

## Consuming soy flour after weight training: An alternative to increase leg muscle strength Consumir harina de soja después del entrenamiento con pesas: una alternativa para aumentar la fuerza de los músculos de las piernas

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**Abstract.** The aim of this study was to find out whether soybean flour and lunge training can have a significant effect on muscle strength. This research method is a pre-test-post-test design (quasi-experiment). Using a total sampling technique, 14 Indonesian PPLP West Sumatra Pencak Silat athletes were used as research samples. The research procedure included measuring muscle strength (leg dynamometer) before administering 29g protein after lunges training (pre-test). Then the treatment was given in 16 meetings, with a frequency of 2 sessions per week for 8 weeks. The intensity of the training/intervention given was submaximal (80% to 90% of maximum capacity). Giving soy flour to athletes 30 minutes after training is in accordance with the protein requirements given to athletes in each session, namely 29 grams of protein equivalent to 73 grams of soy flour with the addition of 1 tablespoon of granulated sugar and 200 ml of water. The results of statistical tests using the t test showed that testing the data resulted in ( $p < 0.05$ ) a percentage increase of 6.91%. In conclusion, adding protein supplementation to support weight training can increase muscle strength. Planned, structured and consistent exercise is necessary for any protein supplement to work. The use of this protein supplement must be adjusted to the needs of each participant to get the best preparation results. The findings of this research can be used by athletes who want to or are currently implementing a training program, as well as coaches as evaluation material, and nutritionists as material experts.

**Keywords:** Muscle Strength, Soybean Flour, Lunges, Pencak Silat

**Resumen.** El objetivo de este estudio fue descubrir si la harina de soja y el entrenamiento de estocadas pueden tener un efecto significativo sobre la fuerza muscular. Este método de investigación es un diseño pre-test-post-test (cuasi-experimento). Utilizando una técnica de muestreo total, se utilizaron como muestras de investigación 14 atletas indonesios de PPLP West Sumatra Pencak Silat. El procedimiento de investigación incluyó medir la fuerza muscular (dinamómetro de piernas) antes de administrar 29 g de proteína después del entrenamiento de estocadas (prueba previa). Luego el tratamiento se dio en 16 sesiones, con una frecuencia de 2 sesiones por semana durante 8 semanas. La intensidad del entrenamiento/intervención realizada fue submáxima (80% a 90% de la capacidad máxima). Dar harina de soja a los deportistas 30 minutos después del entrenamiento está de acuerdo con los requerimientos proteicos proporcionados a los deportistas en cada sesión, es decir, 29 gramos de proteína equivalentes a 73 gramos de harina de soja con la adición de 1 cucharada de azúcar granulada y 200 ml de agua. Los resultados de las pruebas estadísticas utilizando la prueba t mostraron que probar los datos dio como resultado ( $p < 0,05$ ) un aumento porcentual del 6,91%. En conclusión, agregar suplementos proteicos para apoyar el entrenamiento con pesas puede aumentar la fuerza muscular. El ejercicio planificado, estructurado y constante es necesario para que cualquier suplemento proteico funcione. El uso de este suplemento proteico debe ajustarse a las necesidades de cada participante para obtener los mejores resultados de preparación. Los resultados de esta investigación pueden ser utilizados por deportistas que quieran o estén implementando actualmente un programa de entrenamiento, así como por entrenadores como material de evaluación y nutricionistas como expertos en material.

**Palabras clave:** Fuerza muscular, Harina de soja, Estocadas, Pencak Silat

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### Introduction

Pencak silat is a traditional and modern martial art that is performed both solo and in duels with or without musical accompaniment (Damrah et al., 2023; Kartomi, 2011). Pencak silat provides physical exercise for teenagers that can improve overall physical fitness. The sparring category is one of the categories contested in Pencak Silat, in this sparring category the kicking technique is very important to master because kicking is one of the attack techniques in Pencak Silat, the muscles that play a role in kicking are the rectur femoris, broadus intermedius, broadus medialis, broadus lateralis, gluteus maxumus, semimembranosus, bicep femoris, iliosoas, pectineus, tensor fascia latae, adductor longus and soleus (Demorest et al., 2016). However, this kick is difficult for athletes to master because the muscles involved in the kick are not working optimally. Therefore, these muscles need to be supported by a combination of weight training and post-workout protein

intake (Rifki et al., 2023).

Protein is a macronutrient supplement that supports biological functions. The elements oxygen (O), carbon (C), hydrogen (H), nitrogen (N), sulfur (S), and phosphorus (P), which form the amino acid units of proteins, make up the chemical composition of the material. All vital organs, muscles (including heart muscle), hormones, and biological fluids, including blood, are built from amino acids (APA) found in food proteins (Welis, 2017). Consuming protein supplements is highly recommended (Ma et al., 2011) because in sports, the main function of protein is to facilitate muscle growth. In addition, protein helps repair muscles damaged by exercise. However, most research focuses on the effects of drinking liquid protein isolate (Burd et al., 2015), because it has been found that reconstituted protein can reduce muscle fatigue after resistance training (Babault et al., 2014). Soybean is one of the isolated proteins that is soluble in water. When compared to other nuts, soybeans are a unique source of vege-

table protein because they contain high concentrations of protein and low amounts of carbohydrates (Hoffman & Falvo, 2004). Developing plant-based protein sources may be the best option to reduce ecological exploitation (Kumar et al., 2017). Soy products are an important dietary source of the isoflavone glycosides genistein and daidzine, which are utilized by colonic microflora to form the dynamic aglycones genistein and daidzein (Allen et al., 2001). Soy milk is one of them, and is a functional food full of isoflavones such as glycitein, genistein, daidzein, and bioactive peptides as well as unsaturated fatty acids and fiber. Soy protein contains all the essential amino acids, except methionine (Denkova & Murgov, 2005). As a result, the body absorbs 90% of soy protein and digests 95-100% of milk (Ghosh et al., 2010). Compared to animal protein, soy protein has a number of benefits, including lowering blood cholesterol levels and increasing muscle mass and strength (Tokede et al., 2015).

Lack of protein intake in athletes greatly affects muscle strength and athlete performance (Puya-Braza & Sanchez-Oliver, 2018). Protein intake can be a post-workout supplement to obtain quality muscle strength and can improve athlete performance. Muscular strength (i.e., the ability of a muscle to exert force), endurance (i.e., the ability of a muscle to continuously perform consecutive efforts or many repetitions) and strength (i.e., the ability of a muscle to exert force per unit time) differ in practice (Garber et al., 2011; Marlina et al., 2023). Muscle strength can be gained with exercise and supplementation (Izquierdo et al., 2002). One form of weight training that targets the lower body is lunges (Cronin et al., 2003). Better muscle growth and greater muscle development or muscle mass are the result of structured and scheduled weight training (Welis et al., 2024). Several parts of weight training should be thought about, including strength and volume of activity, sequence of activity, number of repetitions, sets, speed of development, rest time between sets, and type of activity (Pratama et al., 2024; Ralston et al., 2018). Additionally, progressive weight training works best when done every other day (Ireland, 1975). With the right weight training plan and soy protein intake, muscle growth can be achieved (Deibert et al., 2011).

Weight training with protein is a powerful source of energy and protein for muscles (Berhimpong et al., 2023; Welis et al., 2024). Post-exercise protein use can also increase muscle protein accumulation and produce a good net protein balance, by maximizing glycogen replenishment, muscle repair and recovery (Naclerio et al., 2019). Supplements containing protein should consume at least 1.6g protein/kg/weight per day (Morton et al., 2018). Average growth in early childhood is one of the benefits of protein (Rodriguez, 2005), and avoid aging in the elderly (Joy et al., 2013) and maximize lean body mass (Hudson et al., 2020; Perdana et al., 2021). According to a statement on nutrition and athletic performance made by the American College of Sports Medicine, the American Dietetic Association, and the Dietitians of Canada, athletes

may need 50 to 100 percent more protein to produce exercise-related energy, repair exercise-related muscle damage, and build muscle (Rodriguez et al., 2009; Sridadi et al., 2021; Sukarmin et al., 2021). In power lifting, food intake is something you have to think about. With the right amount of food or according to the body's needs, muscle growth can occur. Increases in mass and strength are represented by ordered workouts and a healthy, customized diet.

Several studies have investigated the effects of high protein supplements, the effects of high protein supplements such as soy protein and resistance training on postmenopausal women on muscle performance and bone health. Osteoporosis has been the subject of many studies (Shenoy et al., 2013). In conjunction with obstruction training, increasing pea protein powder may work on some areas of muscle growth and strength in older individuals (Lamb et al., 2020). Additionally, increased protein and cell strengthening can help rebuild muscle capacity after a surprising workout (Ives et al., 2017). Even in older women, resistance training improves physical performance and muscle condition (Hofmann et al., 2016). Mycoprotein consists of amino acids and is bioavailable as an upcoming dietary protein source to aid in the digestion of skeletal muscle proteins and compensate for large amounts for healthy maturation (Coelho et al., 2020). Consuming 40g of protein after endurance exercise can increase positive strength and change body composition in old age through reducing fat mass (Atherton et al., 2020). Soybean peptides that induce lipolysis protect skeletal muscle from apoptosis on a high-fat diet (Asokan et al., 2018). However, the effects of weight training and protein supplementation on muscle strength have not been examined in any studies. As a consequence, our work is groundbreaking because it provides a protein-rich soy food supplement to enhance the effects of weight training on muscle strengthening. The aim of this research is to determine the effectiveness of leg muscle strength training interventions using lunges and providing protein-based supplements, namely soy flour. This research is useful in confirming that the lunges training menu in a regular physical training program can progressively increase leg muscle strength in Pencak Silat athletes if done well. High protein food sources contain more protein than other ingredients. In addition, this high protein food does not contain any added flavors, colorings or preservatives, and is cheaper than other high protein supplements.

## Materials and Methods

### Research design

This research is a quasi-experiment with a one group pretest-post-test design, there is no control group (Montgomery, 2013). In this study, the experimental group was given weight training by consuming high protein foods such as soy flour 30 minutes after exercise. Samples were taken using total sampling technique.

### Participant inclusion and exclusion criteria

14 Indonesian West Sumatra PPLP Pencak Silat athletes were used as research samples. With 7 male and 7 female Pencak Silat athletes from the Student Sports Education and Training Center (PPLP) West Sumatra Indonesia willing to take part in this research, the characteristics of the participants were an average age of 17 years, both male and female. For boys, the average weight is 61.85kg, the average height is 169.71cm, the average body mass index is 21.66. Meanwhile, for girls, the average weight is 57.85kg, the average height is 163.14, the average body mass index is 21.59. Samples were taken using total sampling technique. This research was conducted after receiving a consent form because it involved minors from the Department of Investment and One Stop Integrated Services with Number: 570/15788-PERIZ/DPM&PTSP/VIII/2021.

### Research procedures

The procedure in this research has two stages, namely pre-test and post-test. At the pre-test stage, initial data was taken to measure muscle strength before the sample was given treatment, after that treatment was given for 16 meeting sessions and continued at the post-test stage, at this stage muscle strength was measured again after the sample was given treatment.

### Training program procedures

After the training program has been validated by the validator team (physical condition experts), the training program is given for 16 meetings, with a frequency of 2 sessions per week for 8 weeks with submaximal intensity (80%-90% of maximum capacity) starting with warming up and ending with cooling down. In meetings 1-4 with 5 sets, 12 repetitions and meetings 5-8 with 7 sets, 15 repetitions are included in the general conditioning category. Furthermore, meetings 9-12 with 9 sets, 15 repetitions and meetings 13-16 with 11 sets, 15 repetitions are included in the muscle building category.

### Supplement strategy

Table 1.  
Strategy for giving supplements

Protein intake recommendations	Protein in 100gr soybean flour	Average body weight	Athlete recall	Sugar	Water
1.6gr/kg/BW/day	39.70%	60kg	67gr	1 tbsp	200ml

The recommended intake for protein is 1.6 gr/kg/BW/day. In nutritional analysis, there is 39.7% protein in 100 grams of soybean flour. So the amount given is in accordance with the average athlete's body weight, 60kg x 1.6 gr/kg/BW/day = 96g protein. 96gr x 39.7% = 241gr soybean flour. So the amount of protein an athlete needs per day is 96g of protein, equivalent to 241g of soybean flour. The athlete's food recall can provide 67 grams of protein, so the protein needed is 96 grams - 67 grams = 29 grams of protein. 29gr x 39.7% =

73gr soybean flour. So, the amount of protein required for athletes in each session is 29g of protein, equivalent to 73g of soybean flour. Giving soy flour to athletes 30 minutes after training with added 1 tablespoon sugar and 200ml water (Atherton et al., 2020), so that researchers obtain significant results or not from this research.

### Instruments

To get muscle strength results, researchers used a leg dynamometer. The leg dynamometer is a tool that can measure the isometric force produced by the leg, back and arm muscles and is an alternative for testing leg muscle strength. Dynamometry tools are efficient for research and clinical purposes and are often used to validate other strength assessment techniques (Najiah et al., 2021).

### Statistical Analysis

In this research, the researcher used descriptive statistics to explain each variable, while to test the hypothesis the researcher used a paired sample test (t-test). The paired sample test is a method to determine the effectiveness of treatment which is characterized by the difference in averages before and after treatment (Frey, 2023). Before testing the hypothesis, the researcher tested the analysis requirements, namely normality and homogeneity tests. This research was also assisted by the IBM SPSS version 24 application program, with a significance value of  $p < 0.05$ . In this study, a correlation test was also used to see whether there was a relationship between variables. The analysis requirements test states that the normality and homogeneity test of data is normally and homogeneously distributed ( $p > 0.05$ ).

### Results

This study obtained average muscle strength results for the pre-test groups of  $83.09 \pm 19.67$ , respectively. Meanwhile, in the post test group, each was  $90.00 \pm 20.34$ . This shows that the post-test group average is greater than the pre-test group average (Table 2). Thus the difference between the pre-test and post-test averages is in line with the significance value with ( $p < 0.05$ ), presented in (table 3).

Table 2.  
Results of muscle strength for each treatment group

Group	Experimental group				Percentage (%)
	N	Minimum	Maximum	M $\pm$ SD	
Pre-test	14	45.5	109	83.09 $\pm$ 19.67	6.91
Post-test	14	58.2	132.9	90.00 $\pm$ 20.34	

Note: Average percentage increase (%)

Table 3.  
T-test

Group	Paired samples test				Conclusion
	M	SD	Df	P	
Pre-Test vs Post-Test	-16,94	6.46	13	0.000	Significant

Note: The dependent variable is agility; Significant difference ( $p < 0.05$ ).

Table 3 shows significantly that soy protein supple-

mentation substantially supports the benefits of weight training in increasing muscle strength with ( $p < 0.05$ ). Data are presented as Mean Std Error. P-values were obtained using paired t-tests to compare the pre-test and post-test of each group. The following linearity curve for pre-test and post-test data is presented in Figure 1.

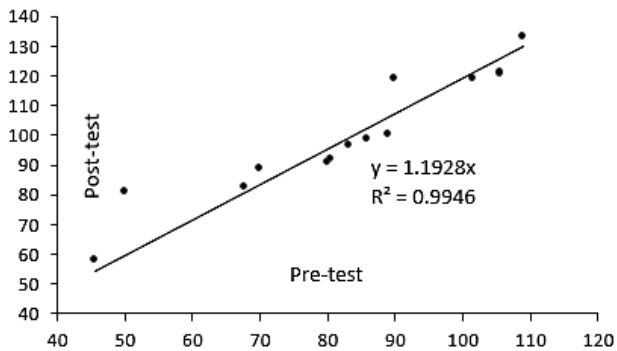


Figure 1. Linearity curve between pre-test and post-test data

Judging from Figure 1, it shows that the pre-test and post-test muscle strength data are linear with  $y = 1.1928x$  and  $r^2 = 0.8547$ .

## Discussions

According to our research findings, supplementing with protein after weight training can result in a 6.91% increase in muscle strength. Based on the results of statistical tests, a p-value of  $0.00 < 0.05$  was obtained. To obtain optimal muscle strength increases, consuming high protein supplements is a viable alternative to provide a supporting effect on weight training. This research is in line with research (Mangano et al., 2017) that muscle mass and muscle strength are positively influenced by protein intake from nuts and the time of consumption of fat-free milk after exercise effectively encourages an increase in lean body mass, strength, weight loss and body fat (Stark et al., 2012).

Consistent with previous research, during weight training, consumption of soy milk can facilitate amino acid delivery to muscles and protein synthesis (Mario, Komaini, Welis, Sepdanius, et al., 2022). Non-whey soy protein may protect against oxidative damage (Brown et al., 2004). According to previous research, the use of soybeans is on the rise due to its excellent nutritional content and health benefits (Wang et al., 2020). Additionally, soy milk is low in fat and a cost-effective source of protein, making it suitable for vegan and lactose intolerant populations (Bogsan et al., 2015). In addition, soy milk contains valuable components such as soy protein, peptides, saponins, oligo-polysaccharides and isoflavones and is considered globally as a healthy drink (Messina et al., 2018). Protein supplementation will only produce muscle strength with carefully planned, structured, and prolonged weight training. According to previous research, effective sports training must be planned and programmed (Antara

et al., 2023; Firdaus et al., 2023; Umar et al., 2023; Welis et al., 2023). In weight training, it is important to know the following: intensity and volume of training, sequence of exercises, number of repetitions, sets, tempo of movement, rest time between sets, and type of exercise (Ralston et al., 2018). Weight training with short (60 seconds or less) and long (more than 60 seconds) rest intervals can help in training muscle strength (Grgic et al., 2017). According to (Dimiyati, Ilham, et al., 2023; Dimiyati, Setiawati, et al., 2023; Ndayisenga et al., 2021; Yendrizal et al., 2023) to produce optimal muscle strength, you must pay attention to motor skills in weight training. Protein supplements are beneficial for muscle hypertrophy, strength, and myofibrillar protein synthesis (soybean) (Josse et al., 2010). In line with research (Mario, Komaini, Welis, Rifki, et al., 2022) weight training is done with a technique, without help (protein) it is difficult to achieve ideal muscle hypertrophy. This study is also in accordance with research (Mario, Komaini, Welis, Sepdanius, et al., 2022) consuming high-protein supplements such as soy milk, egg whites and tofu can also increase muscle hypertrophy.

Researchers believe that taking protein supplements after weight training promotes muscle gains. However, we recognize that future research needs to validate certain boundaries. These limitations include that weight training was provided for one month with a well-designed program (approved by a sports coaching specialist). A longer period of time ( $> 1$  month of movement) and a more effective program will influence the results of this research. The number of samples still needs to be increased. Therefore, a larger sample size is recommended.

## Conclusions

This study concluded that adding protein supplementation to support weight training can increase muscle strength. According to our research findings, athletes' muscle strength increased by a percentage of 6,91% with the addition of soy protein supplementation after weight training. A planned, structured and consistent exercise routine is necessary for any protein supplement to work. The use of this protein supplement must be adjusted to the needs of each participant to get the best preparation results. Athletes who want to or are currently implementing a training program, as well as coaches as evaluation material, and nutritionists as subject matter experts can benefit from the findings of this research.

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## Conflict of interests

The authors disclose that there is no conflict of interest.

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