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JSSF (9) (2) (2023)

Journal of Sport Sciences and Fitness

http://journal.unnes.ac.id/sju/index.php/jssf

EFFECTIVENESS OF WHEY PROTEIN AND SOYMILK ON MUSCLE MASS AND HEMATOCRIT LEVELS OF VOLLEYBALL ATHLETES

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Article's Info

Article's History:
Received June 2024
Accepted July 2024
Published July 2024

Keywords:
whey protein, soy milk, muscle mass, hematocrit levels, volleyball athlete

Abstract

Volleyball is one of the team sports that requires robust muscle mass for exceptional performance and endurance. Protein intake contributes to the formation of muscle mass and red blood cells that are tightly linked to hematocrit levels. The objective of this study was to determine the effectiveness of whey protein and soymilk on muscle mass and hematocrit levels in volleyball athletes. The study was a true experiment with a randomized pre-test and post-test design, involving 20 adolescent, male volleyball athletes divided into 2 groups: whey protein and the soymilk group selected by purposive sampling. The research variables were muscle mass and hematocrit levels. Statistical analysis used independent t-test and paired t-test. The results showed increased muscle mass in the whey protein group (3.50 ± 15.04), but the opposite was found in the soymilk (-1.82 ± 6.46), resulting in significant difference in muscle mass changes between groups (p=0.020). Both groups exhibited reduced hematocrit levels (whey protein group = -3.50±7.69; soymilk group= -1.20±6.30), with a significantly higher decrease shown in the whey protein group (p=0.019).

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ISSN 2252-6528

INTRODUCTION

Volleyball is a very popular team sport in Indonesia because volleyball is a fun sport and can be a place to channel talent (Oktaviany, 2017). Volleyball athletes need good muscle strength to provide a high-quality play (Fauzan, 2019). Muscle tissue makes up 40-50% of total body weight. Adequate muscle mass is required in volleyball games to reduce risks of joint injury during training. The more muscle mass in the body, the better the muscle capacity is (Harahap, 2014). Optimal muscle mass is achieved from a combination of intense training and sufficient protein intake (Azhar, 2013).

Protein plays a major role in muscle building (Harahap, 2014). Protein contains essential branched-chain amino acids (BCAA)—leucine, isoleucine, and valine—which are metabolized in skeletal muscle. Setiowati (2013) reported that increased protein intake led to elevated muscle mass of 3.8%. Accordingly, Morton (2017) stated that increasing daily protein intake, along with regular exercise training, will cause changes in muscle mass. In addition, protein promotes blood cell formation (hemopoiesis), particularly erythrocytes (Andarina and Sumarni, 2006).

An athlete's VO_2max can be influenced by nutrient intake, particularly protein (Kameswara P.S, 2014). VO_2max is the amount of oxygen available to exercising muscles to produce energy (Hariyanti et al, 2020). Chai et al (2019) found a simple but significant correlation between VO_2max and hematocrit levels. The volume of red blood cells in 100 ml of blood is expressed as hematocrit (Rahmatillah, 2019). Hematocrit reflects the ratio of red blood cells compared to total blood volume (Lita et al, 2016). Physical activity incites elevated lung capacity and overall blood circulation, implying increased number of circulating red blood cells which transports oxygen to cells and tissues (Norwidianti et al, 2022).

Whey protein is the protein component in whey milk (Hutama, 2019). It has a high concentration of BCAA (26%) and has been proven to be beneficial for muscle building (Mardiana et al, 2022). However, the high product cost makes it unfit for athletes that would require regular consumption. As an alternative, soybeans may be a more affordable and accessible option.

Soybean (*Glycine max*) is known for its high protein content complemented with the complete essential amino acids and excellent digestibility. Lynch et all (2020) discovered that consuming soybeans positively affected muscle mass. Soy protein (*Glycine max*) contains isoflavones (sub-class of flavonoids) which function as antioxidants to prevent muscle damage (Fitriana et al, 2014). One of the processed soybean products is soy milk. Soy milk according to SNI 01-3830-1995 is a product derived from soy bean seed extract with water or a solution of soy flour in water, with or without the addition of other permitted food ingredients (Adawiyah et al, 2018). This study aims to determine the effectiveness of whey protein and soymilk on muscle mass gain and hematocrit levels in volleyball athletes.

METHOD

The study was a true experiment with a randomized pre-test post-test design. A total of 16 young, male volleyball athletes were selected by purposive sampling based on the following inclusion criteria: adolescents aged 14 to 18-

year-old, have been an athlete for at least a year, not currently taking muscle mass enhancing supplements, and not participating in any programs to build muscle mass. Samples were equally divided into 2 groups and given a glass of (210 ml) either whey protein milk or soymilk after training for 12 days within 4 weeks. Muscle mass measurements were taken at the beginning and end of the study using a skinfold caliper while hematocrit levels were measured at the beginning and end of the study using For a Kit Test 6 Plus.

Primary data collected were training status, intake, physical activity, and nutritional status. Intake was assessed with 4 x 24-hour recall. Measurements of muscle mass and hematocrit levels were carried out on athletes before and after treatment. Univariate analysis was done to describe the mean, standard deviation, maximum and minimum value of the data. Normality test was done with Shapiro Wilk, then bivariate analysis used Independent Sample T-Test and mean difference was analyzed using Paired t-test.

RESULT AND DISCUSSION

Sample Characteristics

Table 1 Sample characteristics

Characteristic	Whey Protein	Soymilk	*p*
BMI-for-age (kg/m²)	0.73±0.45	0.63±0.62	0.693
Age (year)	16.50±1.17	16.30±1.49	0.744
Training status (year)	3.90±1.66	2.30±1.76	0.052
Physical activity level (PAL)	1.68±0.57	1.50±0.18	0.051
Energy intake (%)	102.07±1.50	91.25±1.06	0.082
Protein intake (%)	83.14±1.27	78.34±1.08	0.377
Fat intake (%)	85.80±1.78	75.00±1.71	0.185
Carbohydrate intake (%)	110.67±1.74	102.00±2.06	0.323
Calcium intake (%)	31.4±1.06	21.6±1.33	0.084
Vitamin C intake (%)	38.4±2.68	30. 8±2.45	0.516
Iron intake (%)	78.6±1.17	70.21±1.84	0.244

Sixteen male volleyball athletes were divided into two groups, whey protein and soy milk group, had characteristics as described in Table 1. The level of compliance in consuming whey protein and soy milk was 100%.

No difference was found between groups for any of the sample characteristics listed in Table 1 ($p>0.05$) so that BMI-for-age, age, exercise status, physical activity (PAL), adequacy level did not become confounding variables.

Body composition is the sum of all parts of the body consisting of adipose or fat tissue and lean tissue mass. Lean body mass includes muscle mass, bone, skin, non-fat body tissue and other body tissues, with muscle mass constituting to 40-50% of lean body mass (Browers & Fox, 1988). The formation of body fat mass in comparison to lean body mass is related to athlete performance.

Muscle Mass

Tabel 2. Muscle mass changes during the intervention

Muscle mass	Mean±SD			p^a
	Pre (%)	Post (%)	Δ muscle mass	
Whey Protein	67.87±15.2	71.37±10.4	3.50±15.04	0.048
Sari Kedelai	66.82±9.52	65.00±8.59	-1.82±6.46	0.039
p^b	0.856	0.022	0.020	

Notes :
p^a : paired t-test
p^b : independent t-test

Significant difference was found in muscle mass changes in both groups. Paired t-

test analysis confirmed that whey protein group exhibited a notable increase (p = 0.048) of muscle mass at the end of the intervention, whereas the soymilk group experienced a significant reduction (p = 0.039). Therefore, it could be inferred that the two protein sources had opposite effects on muscle mass.

This study proved that whey protein is more effective for increasing muscle mass than soymilk, possibly due to the difference in BCAA amino acid contents. One gram of whey protein contains 116 mg leucine, 64.1 mg isoleucine and 60.9 mg valine; while BCAA content for every gram of soybean protein is 86.08 mg leucine, 54.4 mg isoleucine and 55.84 mg valine (Yanti et al, 2021). Furthermore, one serving of whey protein contains 11.22 grams of protein while one serving of soymilk contains 10.5 grams of protein. Setiowati and Hadi (2013) also affirmed that high protein intake was significantly correlated with muscle mass.

The post-intervention disparity of muscle mass changes among groups were most likely linked to BCAA which plays an important role in energy metabolism for muscle performance (Mardiana et al, 2022). The increased muscle mass was seemingly attributed to the high BCAA content in whey protein (26%). This type of amino acids is typically absorbed by the intestines to later produce NH_3 and other organic compounds that will eventually culminate in the urea cycle. However, during exercise, constant muscle damage occurs, inciting immediate body response including the conversion of amino acids into new muscle cells (Harahap, 2014).

On the other hand, the decreased muscle mass in the soymilk group could be caused by the presence of antinutritional compounds in soybeans. Antinutrient compounds are secondary metabolites produced by plants as a form of defense against biological attacks (Aviles-Gaxiola et al, 2018). The metabolites produced are tannin, phytic acid, and antitrypsin, of which antitrypsin is the main factor causing limited protein utilization in soybeans (Khattab and Arnfield, 2009). Antitrypsin is the main antinutrient compound in soybeans that can inhibit the performance of the trypsin enzyme by forming an indigestible enzyme-inhibitor complex, thus interfering protein absorption. The antitrypsin content in soybeans reported the highest content of 94.1 U/mg (Khattab and Arnfield, 2009).

Hematocrit levels

Tabel 3. Hematocrit level changes during the intervention

Hematocrit	Mean±SD			p^a
	Pre (%)	Post (%)	Δ hematokrit	
Whey Protein	39.30±4.62	35.80±9.17	-3.50±7.69	0.021
Soymilk	37.10±3.81	35.90±5.85	-1.20±6.30	0.040
p^b	0.261	0.049	0.047	

Notes :
p^a : paired t-test
p^b : independent t-test

There was a notable difference in hematocrit levels across groups post-intervention. Paired t-test analysis revealed significant effects on hematocrit levels in both the whey protein (p=0.021) and soymilk group (p=0.040).

This study proves that soymilk can maintain hematocrit levels in athletes compared to whey protein because soymilk contains isoflavones that function as antioxidants. Antioxidants can play a role in preventing oxidative stress due to exposure to free radicals

that affect hematocrit levels. In addition, soymilk protein plays a role in increasing hematocrit levels which affect VO_2max. Similarly, Chai et al (2019) also found a simple but significant correlation between VO_2max and hematocrit. An athlete's VO_2max can be influenced by macronutrient intake such as protein (Kameswara, P.S, 2014).

Both groups experienced decreased hematocrit levels post-intervention, suggesting that neither whey protein nor soymilk were effective in increasing hematocrit levels. One of the factors related to this is "sports anemia" or anemia that occurs in athletes. Sports anemia is caused by increased plasma volume in the blood. Physical exercise with heavy intensity that is carried out continuously and with a long duration can also cause a decrease in red blood cell mass by intravascular hemolysis, causing hematocrit levels to decrease.

The protein in whey protein and soymilk affects iron absorption. However, whey protein and soymilk also contain calcium, which negatively impacts the absorption of heme and non-heme iron. Calcium inhibits iron transport through the basolateral membrane and enterocytes to the plasma. If iron absorption is inhibited, hematocrit levels will be low. The calcium content in one serving of whey protein is 171.6 mg while soy milk is 57.72 mg. Therefore, soy milk is more effective in maintaining hematocrit levels than soy milk (Roziqo and Nuryanto, 2016).

CONCLUSION

Whey protein has better effects than soymilk in building and increasing muscle mass. Soymilk is better for maintaining hematocrit levels than whey protein.

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