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Protein-Based Soy Flour Supplementation to Support the Effects of Weight Training on Muscle Hypertrophy

Suplemento de harina de soja a base de proteínas para respaldar los efectos del entrenamiento con pesas sobre la hipertrofia muscular

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Abstract. Replacement supplements are required for optimal muscular hypertrophy in athletes. However, not all athletes can afford high-protein supplements due to their high expenses. The aim of this paper is to investigate and demonstrate the efficacy of protein-based supplements in enhancing the effects of resistance training on muscle growth. This method of study is a pseudo-experimental pre-test-posttest design. Using the entire sampling technique, 14 PPLP West Sumatra Indonesian Pencak silat athletes were used as study samples. The research procedure includes the measurement of thigh muscle circumference and thigh fat thickness of athletes (pretest), treatment of lunges 1-8 times, measurement of thigh muscle circumference and thigh fat thickness of athletes after eight treatments (midtest), and the size of thigh muscle circumference and thigh fat thickness after 9-16 lunges training sessions (posttest). Soy flour was administered depending on the athlete's average food intake, administered 30 minutes after the lunges exercise. The lunge training consisted of 16 sessions, moderate intensity (30% - 50% of maximum capacity), six repetitions, five sets, and 3 - 6 minute intervals. A tape meter was used to measure thigh muscle circumference and skinfold thickness to calculate thigh fat thickness using the formula MTMC = MTC - skinfold thickness (3.14 x TSF). The test utilized was the Kruskal-Wallis test. The examination of the data yielded a p-value of 0.03 < 0.05 and a percentage increase of 10.68%. In lunges training, high-protein soy flour can be administered as an alternative or replacement for supplements for muscular hypertrophy.
Keywords: Muscular Hypertrophy, Soy Flour, Lunges

Abstracto. Se requieren suplementos de reemplazo para una hipertrofia muscular óptima en los atletas. Sin embargo, no todos los deportistas pueden permitirse suplementos ricos en proteínas debido a sus elevados gastos. El objetivo de este artículo es investigar y demostrar la eficacia de los suplementos a base de proteínas para mejorar los efectos del entrenamiento de resistencia en el crecimiento muscular. Este método de estudio es un diseño pseudoexperimental pretest-postest. Utilizando toda la técnica de muestreo, se utilizaron como muestras de estudio 14 atletas de silat Pencak indonesio del PPLP Sumatra Occidental. El procedimiento de investigación incluye la medición de la circunferencia del músculo del muslo y el espesor de la grasa del muslo de los atletas (prueba previa), el tratamiento de estocadas de 1 a 8 veces, la medición de la circunferencia del músculo del muslo y el espesor de la grasa del muslo de los atletas después de ocho tratamientos (prueba intermedia) y el tamaño de circunferencia del músculo del muslo y grosor de la grasa del muslo después de 9 a 16 sesiones de entrenamiento de estocadas (prueba posterior). Se administró harina de soja dependiendo de la ingesta promedio de alimentos del atleta, administrada 30 minutos después del ejercicio de estocadas. El entrenamiento de estocadas consistió en 16 sesiones, intensidad moderada (30% - 50% de la capacidad máxima), seis repeticiones, cinco series e intervalos de 3 a 6 minutos. Se usó una cinta métrica para medir la circunferencia del músculo del muslo y el espesor de los pliegues cutáneos para calcular el espesor de la grasa del muslo usando la fórmula MTMC = MTC - espesor de los pliegues cutáneos (3,14 x TSF). La prueba utilizada fue la prueba de Kruskal-Wallis. El examen de los datos arrojó un valor p de 0,03 <0,05 y un aumento porcentual del 10,68%. En el entrenamiento de estocadas se puede administrar harina de soja rica en proteínas como alternativa o sustituto de los suplementos para la hipertrofia muscular.
Palabras clave: hipertrofia muscular, harina de soja, estocadas

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Introduction

The combination of protein consumption and resistance training is a powerful dietary stimulant for muscle protein synthesis. Post-exercise protein ingestion can improve muscle protein synthesis and result in a favorable net protein balance (Moore et al., 2009; Rifki & Mario, 2014), optimizing recovery, muscle repair, and glycogen replenishment (Naclerio et al., 2019). Protein-containing supplements should be consumed at a rate of at least 1.6g protein/kg/weight per day (Morton et al., 2018). Average growth in early childhood is one of the protein benefits (Rodriguez, 2005), as well as avoiding aging in the elderly (Joy et al., 2013) and maximizing lean body mass (Hudson et al., 2020). A statement issued on nutrition and athletic performance by the American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada suggests that athletes may need to consume 50 to 100 percent more protein for exercise-related energy production, post-exercise muscle damage repair, and muscle hypertrophy (Rodriguez et al., 2009).

One of the macronutrients necessary for supporting biological functions is protein. Protein is a material whose chemical composition includes the elements Oxygen (O), Carbon (C), Hydrogen (H), and Nitrogen (N), as well as sulfur (S) and phosphorus (P), which together form amino acid units (Welis & Syafrizar, 2009). Amino acids (AA) included in dietary protein serve as building blocks for all critical organs, muscles (including heart muscle), hormones, and biological fluids, including blood (Welis, 2017). Animal and plant-based protein sources are gaining in popularity, as seen by the rising consumer demand (Henchion et al., 2017). Protein supplementation is frequently advised (Ma et al., 2011). However, most re-

search focuses on the effects of consuming isolated protein reconstituted in liquid beverages (Burd et al., 2015), as reconstituted protein has been found to minimize muscular fatigue after resistance training regimens (Babault et al., 2014). Soybeans have a high protein concentration and a low carbohydrate level, making them a unique source of vegetable protein compared to other legumes (Hoffman & Falvo, 2004). To reduce ecological exploitation, creating plant-based protein sources can be a viable solution (Kumar et al., 2017). Soy products are a primary dietary source of the isoflavone glycosides genistin and daidzin, which are metabolized by colonic microflora into the biologically active aglycones genistein and daidzein (Allen et al., 2001). This includes soy milk, a functional food rich in isoflavone sources, including genistein, daidzein, glycitin, bioactive peptides, unsaturated fatty acids, and fiber. Soy protein satisfies the requirements for all essential amino acids except methionine (Denkova & Murgov, 2005); hence, 90% of soy protein is absorbed by the body, whereas 95-100% of milk is digested (Ghosh et al., 2010). Soy protein may provide several advantages over animal protein, such as reducing blood cholesterol levels and boosting muscle mass and muscle strength (Tokede et al., 2015).

Resistance training (RT) is an exercise modality that maximizes and stimulates muscle hypertrophy during a particular activity (Nunes et al., 2021). Weight training that is structured and scheduled will result in improved muscle growth and muscle building or greater muscular mass. Lower body workouts include lunges (Cronin et al., 2003) or lower body exercises (Krause Neto et al., 2020). In weight training, dietary intake is a consideration that must be made. Muscle growth is enabled by adequate nutritional intake or intake following the body's needs. The development of muscle mass and strength is governed by scheduled activity and a healthy, well-balanced diet. The primary function of protein in sports is to facilitate muscular growth. Protein is also utilized to repair exercise-damaged muscles. Several aspects of weight training must be addressed, including exercise intensity and volume, exercise sequence, number of repetitions, sets, movement pace, rest times between sets, and exercise types (Ralston et al., 2018). Muscle hypertrophy training can be beneficial with both short (60 seconds or less) and extended (more than 60 seconds) rest times between sets (Grgic et al., 2017). Thus, muscle growth can be achieved with weight training with the proper training program, supported by the consumption of soy protein (Deibert et al., 2011).

Several studies have investigated the effect of high-protein supplements, such as soy protein and resistance training, on the muscular performance and bone health of postmenopausal women with osteoporosis (Shenoy et al., 2013). In association with resistance exercise, pea protein powder supplements can increase some aspects of muscular growth and strength in older persons (Lamb et al., 2020). In addition, protein supplements and antioxidants can aid in the rehabilitation of muscular function following an unexpected attack (Ives et al., 2017). Even in older women, resistance exercise enhances physical performance and muscle condition (Hofmann et al., 2016). Mycoprotein is composed of amino acids and bioavailability as a prospective dietary protein source to assist skeletal muscle protein metabolism and preserve muscle mass for healthy aging (Coelho et al., 2020). Consuming 40g of protein after resistance exercise is expected to contribute to positive strength and body composition adjustments in the elderly via fat mass reduction (Atherton et al., 2020). Lipolysis-stimulating peptides from soy protect skeletal muscle from apoptosis caused by a high-fat diet (Marthandam Asokan et al., 2018). However, research has yet to evaluate the effects of protein supplementation and resistance training on muscle hypertrophy. Consequently, our work is innovative in offering a protein-based soy flour supplement to enhance the impact of resistance training (lunges) on muscular development.

This study aims to investigate and demonstrate the efficacy of protein-based supplements in enhancing the effects of resistance training on muscular growth. Soy flour is the protein supplement in question, while lunges are the weight workout in question. This research is anticipated to be helpful as an alternative for weightlifters who desire or are undertaking a muscle hypertrophy program for athletes.

Materials and Methods

Research Design

This study is a quasi-experiment with a one-group pre-test-posttest design; the experimental group is the only group in the study; there is no control group (Montgomery, 2013). In this study, the experimental group is given weight training while consuming high-protein foods, including soy flour. There are five steps in this study: pre-test stage, treatment stage, mid-test stage, treatment stage, and post-test stage. Before treatment, athletes' thigh muscle size and thigh fat thickness were measured during the pre-test phase. Next, treatment was given for 1-8 meetings, after which mid-test data was taken. After the mid-test data is obtained, the treatment continues for 9-16 meetings, then continues with final data collection (post-test).

Participants

Fourteen Pencak silat athletes from the West Sumatra Indonesian Student Sports Education and Training Center (PPLP) of West Sumatra, Indonesia, participated in this study using the total sampling technique. This research was conducted after obtaining approval from the Department of Investment and One Stop Integrated Services with Number: 570/15788-PERIZ/DPM&PTSP/VIII/2021.

Procedures

There are five steps in this study: pre-test stage, treatment stage, mid-test stage, treatment stage, and post-test stage. Before treatment, athletes' thigh muscle size and

thigh fat thickness were measured during the pre-test phase. In Stage 2 (treatment), the sample did a lunges training program, a walking activity with the body in an upright position and the view directed ahead; the legs could be bent to a 90-degree angle. At 1-8 sessions, lunges are performed with a moderate intensity of 30% to 50% of maximal capacity, 6x repetitions, five sets, and a 3 to 6-minute break. 30 minutes after performing lunges. The samples consumed a protein supplement. The protein supplement is soy flour, and the dose administered is 29 grams, equivalent to 72 grams of soy flour. The amount is determined by averaging the meal intake of athletes before therapy. After 1-8 treatments, athletes' thigh muscle diameter and fat thickness were measured during the third stage (mid-test). In Stage 4 (treatment), the sample returned to lunge training, performed 9-16 times with moderate effort (30% - 50% of maximum capacity), 6x repetitions, five sets, and 3 - 6 minute intervals. Thirty minutes after performing lunges, the subject consumed a protein supplement. The protein supplement provided is soy flour, with 29 grams of protein corresponding to 72 grams of soy flour. The average food intake of athletes before treatment is used to calculate the dose. Athletes' thigh muscle circumference and fat thickness are measured at stage 5 (post-test) once the entire training program and protein supplementation procedures have been completed. This research was carried out at a sports arena with a frequency of 4 sessions in 4 weeks on Monday, Wednesday, Friday and Sunday. This research was also supervised by the researchers themselves and the trainers. Can be seen in the image below.

Figure 1. Research Design

Information :
P : Research Population
S : Sample
Pre : Pre-Test
Treatment : Treatment
Mid : Mid-Test
Post : Post-Test

In addition, the treatment carried out refers to training principles, for example individual principles, overload principles, training components (sets, repetitions, recovery and training intensity. Not only that, signs for strength training have been included in the program according to the objectives Exercise is to increase hypertrophy.

Instruments

The thigh muscle diameter is measured with a measuring tape (meter). While the thigh fat thickness is measured by skinfold thickness.

After obtaining the data (Benjamin Caballero, Lindsay Allen, 2005), the information is formulated: MTMC = MTC – (3.14 X TSF). MTMC = Thigh Muscle Circumference, MTC = Thigh Circumference, TSF = Thigh Fat Thickness.

Table 1.
Measurement of Thigh Muscle Hypertrophy

Instruments	Objective	Unit
Tape Measure	Thigh Circumference	CM
Skinfold Thickness	Thigh Fat Thickness	MM

Statistical Analysis

This research does not use the analytical requirement test assumptions of either normality or homogeneity, therefore this research uses the Kruskall-Wallist Test. The Kruskall-Wallist test was used to examine the data. The Kruskall-Wallist test is a nonparametric test used to determine whether there is a significant difference between groups of independent variables and the dependent variable. This test is identical to the one-way ANOVA test in parametric testing; hence, it is an alternative to the one-way ANOVA test if the analysis requirements test's assumptions are not met.

Results

Variable Descriptions

The objective of the variable description is to describe the primary study variables, including age, gender, weight, height, and body mass index.

Table 2.
Variable Descriptions

Variable	Entire Sample (N = 14)
Sex, No.	
Male	7
Female	7
Characteristic, Entire Sample, and mean ± SD.	
Age, y	17
Height, m	166,4 ± 5,8
Mass, kg	59,8 ± 9,0
Body Mass Index	21,5 ± 2,5

Data Descriptions

The purpose of the data description is to describe the pre-test, mid-test, and post-test data about thigh muscle hypertrophy. After carrying out initial measurements, treatment, and posttest, it was found that in each test there was an improvement, for example in the initial test to the mid test the average hypertrophy score was 3.92 ± 30.6 and 23.05 ± 5.57. Meanwhile, during the post-test measurements, the results of hypertrophy were 34.8 ± 12.29. For more clarity, see Table 3 and Figure 2.

Table 3.
Statistical Description of Muscle Hypertrophy Data

Group	N	Data	Muscle	Minimum	Maximum	Average	Std.Dev
	14	Pre-Test	Thigh	-35.6	51.3	3.92	30.6
Experiment	14	Mid-Test	Thigh	13.5	30	23.05	5.57
	14	Post-test	Thigh	15.5	50.3	34.8	12.29

Note: - Unit (mm)

Hypothesis Testing

The Kruskal-Wallis test examines the average difference between more than two groups. If the research data

to be analyzed are in the form of ranked data or data on an ordinal scale, this test statistic can be employed instead of the one-way ANOVA test. As with other nonparametric tests, the Kruskal-Wallis Test does not require the main distribution to be normal and homogenous.

Table 4 explains that there is an increase in significance for each group, and also shows that the significance value is ($p < 0.05$). Shows that protein supplementation substantially supports the benefits of resistance training in improving thigh muscle hypertrophy.

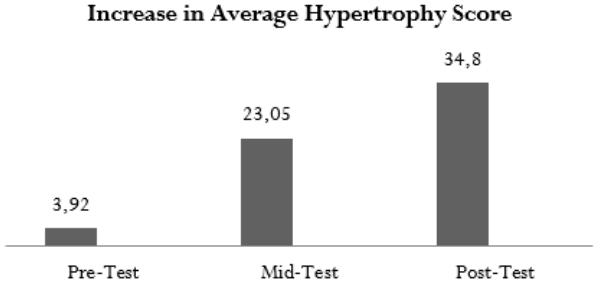

Figure 2. Statistical Description of Muscle Hypertrophy Data

Table 4.
Kruskal-Wallis Test of Muscle Hypertrophy Data

Group	N	Significance
Pre-Test vs Mid-Test	14	0.55
Mid-Test vs Post Test	14	0.01
Pre-Test vs Mid-Test vs Post-Test	14	0.03

Note: Significance ($p < 0,05$)

Discussions

According to the findings of our study, supplementing with protein after weight training can result in a 10.68% increase in thigh muscle growth. Regarding the outcomes of the statistical test, the p-value is $0.03 < 0.05$. To get optimal thigh muscle development, ingesting protein supplements is a viable alternative to weight training. The results of this study are consistent with previous research indicating that consuming 40 g of protein after resistance training led to a more significant response in the elderly (Atherton et al., 2020), protein supplementation after resistance training promotes increased muscle protein synthesis, which ultimately results in more significant net muscle gain (Figueiredo & Cameron-Smith, 2013), and natural whey protein increases phosphorylation, the rate of muscle protein synthesis to a greater extent (Hamarsland et al., 2017) and increases abdominal fat loss and fat-free relative mass adaptation in response to resistance training (Hulmi et al., 2015) and maintaining and gaining weight for professional athletes (Puya-Braza & Sanchez-Oliver, 2018).

Muscle mass and muscle strength are positively affected by protein intake from legumes (Mangano et al., 2017), and the time of post-exercise consumption of fat-free milk is effective in encouraging enhanced lean body mass, strength, muscle hypertrophy and decreased body fat (Stark et al., 2012). Consistent with prior studies, the results of this study indicate that soy protein causes lean muscle growth when combined with weight training (Mario, Komaini, Welis, Sepdanius, et al., 2022). During weight training, the consumption of soy milk can facilitate amino acid delivery to muscles and protein synthesis, hence supporting the creation of muscular hypertrophy (Fardi & Welis, 2018). Non-whey soy protein can protect against oxidative damage (Brown et al., 2004). According to a previous study, the use of soy is on the rise due to its excellent nutritional content and health benefits (Wang et al., 2020). Muscle mass and muscle strength are positively affected by protein intake from legumes (Mangano et al., 2017), and the time of post-exercise consumption of fat-free milk is effective in encouraging enhanced lean body mass, strength, muscle hypertrophy and decreased body fat (Stark et al., 2012). Consistent with prior studies, the results of this study indicate that soy protein causes lean muscle growth when combined with resistance training.

During weight training, the consumption of soy milk can facilitate amino acid delivery to muscles and protein synthesis, hence supporting the creation of muscular hypertrophy (Fardi & Welis, 2018). Non-whey soy protein can protect against oxidative damage (Brown et al., 2004). According to a previous study, the use of soy is on the rise due to its excellent nutritional content and health benefits (Wang et al., 2020). According to this study's findings, soy milk is an excellent source of dietary fiber, numerous minerals, and phytochemicals, consistent with prior studies. Soy milk is an extract of soybean water.

Additionally, soy milk is low in fat and a cost-effective source of protein, making it appropriate for vegan and lactose-intolerant populations (Bogsan et al., 2015). Moreover, soy milk contains valuable components such as soy protein, peptides, saponins, oligo-polysaccharides, and isoflavones and is regarded globally as a healthful beverage (Messina, 2016). Protein supplementation will only result in muscle hypertrophy in the presence of carefully planned, structured, and prolonged resistance training. According to previous research, an effective exercise program should have the right intensity, frequency, and duration (Josse et al., 2010). In weight training, it is essential to know the following: exercise intensity and volume, exercise sequence, number of repetitions, sets, movement tempo, rest time between sets, and exercise type (Ralston et al., 2018). Resistance training with short (60 seconds or less) and long (more than 60 seconds) inter-set rest intervals can be helpful in training muscle hypertrophy (Grgic et al., 2017). Likewise, slow movements in weight training can produce muscle hypertrophy (Mario, Komaini, Welis, Rifki, et al., 2022). Protein supplements benefit muscle hypertrophy, strength, and myofibrillar protein synthesis (soybean) (Josse et al., 2010). In line with research (González et al., 2022) training in accordance with guidelines will provide optimal results to a large extent, and the

application of internal focus (IF) contributes to muscle hypertrophy in strength-trained men (Vargas-molina et al., 2023).

The researchers believe that ingesting protein supplements after weight exercise promotes muscular growth. However, we recognize that future research will need to validate certain limits. These limitations include that weight training was administered for one month (4 weeks) with a well-designed program (approved by specialists in sports coaching). A more extended period (> 1 month of movement) and a more effective program would have affected the results of this study. The sample size still needs to be increased. Hence a larger sample size is recommended. It is also required to include another treatment group as a comparison or control group (not given protein supplementation) so that the efficacy of the group receiving protein supplementation can be compared to that of the group not receiving protein supplementation.

Conclusions

This study concludes that protein supplementation with weight training is a highly effective alternative for muscular hypertrophy. According to the findings of our study, protein supplementation (soy flour) during weight training (lunges) is highly influential for thigh muscle growth, with a significance P-value ($k < 0.05$) and a percentage increase of 10.68%. Ingesting any protein supplementation will only have an effect following a well-planned, structured, and sustainable exercise routine. Consumption of this protein supplement must be customized to each athlete's demands to get the best training results. The advantages of this protein supplement have been nutritionally analyzed at the Analysis and Calibration Laboratory of the Balai Besar Agro-Bogor Industry. The high protein food contains more protein than other content. Additionally, this high-protein food does not contain preservatives, dyes, or different flavors, and the price is relatively low and affordable compared to other high-protein supplements. The results of this study are anticipated to be valuable for athletes as an alternative to weight training who desire or are implementing a muscle hypertrophy training program, for coaches as evaluation material, and for nutritionists as subject matter experts.

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Conflict of Interests

The authors disclose that there is no conflict of interest.

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