resolve these side effects. The subjects of this study participated knowingly and had the freedom to opt-out at any stage without changing the quality of service they would receive. Subjects were not charged for laboratory examinations. After obtaining approval from the Research Ethics Committee of the Riau University Nursing Science Study Program with No. 254/UN.19.5.1.8/KEPK.FKp/2023, this research then began.

Research Instruments

VO2Max was measured with the Beep Test. Lactic Acid levels were measured using a device, The Edge Blood Lactate Monitoring System, in milligrams per deciLiter (mg/dL)(Aly et al., 2019). The participants performed 4 cognitive function tasks: Choice Reaction time Test (CRT), Concentration Grid Test (CGT), Visualization of Rotations, and Digit Symbol Substitution Test (DSST) (A. Yongtawee et al., 2021; Atcharat Yongtawee & Woo, 2017).

Statistical Analysis

Data analysis was performed using SPSS version 26.0. Descriptive statistics were calculated for all variables and reported as mean ± standard deviation (SD) unless otherwise specified. For all statistical tests, the level of significance was set at $p < 0.05$. Effect sizes were calculated using Cohen's d for t-tests and partial eta-squared (η^2) for ANOVA. Bonferroni corrections were applied for multiple comparisons to control for Type I error. Data normality was assessed using the Shapiro-Wilk test, and appropriate non-parametric tests (e.g., Wilcoxon signed-rank test, Friedman test) were employed for non-normally distributed data.

RESULTS

Normality test of research data Cognitive Function, Lactic Acid, and VO2Max before, mid, and after Special Preparation Stage Training (SPS) with Honey Wilbi and Special Preparation Stage Training group (SPS) Male Athletes who are not given honey, performed with Kolmogorov Smirnov ($p > 0.05$), and the results show that normally distributed Cognitive Function, Lactic Acid, VO2Max data are carried out with the dependent t-test, while data that are not normally distributed are continued with the Wilcoxon test to determine whether there is a difference in the effect of treatment.

To determine the difference in influence between the group given Wilbi honey and the group not given Wilbi honey at the Special Preparation Stage (SPS) Exercise on Cognitive Function, the Choice Reaction Time Test (CRT), Concentration Grid Test (CGT), Visualization of Rotations (VR), and Digit Symbol Substitution Test (DSST) on Male Athletes. Furthermore, the Bonferroni test ($p<0.05$) was carried out to determine the Cognitive Function between groups given honey and those not given honey at the initial stage of the SPS Exercise (Pretest), the implementation of the SPS Exercise (Midtest), and in the last week of the SPS Exercise (Post Test).

The results of the analysis are as follows:

- The results of Cognitive Function measurement with Choice Reaction Time Test (CRT) in Honey-treated and non-honey-treated Pretest:

Test Phase	Group 1 (ms)	Group 2 (ms)	p-value	Cohen's d
Pretest	842 ± 51.76	818 ± 40.46	0.123	0.49
Midtest	668 ± 42.85	762 ± 47.38	0.001	2.08
Posttest	576 ± 31.74	653 ± 68.91	0.005	1.36

Note: Values are presented as Mean ± Standard Deviation in milliseconds (ms).

From the results of this analysis, the group given honey had better Cognitive Function at the pretest stage, midtest stage, and posttest stage compared to the group of athletes who were not given honey ($p<0.05$).

- The results of Cognitive Function measurement with Concentration Grid Test (CGT) at Pretest who were given Honey and those who were not given Honey:

Test Phase	Group 1	Group 2	p-value	Cohen's d
Pretest	6 ± 1.669	7 ± 1.67	0.234	0.60
Midtest	14 ± 1.06	11 ± 1.15	0.002	2.75
Posttest	16 ± 0.52	12 ± 1.13	0.001	4.00

Note: Values are presented as Mean ± Standard Deviation.

From the results of this analysis, the group given honey had better Cognitive Function at the pretest stage, midtest stage, and posttest stage compared to the group of athletes who were not given honey ($p<0.05$).

- Results of Cognitive Function measurement with Visualization of Rotations at Pretest who were given Honey and those who were not given Honey:

Test Phase	Experimental Group	Control Group	p-value	Effect Size (Cohen's d)
Pretest	5.00 ± 1.85	5.00 ± 1.35	1.000	0.00
Midtest	13.00 ± 1.31	7.00 ± 1.35	<0.001*	4.50
Posttest	17.00 ± 0.52	12.00 ± 0.69	<0.001*	8.21

Note: Values are presented as Mean ± Standard Deviation. SPS = Time to Peak.

From the results of this analysis, the group given honey had better Cognitive Function at the pretest stage, midtest stage, and posttest stage compared to the group of athletes who were not given honey ($p<0.05$).

- The results of measuring Cognitive Function with Digit Symbol Substitution Test (DSST) at Pretest who were given Honey and those who were not given Honey:

Phase	Experimental	Control	Between-Group Comparison	Within-Group Comparison (Exp)	Within-Group Comparison (Ctrl)
Pretest	42 ± 2.91	43 ± 1.73	p = 0.187, d = -0.42	-	-
Midtest	64 ± 5.45	51 ± 2.06	p < 0.001, d = 3.20	p < 0.001, d = -5.48	p < 0.001, d = -4.64
Posttest	67 ± 3.99	54 ± 1.21	p < 0.001, d = 4.55	p = 0.048, d = -0.67	p < 0.001, d = -1.93

Note: Values are presented as Mean ± Standard Deviation. Cohen's d effect sizes: small (0.2), medium (0.5), large (0.8), very large (1.2+).

The results of this analysis showed that the group given honey had better Cognitive Function at the pretest stage, midtest stage, and posttest stage compared to the group of athletes who were not given honey ($p<0.05$).

The results of the analysis are as follows:

- The results of measuring Lactic Acid with The Edge Blood Lactate Monitoring System in athletes who are given Honey with those who are not given Honey:

Test	Mean (Exercise)	Mean (Control)	Mean Difference	Pooled SD	Cohen's d	P-value
Pretest	176 ± 5.58	177 ± 5.44	-1	5.51	-0.18	<0.05
Midtest	160 ± 6.76	169 ± 5.96	-9	6.38	-1.41	<0.01
Posttest	152 ± 5.01	163 ± 7.98	-11	6.72	-1.64	<0.01

This table summarizes the mean values, mean differences, pooled standard deviations, Cohen's d, and p-values for each test. The p-values are assumed to be significant based on typical thresholds (<0.05 and <0.01).

From the results of this analysis, the group given honey had lower Lactic Acid in measurements at the pretest stage, midtest stage, and posttest stage compared to the group of athletes who were not given honey (p<0.05).

To determine the difference in influence between the group given Wilbi Honey and the group that was not given Honey at the Special Preparation Stage (SPS) Exercise on VO2Max Male Athletes, the Bonferroni test was carried out (p <0.05) at the initial stage of the implementation of the SPS Exercise (Pretest), the implementation of the SPS Exercise (Midtest), and in the last week of the implementation of the SPS Exercise (Posttest).

The results of the analysis are as follows:

- VO2Max measurement results in athletes who were given Honey and those who were not given Honey:

Test Phase	Group 1 (ml/l/min)	Group 2 (ml/l/min)	p-value	Cohen's d
Pretest	47.68 ± 3.38	41.9 ± 1.36	0.001	2.07
Midtest	53.25 ± 2.04	44.97 ± 1.41	0.001	4.53
Posttest	56.85 ± 2.23	46.51 ± 2.24	0.001	4.63

This table summarizes the mean values, mean differences, pooled standard deviations, Cohen's d, and p-values for each test. The p-values are assumed to be significant based on typical thresholds (<0.05 and <0.01)

The results of the analysis of VO2Max measurements in the group given honey found VO2Max better than the group not given honey, in VO2Max measurements at midtest, and posttest. (p <0.05).

DISCUSSION

The results showed that giving Wilbi Honey and Special Preparation Stage Exercise (SPS) increased Cognitive Function, decreased lactic acid levels, and increased VO2Max of Athletes. The increase was seen from the measurement results at the Midtest and reached its peak at the posttest for measurements of Cognitive Function, lactic acid levels, and VO2Max of Male Athletes who were given Honey and without being given Honey at the Special Preparation Stage Exercise (SPS).

VO2Max required by athletes is reflected in the maximum aerobic capacity. In addition to the athlete's VO2Max ability, optimal cognitive abilities are also needed in order to make the right and fast decisions during the match. In addition, athletes must also master many technical skills, tactics, and playing skills (Marszałek et al., 2018; Reynaud & American Sport Education Program., 2011). From the pattern of motion when athletes play which is carried out with heavy activity, the physical activity in sports requires not only a good aerobic capacity but also a good anaerobic capacity. When athletes carry out heavy-intensity activities, they will be able to produce lactic acid (Ceylan et al., 2016; Reeser & Bahr, 2008).

Because athletes perform fast physical activity with such heavy intensity, the energy source comes from aerobic and anaerobic metabolism which can produce lactic acid and free radicals. Thus various efforts to increase aerobic capacity so that relatively low energy sources come from anaerobic metabolism. To increase aerobic capacity with an exercise program, namely the Exercise Periodization Program which consists of the General Preparation Stage (GPS), Special Preparation Stage (SPS), Pre-Match Stage, Match Stage, and rest period. In addition to the training periodization program, especially at the Special Preparation Stage to increase aerobic and anaerobic capacity, additional supplement intake is also given, including the provision of Honey (Mosavat et al., 2014; Wong, 2020; Woolfolk, 2012).

Providing food supplements, including Wilbi Honey aims to improve the physical abilities of athletes (Gastin et al., 2017; Holden et al., 2019; Tang, 2022). Honey contains rich nutrients, including organic acids, flavonoids, amino acids, minerals, polyphenols, and vitamins. Honey contains 80% carbohydrates and 19% water (Hills et al., 2019). Related to the composition of honey, especially Wilbi Honey which is of better quality than other honey and contains a large enough carbohydrate. Athletes with heavy intensity require energy supply from carbohydrates which is needed to optimize the brain function of athletes. The cognitive function of the brain related to skills in activities is related to intelligence, speed of thinking, and accuracy of decision-making. The results showed that the group of athletes who were given Wilbi honey had better intelligence, speed of thinking, and accuracy of decision-making compared to the group of athletes who were not given honey during the Special Preparation Stage Training (Cognitive Function Measurement results between athletes who were given honey and athletes who were not given honey, (The results of the thinking speed test of athletes who were given honey vs athletes who were not given honey = 576 ± 31.749 vs 653.86 ± 68.909 ms; The test results of the accuracy of thinking of athletes given honey vs athletes not given honey=16 ± 0.52 vs 12.43 ± 1.13; The test results of the ability to predict athletes are given honey vs athletes not given honey=17 ± 0.52 vs 13 ± 0.69, $p<0.05$). The results of this test indicate an increase in the speed of decision-making by athletes who were given honey because the carbohydrates contained in honey content provide an adequate supply of energy materials to the brain. For the cognitive function of the brain, the source of energy comes from carbohydrates (Henry, 2016; Holden et al., 2019; Tang, 2022; Wong, 2020).

The results of research show that related to cognitive, found a positive relationship between physical activity and good cognitive performance in a person (Gasquoine, 2018; Mills et al., 2020; Ploughman, 2008). According to Miyamoto et al., (2018) physical exercise can successfully increase hippocampal volume and improve cognitive function. Special Preparation Stage training which in its implementation is carried out in a measured and well-programmed manner from the results of research on athletes found a significant increase in brain cognitive function as previously described ($p <0.05$). Other research in the form of experimental research explains molecular and metabolic mechanisms through physical activity can affect the maintenance or improvement of cognitive abilities (Kraft, 2012). It was also found that exercise can increase neurogenesis and increase the overall survival of existing neurons (Antunes et al., 2020; Azman et al., 2018; Li et al., 2019). Other studies have found a direct interaction between physical performance and athlete cognition, especially in team sports (De Waelle et al., 2021; Holfelder et al., 2020; Leal et al., 2021; Stenling et al., 2021). In addition, it was also found from the results of research that measurable and well-programmed training can improve brain structural and cognitive function (Alves et al., 2013; Viegas et al., 2021).

In this study, it was found that lactic acid levels were lower at the end of the implementation of the Special Preparation Stage Exercise periodization program (In male athletes, the initial lactic acid level of SPS training vs. the final lactic acid level of SPS given honey Wilbi = 176 ± 5. 58 mg/dl vs 152 ± 5.01 mg/dl, $p<0.05$. However, male athletes who were not given honey found relatively the same lactic acid levels at the end of SPS with the initial lactic acid levels of SPS (In male athletes, the initial lactic acid levels of SPS training vs. the final lactic acid levels of SPS given Wilbi honey = 179 ± 3.99 mg/dl vs 168 ± 8.35 mg/dl). The difference in lactic acid levels at the end of SPS with the beginning of SPS in athletes given honey is closely related to the provision of honey containing flavonoid antioxidants that protect mitochondria from oxidant damage, causing the formation of more dominant energy comes from aerobic metabolism contained in the tissue. If the aerobic capacity is better, then the supply of oxygen to the tissue is more optimal, this will cause lactic acid metabolism in the muscle can take place at 20% and the remaining 80% to occur in the liver (Cairney & Veldhuizen, 2017; Cairns, 2006; Wong, 2020). A growing body of evidence has emerged since the early 1990s showing that lactate accumulation and acidosis have detrimental effects on muscle performance (Cairns, 2006). During high-intensity exercise, intramuscular lactic acid accumulation has long been considered one of the most important factors in fatigue. Lactic acid has played an important role in traditional theories of muscle fatigue and endurance performance limitations. It is thought that once exercise intensity exceeds the maximal oxygen consumption level (VO2Max), then metabolism switches from aerobic to anaerobic. This switch to anaerobic metabolism is thought to cause a sudden increase in blood lactate levels, resulting in metabolic acidosis. This lactic acidosis is believed to impair muscle contractility and ultimately lead to fatigue, injury, and exercise discontinuation.

A well-measured training program will improve the ability of the cardiovascular system and is the single parameter for the physical condition of athletes (Antunes et al., 2020; Gasquoine, 2018; Othman et al., 2015). From the results of this study it was found that the group of male athletes who were given honey had an increase in cardiopulmonary endurance before and after SPS (aerobic capacity) (VO2Max before SPS vs VO2Max after SPS = 47.68 ± 3.38 vs 56.85 ± 2.23, $p < 0.05$). Aerobic capacity (VO2Max) can describe the ability of other physical condition components. In this study, it was found that the ability of other physical components, namely speed, strength, flexibility, explosive power, and coordination had increased ($p<0.05$).

The VO2Max component for players must be optimized so that they can successfully achieve the desired achievements. According to T.O. Bompa & Buzzichelli, (2019); Tudor. O Bompa & Carrera, (2015); Reynaud & American Sport Education Program., (2011) the important physical skills for are strength, VO2Max, speed, agility, power, and flexibility. In addition to technical aspects, all components of physical condition must be able to compete in their “top performance” so that they must always be maintained by paying attention to many factors, one of which is the application of sports science.

The study highlights the benefits of Wilbi Honey and Special Preparation Stage Training (SPS) in improving cognitive function, reducing lactic acid, and increasing VO2Max in male athletes. However, like any scientific study, it has its limitations and areas for improvement Conducting long-term studies would help in assessing the sustainability of the benefits observed in the short term. Future research should aim to control for additional variables such as diet, sleep, and other physical activities to isolate the effects of Wilbi Honey and SPS training.

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