

Research Article

Impact of Whey Protein on Canoeing Athletes in Training and the Mechanism

¹Bo Zhou and ²Chao Zhou

¹College of Physical Culture, Hunan Normal University, Changsha 410012, Hunan, China

²Department of P.E, Hunan University of Arts and Science, Changde 415000, Hunan, China

Abstract: Sports completion is unprecedentedly intensive now and performance of athletes becomes closer and closer to limit of human's capacity. To constantly create better performance, athletes must do a large amount of limitation training. Athletes would be found with water desorption, electrolyte loss, enhanced protein catabolism, imbalanced cell membrane penetration and enzyme escape after overloaded training and competition. Whey protein can rapidly provide athletes with water, electrolyte and energy substance, prevent excessive fatigue of athletes during sports, sustain and promote fluid balance within body and help athletes rapidly recover physical ability. Sports nutritional food is a powerful nutritional basis for athletes who engage in a large amount of overloaded training and competition. This study first discusses over the application of whey protein in the perspective of the functional characteristics of whey protein, then emphatically analyzes the impact of whey protein on physical ability recovery and fatigue elimination of canoeing athletes and finally explores the impact of whey protein on various indexes during training based on a case, thus to further confirm the action mechanism of whey protein for canoeing athletes.

Keywords: Blood volume, canoeing athletes, fatigue relief, physical ability recovery, whey protein

INTRODUCTION

Bounous (2000) compared the antitumor effect of whey protein and casein through animal and in vitro test and found whey protein was more effective in inhibiting growth of cells of prostatic cancer, breast cancer and colon cancer compared to casein and lower the incidence rate of tumor for 50%. Frid *et al.* (2006) once researched the influence of whey protein on blood glucose on 14 cases of type II diabetics and found whey protein could reduce the increasing degree of blood glucose in 2 h after breakfast and 3 h after lunch. Study of Morifuji *et al.* (2005) suggested that, whey protein could restrain activity of liver, remove fat accumulation in body and meanwhile stimulate muscle tissues to store energy substance for adapting to long-time uninterrupted endurance training. By comparing the effect of whey protein and soy protein on white mouse suffering loaded exercise, (Elia *et al.*, 2006) found whey protein strengthened antioxidant activity through changing concentration of free radical and glutathione, while soy protein improved antioxidant activity by changing substrate concentration of thiobarbituric acid reaction. They thought taking either of them both can help body endure more intensive training. It has been found that, whey protein can keep nice nutritional state and prevent loss of muscle tissue, thus delay aging (Mackenzie-Shalders *et al.*, 2015). Moreover,

supplementing whey protein can strengthen muscle circumference of the upper arm of canoeing athletes, promote synthesis of muscle and sustain and improve the level of testosterone (Liao *et al.*, 2007; Mackenzie-Shalders *et al.*, 2015). Whey protein can help reduce weight, control blood glucose and promote secretion of insulin, which is beneficial to recovery of diabetics (Pan *et al.*, 2012). Thus this study analyzes the effect of whey protein on physical ability recovery and fatigue relief of athletes in the aspect of action mechanism of whey protein on canoeing athletes.

METHODOLOGY

Functional characteristics of whey protein and its application in sports nutrition:

Characteristics of whey protein: Whey protein, a protein condensed from whey produced during production of cheese or extracted from milk, is composed of tiny and tight globular proteins and has special amino acid sequence and three dimensional structures. Whey protein contains more than twenty amino acids. Except sulfur-containing amino acid, other amino acids that are needed by human body account for a high proportion. It has been found that (Samadi, 2009), whey protein is effective in strengthening power of muscle, improving environmental inside body, accelerating recovery of physical ability and enhancing sports performance of athletes.

Corresponding Author: Bo Zhou, Physical Culture College, Hunan Normal University, No. 529, Lushan South Road, Yuelu District, Changsha 410012, Hunan, China

This work is licensed under a Creative Commons Attribution 4.0 International License (URL: <http://creativecommons.org/licenses/by/4.0/>).

Table 1: Ingredients and biological activities of whey protein

Ingredients	Biological activity
Lactalbumin	Synthesis of lactose, immunoregulation and anti-tumor
Lactoglobulin	Retinol carrier, antioxidation
Immune globulin	Immunoprotection
Glycomacropeptide	Promotion of bifidobacterium, immunoregulation and anti-virus
Lactoferrin	Anti-bacteria, wound healing promotion, anti-virus, antioxidation, anti-tumor, anti-toxicity, anti-inflammation, antithrombus, immunoregulation and help absorption of iron
Lactoperoxidase	Antibacteria, wound healing promotion
Growth factor	Cell growth promotion, wound healing promotion and immunoregulation

Moreover, whey protein contains multiple functional activity substance (Bordi *et al.*, 2003) including β -lactoglobulin, α -lactoglobulin, serum albumin, immune globulin, lactoferrin, lactoperoxidase, growth factor and glycomacropeptide. Whey protein characterized by high protein, low cholesterol, low lactose and low fat and easy to digest is of high nutritional value; therefore, it is called the king of protein.

Branched chain amino acids such as leucine and isoleucine accounting for 26% in whey protein can provide energy as energy source; whey protein also contains glutamine, lysine and arginine which can help update inosose., prevent immunocompetence decline due to excessive sports, stimulate synthesis and secretion of synthesized metabolic hormone and strengthen growth of muscle; as the source of sulfur-containing amino acid such as methionine and cysteine, it can maintain the content of glutathione inside body; as a good source of threonine, it can protect intestinal cells and intestinal tract barrier continuity; moreover, it is beneficial for preventing osteoporosis (Xu *et al.*, 2011).

Functional characteristics: Whey protein composing of some tiny and tight globular proteins such as lactoglobulin, immune globulin, growth factor and glycomacropeptide has a special three dimensional structure. It has functions such as lowering blood fat, blood sugar, antioxidation, anti-aging and anti-tumor, enhancing immunity and strengthening body constitution (Jakopović, 2014). Ingredients and corresponding biological activities of whey protein are shown in Table 1.

Application of whey protein in sports nutrition: Whey protein is widely applied in food, medicine and cosmetic, fine chemical engineering and fodder industry for its healthcare functions and multiple physicochemical properties. Sports nutrition aims at maintaining the balance of environment inside body by supplementing water, energy and nutritional substance, thus to improve sports ability; relieve fatigue and recovery physical ability. Athletes require more than non-sports or labor individuals and the demand quantity is determined by sports time, sports category and loading quantity. American Diet Committee has pointed out that, ordinary athletes should take 1.5 g protein

every day and the dose for those who do strength sports is more than 2.0 g every day. Lack of protein would result in negative nitrogen balance (Sundell *et al.*, 2011) which can strengthen catabolism and delay physical ability recovery. But there is no protein that can be completely utilized. Excessive uptaking of proteins may boost metabolic stress; therefore, only high-quality proteins are quailed. Based on the requirements of sport nutrition, ideal proteins should be characterized by easy to digest, high bioavailability, balance between necessary amino acid and unnecessary amino acid, rich content of branched chain amino acid and low content of cholesterol and fat. Characteristics of proteins determine its high sports nutritional value.

Besides, whey protein is able to strengthen muscle powerful of athletes, improve composition of body and maintain and enhance immunity of athletes during training.

IMPACT OF WHEY PROTEIN ON PHYSICAL ABILITY RECOVERY AND FATIGUE RELIEF OF ATHLETES

Impact of whey protein on blood volume of canoeing athletes: Whey protein can improve immunity of sports body (Devries and Phillips, 2015), strengthen muscle strength of sports body and resisting antioxidation, damage and fatigue. Whey protein obtains wide application for its various sports nutritional performance. Supplementing whey protein timely can prevent significant decline of hemoglobin and maintain the functions of hemoglobin. In addition, it has been found that, whey protein drinks can reduce level of creatine kinase in serum and keep the stability of blood sugar concentration, thus to prevent occurrence of central fatigue and sustain functions of skeletal muscle (Silverberg, 2012). Hematocrit level inside body of athletes is observed to be significantly improved after supplementation of whey protein; therefore, whey protein drinks is effective in preventing reduction of blood volume.

Impact of whey protein on physical ability recovery and fatigue relief: Body of athletes can rapidly recover after supplement of whey protein; moreover, physical quality of athletes can be improved. Lactate level of athletes is found to be remarkably lowered after long-term load exercise. Supplement of whey protein can

enhance aerobic capacity of skeletal muscle and increase fat free mass of athletes. Moreover, supplement of whey protein can help improve physical quality and physical energy recovery.

Physical energy is an important component of competition skills of canoeing athletes. Thus preservation of physical energy of athletes attracts more and more attention. Modern canoeing is characterized by high speed and large consumption of physical energy. It is hard to obtain satisfactory performance without good physical energy preservation. As a result, we suggest improving physical energy preservation in daily load training by adding sports nutrition. Observation competition site and statistical analysis suggest that, a good sports related fitness is required for achieving well competition state. Because, if athletes are lack of physical energy preservation, then they are difficult to perform normally or better as well as keep a stable mentality. Good physical energy preservation can prevent damage and pain during overload training and competition.

Therefore, supplement of whey protein of canoeing athletes can effectively protect functions of red blood cell, prevent decrease of CMC level, enhance rapid recovery of physical energy, promote relief of fatigue and maintain microstructure of muscle.

INSTANCE ANALYSIS

Whey protein is of high sports nutrition value. In the following, we discuss over the impact of whey protein on training by combining oral administration of whey protein and sports experiment. As application of whey protein in plateau training is seldom researched, especially for those high-level national canoeing athletes, we observe the changes of morphology and serum hormones after plateau training of canoeing athletes after being administrated with whey protein.

Research scheme: Athletes were divided into experimental group and control groups. Observation group took 50 g whey protein every evening, while control group took equicaloric carbohydrate. The whey protein (purity 80%) used is produced by Suli

Xinchuang Company. During experiment, athletes are forbidden to take other nourishment. Moreover, diet was made according to menu. Caloric intake ratio of breakfast, lunch and dinner should be controlled at 3:4:3.

Changes of indexes of canoeing athletes after supplement of whey protein: In the 45th day, experimental group tended to have increased weight and control group increased slowly. Percentage of body fat was significantly declined both in experimental group and control group, while thigh circumference tended to increase. Waist circumference in experimental group has large increasing amplitude, but declined slightly in control group. In addition, subcutaneous fat of two groups both decline, but there was no statistical significant difference; but control group rose again after plateau training was over.

Meanwhile, skinfold thickness of upper arm was measured. Supposing subcutaneous fat to distribute evenly along the circumference, we calculated tight circumference of upper arm. Other indexes are shown in Table 2.

Before plateau training, there was no statistical significant difference of serum testosterone level between experimental group and control group; but in the subsequent measurement, the level in control group was lower than experimental group and a statistically significant difference was found. Level of estradiol showed a rising tendency in the whole process of test in both groups. In the 45th day, estradiol level in control group had significantly higher than before training. Moreover, estradiol/testosterone tended to rise in experimental group and the ratio in control group remained unchanged. In the third week of training, testosterone and estradiol both decreased (Table 3).

Biochemical test suggest that, level of testosterone had no statistical significant difference between experimental group and control group, but under the stimulation of plateau training, level of testosterone in control group became 10% lower than experimental group.

Plateau training improves sports ability though double stimulation of high altitude anoxia and sports

Table 2: Changes of various indexes of athletes in two groups during training

Indexes	Group	-3 rd	21 st	45 th
Weight (kg)	Experimental group	82.6±7.9	82.5±6.1	83.2±5.5
	Control group	85.9±5.8	84.9±6.7	86.5±6.1
Body fat (%)	Experimental group	13.4±2.1	12.8±1.6*	12.7±3.2*
	Control group	15.3±2.4	13.3±1.4*	13.9±2.1*
Waist circumference (cm)	Experimental group	81.5±5.1	82.6±4.1*	83.6±4.1*
	Control group	83.8±4.8	83.8±5.8	83.3±5.4
Thigh circumference (cm)	Experimental group	56.0±3.3	55.6±2.3	57.1±3.0
	Control group	57.3±3.0	58.5±3.1	58.0±3.1
Skinfold thickness of upper arm (mm)	Experimental group	7.4±2.6	6.2±1.8*	7.0±2.2
	Control group	7.5±2.2	6.3±1.4*	7.0±2.1
Tight circumference of upper arm (mm)	Experimental group	33.8±2.1	34.4±2.0	34.9±1.6
	Control group	35.4±1.6	35.7±1.1	35.3±1.1

*: p<0.05 compared to -3rd day

Table 3: Changes of testosterone, estradiol and estradiol/testosterone in training cycle

Index	Group	-3 rd	10 th	20 th	30 th	45 th
Testosterone (ng/dL)	Experimental group	632.00±248.00	823.00±157.00*	764.00±183.00	915.00±154.00*	938.00±163.00*
	Control group	643.00±210.00	756.00±203.00	646.00±197.00	842.00±246.00*	872.00±210.00*
Estradiol (pg/mL)	Experimental group	17.40±7.10	27.30±7.20	24.60±6.10	29.20±2.70	36.20±11.20*
	Control group	25.70±14.80	28.20±8.90	19.20±7.00	28.80±6.50	31.80±10.10
E2/T (%)	Experimental group	2.55±1.57	3.65±1.16*	3.63±1.14	3.42±0.67	4.06±1.15
	Control group	4.96±2.21	3.96±0.91	3.16±0.84*	3.74±0.72*	3.96±1.57

*: p<0.05 compared to -3rd day

strength; however, it can result in large consumption of energy and induce fatigue. Thus it is necessary to supplement nutritional substance. Whey protein has a high proportion of branched chain amino acid and a low content of fat and cholesterol; therefore, whey protein as a nutritional supplement is able to enhance various indexes of canoeing athletes who engage in plateau training.

CONCLUSION

With the development of modern sports, improvement of sports skills and performance cannot separate from research on nutrition. Nutritional diet is effective in maintaining health and enhancing sports performance of athletes. During training and competition, canoeing athletes consume considerable energy; if there are not enough nutritional supplements, recovery of body functions would be influenced. Protein, a nutritional element necessary in tissue metabolism and a basic ingredient of body tissue, is an important substance for maintaining basic activities of body and is also correlated to sports ability related multiple factors such as muscle contraction, substance metabolism and regulation of physiological function. Whey protein is widely applied as a sports nutritional supplement for its high purity, low fat, low cholesterol, high absorption rate, reasonable composition of amino acids and multiple healthcare functions (Almeida *et al.*, 2015).

REFERENCES

Almeida, C.C., B.R.C.D. Costa-Lima, T.S. Alvares and *et al.*, 2015. In vitro digestibility of commercial whey protein supplements. *LWT-Food Sci. Technol.*, 61: 7-11.

Bordi, P.L., G. Salvaterra, C. Cole, D.A. Cranage, M. Borja and Y. Choi, 2003. A taste comparison of an isolated soy protein carbohydrate-protein beverage and an isolated whey protein carbohydrate-protein beverage. *Foodservice Res. Int.*, 14(1): 23-33.

Bounous, G., 2000. Whey protein concentrate (WPC) and glutathione modulation in cancer treatment. *Anticancer Res.*, 20(6C): 4785-4792.

Devries, M.C. and S.M. Phillips, 2015. Supplemental protein in support of muscle mass and health: Advantage whey. *J. Food Sci.*, 80(suppl 1(S1): A8-A15.

Elia, D., K. Stadler, V. Horváth and J. Jakus, 2006. Effect of soy-and whey protein-isolate supplemented diet on the redox parameters of trained mice. *Eur. J. Nutr.*, 45(5): 259-66.

Frid, A.H., N.M. Holst, J.J. Bjorck, 2006. Effect of whey on blood glucose and insulin responses to composite breakfast and lunch meals in type 2 diabetic subjects. *Amer. J. Clin. Nutr.*, 82(1): 69-75.

Jakopović, K.L., 2014. Why athletes choose whey proteins? *Mlijeko I Ja*, 2(20): 6-7.

Liao, P., Y. Zhang, Y. Liao, N.J. Zheng and X. Zhang, 2007. Effects of coenzyme Q10 supplementation on liver mitochondrial function and aerobic capacity in adolescent athletes. *Chinese J. Appl. Physiol.*, 23(4): 491-494.

Mackenzie-Shalders, K., N. Byrne, G. Slater and N.A. King, 2015. The effect of a whey protein supplement dose on satiety and food intake in resistance training athletes. *Appetite*, 92: 178-184.

Morifuji, M., K. Sakai, C. Sanbongi and K. Sugiura, 2005. Dietary whey protein downregulates fatty acid synthesis in the liver, but upregulates it in skeletal muscle of exercise-trained rats. *Nutrition*, 21(10): 1052-1058.

Pan, D., J. Cao, H. Guo and B. Zhao, 2012. Studies on purification and the molecular mechanism of a novel ace inhibitory peptide from whey protein hydrolysate. *Food Chem.*, 130(1): 121-126.

Samadi, M., 2009. Whey protein isolate. *J. Amer. Leather Chem. Association*, 58(4): 122-130.

Silverberg, N.B., 2012. Whey protein precipitating moderate to severe acne flares in 5 teenaged athletes. *Cutis*, 90(2): 70-72.

Sundell, J., J. Hulmi and J. Rossi, 2011. Whey protein and creatine as nutritional supplements. *Duodecim; L0101ketieteellinen Aikakauskirja*, 127(7): 700-5.

Xu, R., N. Liu, X. Xu and B. Kong, 2011. Antioxidative effects of whey protein on peroxide-induced cytotoxicity. *J. Dairy Sci.*, 94(8): 3739-3746.