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Enhancing Athletes' Physical Performance Through the Intervention of 'Tiliaya' Food Supplement Derived from Traditional Food Reformulation

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Abstract

Background: Athlete nutrition can indirectly improve athlete performance. One of the efforts to improve athlete nutrition is by providing additional food such as Tiliaya. Tiliaya is a traditional Gorontalo food that is believed to increase stamina, because it has high calories. This study aims to increase the physical activity of athletes through the intervention of reformulated tiliaya products.
Method: This study used 20 respondents of Gorontalo Student Training and Education Program (STEP) Taekwondo athletes. The intervention was carried out for 3 months with the parameters measured, namely nutritional status based on body mass index, measurement of cholesterol levels (Cholesterol Oxidase-Phenol Aminophenazone/CHOD-PAP) and VO2max, before and after the intervention.
Result: The results of the athlete's blood cholesterol test showed that there were 75.00% in the normal category and 25.00% in the high category. The results of T-Test of Cholesterol level and VO2Max significant for treatment group and not significant for control group.
Conclusion: This study demonstrates that the intervention of a reformulated food supplement, Tiliaya (using fiber creme as a substitute for coconut milk), has a significant impact on improving the physical fitness of STEP taekwondo athletes in Gorontalo, particularly by reducing total cholesterol levels and enhancing VO2max capacity.

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INTRODUCTION

Athletes' sports performance is shaped by a complex interplay of coaching quality, athlete well-being, training intensity, and nutrition, with self-efficacy acting as a key mediating factor and cultural values serving as a moderator. Tailored nutrition plans enhance performance by meeting specific energy and recovery needs. Proper nutrition supports training intensity and overall health (Yang et al., 2024). Sport and exercise performance are significantly influenced by nutrition, yet individuals respond differently to the same foods, nutrients and supplements consumed. This holds true for a variety of ages, ethnicities, and level of skill, and whether the goal is optimizing physical activity for health and fitness or for high performance sport (Guest et al., 2019). An appropriate energy intake is the cornerstone of the athlete's diet since it supports optimal body function, determines the capacity for intake of macronutrient and micronutrients, and assists in manipulating body composition. An athletes energy intake from food, fluids and supplements. Energy availability, which considers energy intake in relation to the energy cost of exercise, sets an important foundation for health and the success of sports nutrition strategies (Thomas DT et al., 2016)

Athlete nutrition consists of staple foods, supplementary foods, and beverages. This study specifically focuses on supplementary foods for athletes. Recent research shows that most athlete supplementary foods are in the form of biscuits and modern instant foods, while traditional food-based supplements remain underexplored. One traditional food from Gorontalo that has the potential to be developed as a supplementary food for athletes is Tiliaya. (Hatibie, 2020).

Tiliaya is a traditional food prepared from a mixture of eggs, coconut milk, and brown sugar. One serving of Tiliaya contains a total energy value of approximately 1,407 kilocalories (Hatibie, 2020). Based on the composition of the raw materials, one concern arises regarding the use of coconut milk. Although coconut milk contains fat that is essential for the body as an energy source and for cellular protection and structure, its prolonged cooking and repeated heating may lead to the formation of unhealthy fats. This process can increase the levels of saturated fats and cholesterol, which are associated with a heightened risk of metabolic disorders such as hypercholesterolemia and diabetes mellitus (Martadjadja, 2022) A potential solution to this issue is to substitute coconut milk with Fiber Creme. Fiber Creme is a plant-based creamer that utilizes oligosaccharides as a fiber source, combined with vegetable oils, offering a healthier alternative (Putri et al., 2020). The primary component of FiberCreme is oligosaccharides, which are derived from two main sources: inulin and isomalto-oligosaccharides (IMO). Empirical studies have demonstrated that the consumption of IMO can significantly reduce cholesterol and triglyceride levels, which are recognized as key risk factors for cardiovascular diseases and insulin resistance (Setyaning et al., 2023; Sunarti et al., 2022)

The reformulation of Tiliaya primarily involved the substitution and adjustment of raw material quantities, particularly the replacement of traditional coconut milk with FiberCreme. This reformulation was guided by considerations of caloric intake requirements. The resulting product exhibited a reduced fat content ranging from 7.62% to 10.39%, dietary fiber content between 3.09% and 5.03%, and cholesterol content of 27.554 mg/100g. Further investigation into the effect of steaming duration revealed that the optimal steaming time was 40 minutes, yielding Tiliaya with a fat content of 6.07%, protein content of 15.50%, and significantly reduced cholesterol content of 2.3386 mg/100g (Siatang, 2023). Therefore, the objective of this study is to investigate the potential of reformulated Tiliaya as a dietary intervention to improve physical activity levels among athletes.

METHODS

This research is an experimental research with pre and post-test design with a control group without Tiliaya supplementary food and a treatment group that received Tiliaya supplementary food. The research protocol has ethical clearance by the Health Research Ethics Commission of Gorontalo State University (No. 049D/N47.87/KEl20).

Preparation of Tiliaya fiber Creme

The process of making tiliaya refers to the previous (Siatang, 2023). The preparation of Tiliaya began with the beating of eggs for 3–4 minutes, which were then transferred into a 1000 mL container. Brown sugar was finely chopped and subsequently melted through heating for 1 minute. The melted sugar was then combined with the beaten eggs and FiberCreme in the same container. The mixture was homogenized for 7 minutes, filtered, and subjected to steaming at 100 °C for 40 minutes.

Population and Sample

The target population of this study comprised male athletes enrolled in the Gorontalo Student Training and Education Program (STEP) for the Taekwondo sport. A total of 20 respondents were selected as research participants. The sample included male Taekwondo athletes from STEP who met the following inclusion criteria: aged between 12 and 19 years, male gender, and participation in regular training sessions at a minimum frequency of once every two weeks. Exclusion criteria included refusal to participate in the study, diagnosis of intellectual disability, or current use of psychoactive substances (Majid, 2018)

Measurement of Athlete Nutritional Status

The first stage of measuring height and weight in athletes is with a scale and meter. The results of each measurement are then recorded per sample. After obtaining weight and height data then to determine the type of sample category Underweight (<18,5 Kg/m2); Normal (18,6 – 22,9 Kg/m2); Overweight (23,0 -27,4 Kg/m2) calculated by the IMT formula. After knowing the results of the IMT value data then the research staff calculates the nutritional state of athletes using the average Mean formula (Mielgo-Ayuso et al., 2015)

VO2max Measurement

The first stage of measuring VO2max in athletes is with the Bleep Test. The results of each measurement are then matched with the existing norm value table according to (Buttar et al., 2023; Tanner & Gore, 2012).After obtaining the results, then the researcher analyzes the data by calculating the mean count.

Measurement of Blood Cholesterol Levels

The work stage begins with checking blood cholesterol levels using a prototype of a non-invasive blood cholesterol level checking tool using an oxygen saturation sensor made by Nellcor (Rahmawati et al., 2023). The sensor/ tranduser used must be non-invasive, that is, it does not injure any part of the human body, so the method used is to attach the sensor/ tranduser to the surface of the skin. The results of work accuracy can be known by testing 50 times for each category. The first test, which is checking blood cholesterol levels using the CHODPAP method (Arisanti et al., 2025) using a portable easy touch blood check device. The next test is with a non-invasive blood cholesterol level checking device developed by Maisoha which is attached to the finger. Testing of noninvasive tools is carried out for 30 seconds in determining the reading results of cholesterol levels. The analysis used the Mann Whitney test to determine the difference in reading results of blood cholesterol levels between invasive and non-invasive tools.

Statistical analysis

Data were analyzed by T-Test. Least squares mean was determined with significance ($P < 0.05$).

RESULTS AND DISCUSSION

Nutritional Status Based on Body Mass Index (BMI)

Body Mass Index (BMI) is a widely utilized parameter for assessing nutritional status; however, its applicability to athletic populations necessitates careful interpretation due to the influence of muscle mass on body weight. Although BMI categorizes individuals into general weight classifications—such as underweight, normal weight, overweight, and obese—it does not distinguish between adipose tissue and lean body mass. Consequently, athletes with elevated muscle mass may present with higher BMI values without corresponding increases in body fat percentage, potentially leading to misclassification of their nutritional status. The nutritional status data of Taekwondo athletes based on Body Mass Index (BMI) are presented in Table 1.

Table 1. Nutritional Status of STEP Gorontalo Taekwondo Athletes Based on BMI

Variable	Distribution	Percentage (%)
Weight		
40 – 45 Kg	4	20.00
46 – 50 Kg	12	60.00
51 – 56 Kg	4	20.00
Height		
145 – 150 cm	4	20.00
151 – 155 cm	2	10.00
156 – 160 cm	5	25.00
161 – 165 cm	7	35.00
166 – 170 cm	2	10.00
Body Mass Index		
Underweight (<18,5 Kg/m^2)	8	40.00
Normal (18,6 – 22,9 Kg/m^2)	12	60.00
Overweight (23,0 -27,4 Kg/m^2)	0	0
Obesity (>27,5 Kg/m^2)	0	0

Table 2. Total Cholesterol Level of Taekwondo STEP Gorontalo athletes

The data shows that 60% of the respondents fall within the normal BMI category, indicating a balanced proportion between body weight and height. This suggests that a majority of the population maintains a healthy body composition suitable for general physical performance. Meanwhile, 40% of respondents are classified as underweight, representing a significant proportion with body weight below the ideal range. Notably, there are no individuals categorized as overweight or obese, which implies that this population generally exhibits a lean or normal body mass profile. The BMI data indicates that the majority of athletes are in an ideal physical condition for taekwondo; however, there is a significant concern regarding the underweight group. This issue requires a multidisciplinary approach involving sports nutrition, physical training, and athlete psychology for effective follow-up and intervention.

Body Mass Index (BMI) is widely recognized for its contribution to various medical conditions, and its association with certain sports-related injuries has been acknowledged, although existing evidence remains broad and limited by the scarcity of randomized controlled trials(Amoako et al., 2017). In the context of athletic performance, particularly in Taekwondo, components such as anthropometry and neuromuscular fitness have been identified as key determinants of success (Nikolaidis et al., 2016). During Kyorugi competitions, Taekwondo athletes are classified into weight categories, making body weight a critical factor in match eligibility. However, beyond mere weight classification, it is essential to maintain a balanced nutritional status and optimal body composition. Nutritional imbalances—whether in the form of excess or deficiency—can negatively impact health outcomes and hinder growth and development, especially among child and adolescent athletes (Kerksick & Fox, 2016)

Given the critical role of nutrition in supporting optimal growth, development, and performance among young athletes, the dissemination of accurate nutritional information becomes essential. Coaches, who are often regarded by athletes as a primary source of nutritional guidance, may lack adequate knowledge in this domain, potentially leading to the spread of misinformation(Jacob et al., 2019). Inadequate nutritional guidance can compromise the athlete's dietary balance, increasing the risk of delayed puberty, disordered eating behaviors, and susceptibility to injury, particularly in adolescent athletes (Desbrow et al., 2014).

Total Cholesterol Level

Dyslipidemia is a disorder of lipid metabolism and is one of the important risk factors for cardiovascular disease, in addition to other risk factors such as diabetes mellitus, obesity and hypertension (Jacobson et al.,

2015). The prevalence of dyslipidemia in 2008 was 37% in the male population and 40% in the female population and is considered responsible for 2.6 million deaths and causes 29.7 million other people to experience helplessness every year (WHO, 2020). In Indonesia, 35.9% of the population aged 15 and over has abnormal cholesterol levels, as defined by the NCEP ATP III guidelines (≥ 200 mg/dl). This means that a significant portion of the Indonesian population has cholesterol levels that may increase their risk of cardiovascular disease. Specifically, the data from the 2018 National Basic Health Research (RISKESDAS) indicates that 35.9% of Indonesians aged 15 and above have cholesterol levels exceeding 200 mg/dl, which is considered abnormal according to NCEP ATP III guidelines. This includes individuals with borderline high (200-239 mg/dL) and high (≥ 240 mg/dL) cholesterol levels. Furthermore, 22.9% of the population has low HDL (High-Density Lipoprotein) levels, and 15.9% have high LDL (Low-Density Lipoprotein) levels(Riskesdas, 2018). The results of the total cholesterol test on STEP Gorontalo taekwondo athletes can be seen in Table 2.

Group	Classification	Before Intervention (mg/dL)	After	% of Respondents Before	% of Respondents After	T-Test Result
Control	Normal (<200)	159.43	180.00	70.00%	80.00%	P > 0.05 (not significant)
	High (>200)	235.67	230.50	30.00%	20.00%	
Treatment	Normal (<200)	165.86	138.70	80.00%	100.00%	**P < 0.05 (significant)**
	High (>200)	234.67	–	20.00%	0.00%	

Table 3. VO_{2max} of Taekwondo athletes STEP Gorontalo

Based on the data from Table 2, it shows that 25.00% of respondents have high total cholesterol levels. According to (Loprinzi & Addoh, 2016), based on data from the National Health and Nutrition Examination Survey (NHANES) 1999-2006, it was found that physical activity did not affect total cholesterol levels much, but influenced HDL cholesterol and triglyceride levels. A similar finding was reported by (Crichton & Alkerwi, 2015), who emphasized that lifestyle modifications, particularly an increase in moderate-intensity physical activity, can elevate high-density lipoprotein (HDL) cholesterol levels. HDL accounts for approximately 25–30% of circulating lipoproteins involved in lipid transport within the bloodstream. These lipoprotein particles vary in size and lipid composition. Emerging evidence suggests that the functionality of HDL—determined by its structural characteristics such as particle size, shape, and protein-lipid composition—may be more relevant to cardiovascular health than its concentration alone. HDL functionality is reflected in its cholesterol efflux capacity and its antioxidant, anti-inflammatory, and antithrombotic properties, including its role in protecting low-density lipoprotein (LDL) from oxidative damage.

A substantial body of evidence from various studies and meta-analyses supports the positive influence of aerobic exercise on high-density lipoprotein cholesterol (HDL-C) levels. Regular physical activity is consistently associated with increased HDL-C concentrations, along with reductions in low-density lipoprotein (LDL) cholesterol and triglyceride levels. Beyond these quantitative changes in lipid profiles, exercise has also been shown to promote favorable modifications in HDL particle maturation, composition, and functionality, thereby enhancing its atheroprotective properties (Franczyk et al., 2023)

The T-Test results (Table 2), showed that the treatment group had an effect on the cholesterol levels of respondents while the control group had no effect. The treatment group experienced a decrease in blood cholesterol levels of respondents, where the category of high cholesterol levels (> 200 mg/dL) no longer existed. This shows that Tiliaya intervention in athletes can reduce blood cholesterol levels. The fat content in tiliaya products was reduced

by replacing coconut milk with fiber creme. Optimal fat intake for athletes is essential to support energy production and muscle function. Fat serves as a significant source of energy, especially during prolonged low to moderate intensity exercise, and is essential for maintaining overall health and performance. The recommended fat intake for athletes is generally around 35% of total caloric intake, which supports sufficient energy availability and intramuscular triglyceride storage, which is critical for endurance activities (Lowery, 2004; Pendergast et al., 2000). This intake should be balanced with carbohydrates to ensure glycogen replacement, especially for endurance athletes (Puglisi, 2019)

Saturated fat and trans fat intake should be minimized due to their adverse health effects (Morenga & Montez, 2017), Saturated fat (SFA), ω-6 (n-6) polyunsaturated fat (PUFA), and trans fat (TFA) influence risk of coronary heart disease (CHD) (Wang et al., 2016). Therefore in this study the use of coconut milk was replaced with Fiber cream to reduce saturated fat and trans fat. Although increasing dietary fat can be beneficial, this should not be at the expense of carbohydrate intake, which is important for glycogen storage and high-intensity performance (Puglisi, 2019). Fat intake should be tailored to the athlete's specific sport, training intensity and individual metabolic response (Jäger et al., 2019). While increasing fat intake may improve endurance performance, it is crucial to maintain a balanced intake of carbohydrates and protein to support overall energy needs and muscle recovery. Excessive fat intake without sufficient carbohydrates can lead to glycogen depletion, which negatively impacts performance, especially in high-intensity exercise (Puglisi, 2019).

Maximal Oxygen Consumption (VO2max)

Several factors affect athlete achievement, namely mastery of techniques, physical condition, psychology, and tactics or strategies in competing. And one of the factors that affect the achievement of taekwondo athletes is physical condition. There are several physical conditions that are very important and needed by taekwondo athletes including VO2max, leg muscle explosiveness, agility and flexibility. In Physical Aspects, Taekwondo is very different from many martial arts as it is very dynamic with active movements that include a myriad of foot skills. The development of technical skills in taekwondo and their quality depends on the functional and physical specifics of the preparation (M. Hadad et al., 2014). Taekwondo is also considered a high-intensity intermittent martial sport, making it difficult to assess the effort put in by athletes during competition or simulated combat (Herrera-Valenzuela et al., 2015). VO2max is the maximum volume of oxygen, or a level of body ability expressed in liters per minute or milliliters/minute/kg body weight (R. Tanner & Gore, 2012) Success in endurance is primarily determined VO2max(Parmar et al., 2021). Based on this statement, it can be concluded that VO2max is the maximum limit of oxygen in the human body which is caused by loading for a relatively long time. The results of VO2max measurements using the bleep test are presented in Table 3.

VO_2Max Criteria	Before Intervention - Control	Before Intervention - Treatment	After Intervention - Control	After Intervention - Treatment	% Respondents Before - Control	% Respondents Before - Treatment	% Respondents After - Control	% Respondents After - Treatment
Very Low	42.3	43.1	42.5	–	20.00%	10.00%	10.00%	0.00%
Low	48.0	46.2	46.3	–	40.00%	50.00%	20.00%	0.00%
Moderate	51.9	50.0	51.2	52.91	30.00%	30.00%	60.00%	70.00%
Good	59.0	60.1	60.1	60.67	10.00%	10.00%	10.00%	30.00%
T-Test Result	P > 0.05 (Not Significant)			**P < 0.05 (Significant)**				

Based on the results of the study, the highest percentage of VO2max at STEP Gorontalo Taekwondo athletes is in the deficient (very less) category of 10 - 20%. These results need to be improved to achieve athlete performance. The most important thing that must be possessed by an athlete, especially a taekwondo athlete, is good physical condition, especially in kyorugi matches which really require good physical condition when in the arena. Because according to what has been explained above, if the level of physical fitness is good, it will avoid the possibility of injury which usually often occurs if someone does meaningful physical work. If the athlete's physique is good, the athlete will quickly master the techniques trained(Parmar et al., 2021).

The results of the T-Test test on VO2max, showed that the control treatment had no effect, while the treatment group had an effect on the athlete's VO2max. The optimum energy content in Tiliaya causes maximum athlete energy when testing VO2max with the Bleep Test method.The relationship between fat intake and VO2max is complex and may vary depending on the specific needs of the athlete and the nature of their sport. A low-carbohydrate, high-fat (LCHF) diet can improve fat oxidation and metabolic flexibility without compromising VO2max performance. Athletes on a LCHF diet get most of their energy from fat, even at high exercise intensities, which suggests improved metabolic flexibility (Prins et al., 2023).

High-fat diets (42% to 55% of total calories) have been shown to improve endurance by increasing fat oxidation, which conserves glycogen reserves during prolonged exercise (Pendergast et al., 2000). A balanced diet with approximately 30% of total calories from fat, in addition to sufficient carbohydrates and protein, is recommended for athletes. This composition supports energy needs and glycogen replenishment, which is crucial for maintaining VO2max and overall performance (Pendergast et al., 2000; Prins et al., 2023).

Excessive fat restriction is not recommended as it can lead to inadequate energy intake, negatively impact performance and increase the risk of fatigue and injury (Puglisi, 2019). While LCHF diets may improve fat metabolism, they may not improve performance in all athletes or sports. Some studies have shown that high-carbohydrate diets are more effective for improving aerobic performance, especially in high-intensity sports (Bock & Kruse, 2017)

The effectiveness of fat intake strategies can depend on an athlete's training status, duration of competition, and individual metabolic response(Bock & Kruse, 2017), although higher fat intake may improve flexibility and metabolic endurance, the optimal fat intake to maximize VO2max may vary. Athletes should consider their specific exercise needs and personal metabolic response when determining their dietary fat intake.

CONCLUSION

This study demonstrates that the intervention of a reformulated food supplement, Tiliaya (using fiber creme as a substitute for coconut milk), has a significant impact on improving the physical fitness of STEP taekwondo athletes in Gorontalo, particularly by reducing total cholesterol levels and enhancing VO2max capacity.

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