The effect of milk serum whey on some physical and physiological parameters of diving coaches

Ryeaan Abdel Moneim Abdel Rahim [1] and Saleh Abdel Salam El Tarabily[2]

[1] Department of Specific Education, Faculty of Home Economics "Nutrition", Suez Canal University, Egypt.
[2] Department of Water Sports, Faculty of Physical Education, El Arish, Suez Canal University, Egypt.
Rayyan8@gimail.com

Abstract*: Aim:* This study was conducted to determine the effect of a dietary supplement (milk serum whey) on some physical and physiological parameters of diving coaches. **Methods:** Thirty healthy male divers aged (27.4 ± 3.31 y) height (179.2 ± 4.9 cm), weight (78.8 ± 2.7 kg) were participating in this study. They were divided to two equal groups, a control and experiment group. They were instructed to dive for 45 minutes four times per week in Melia sharm, Reef Oasis. The divers coaches used Nitrox, enriched air, announced by PADI 1996, In case of the control group (using Placebo) and serum milk whey for the experimental one (30 grams) twice daily for 60 days. Physical and physiological tests were determined before and after the dietary program (60 days). **Results:** There was a significant improvement for the sake of experimental group in physical tests (vertical jump, zigzag run, running 30m. x 5, shuttling running and muscle strength) and another improvement in physiological tests (T. proteins, creatinine, lactate, CPK, AST, ALT) together with Malondialdehyde, SOD, Leucocyte counts) and Neutrophils, lymphocytes, Monocytes. **Conclusion:** Milk serum whey demonstrates a beneficial effect on muscle strength, recovery of muscles and affect positively antioxidants and immunity of the divers coaches.
[Ryeaan Abdel Moneim Abdel Rahim and Saleh Abdel Salam El Tarabily. **The effect of milk serum whey on some physical and physiological parameters of diving coaches.** *J Am Sci* 2016;12(7):126-132]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org. 13. doi:10.7537/marsjas120716.13.

Keywords: Milk serum whey. Physical, physiological changes and immunity.

1. Introduction and Problem of the Study

Muscles are a dynamic reservoir of bound and unbound proteins (amino acids) that are constantly broken down and regenerated to meet all the metabolic demands of the body***(Evans, 1997).*** Muscle is also the metabolic furnace that burns fat for fuels and drives the metabolism ***(Nagy et al., 1996).*** Metabolic rate is simply the rate at which the body burns calories, an individuals metabolism ultimately determines the body composition ***(Calles et al., 1995).*** The controlled process of breakdown and synthesis of muscle protein diminishes with aging ***(Dröge and Holm, 1997).*** Additionally, the body's ability to use fat fuel also decreases. The result is a slower metabolic rate that predisposes the older adult to further muscle loss and unwanted fat gain ***(Inelmen et al., 2003).***

Lori et al., (2013) reported the physiological effects of aquatic exercise on neural and circulatory functions, and stated that the greater the level of immersion, the greater the effect the aquatic environment will elicit on the immersed body. Many physiological effects are produced during immersion that could potentially effect executive function. The challenges that the physical attributes for the aquatic environment lend to individuals in the pool also drive the requirement for variance of muscular contractions and coordination while performing aquatic exercise. They added that the increase in circulatory function increased cerebral circulation which has been seen to promote neural structure maintenance and growth studies support a higher level of exercise continuation when exercise is performed in water, due to sensation of security and the reduction in pain by hydrostatic press or off loading of the joints ***(Erickson et al., 2009; Barnes et al., 2007).***

Cynthia (2006) stated that recent studies show that consumption of Whey protein in combination with resistance training exercise is a safe and effective strategy that will help adults built and maintain valuable muscle mass and preserve their health throughout the aging process. In a variety of clinical settings such as cancer and hepatitis, the health benefits of Whey supplementation are suggestive ***(Bounous 2000; Watanabe et al., 2000; Micke et al., 2002).*** Whey's unique ability to boost glutathione concentrations within various cells in the body is clear ***(Lands et al., 1999).*** Glutathione is a primary antioxidant defense system in the body that protects cells against free radical damage, pollutions, toxins, infection and U.V. exposure ***(Bounous, 2000).***

Objective : This study was conducted to determine the effect of a dietary supplement on some physical and physiological parameters of diving coaches.

Hypothesis:

There are a significant differences of the effect of a dietary supplement on some physical and physiological parameters of diving coaches.

2. Materials and Methods

Sample method: The experimental method was

used, of pre-post measurement. Thirty healthy male divers aged (27.4 ± 3.31y.) height (179.2 ± 4.9 cm), weight (78.8 ± 2.7 kg), with a practical diving history of (3-4 years) were participating in the study. They were divided to two equal groups, a control (15 divers) and experimental group (n = 15). They were instructed to dive for 45 minutes four times per week in Melia Sharm, Reefoasis. All participants were asked to fill out their healthy history. They were free from contagious diseases. They did not take any medication throughout the experiment, refrained from caffeine and medications or any vitamins 72 hours prior to the test. All participants gave a written informed consent about participation.

The divers used Nitrox, enriched air, which was announced by ***Padi, (1996); Gilliam, (2000)*** reported that nitrox can dramatically increase no decompression times and shorten the necessary surface intervals between dives. With a bit of planning a nitrox divers could dive all day in depths of 60-80 feet and never run into required decompression.

All participants (control, experimental) dives in case of the control groups (using placebo) and experimental one (using dietary compound of milk serum whey 30 grams. Twice a day for 60 days 1/5/2016 – 31/6/2016, dive time for 45 minutes.

5 ml of blood sample was drawn before and at the end of the diving program for 60 days for the analysis of T.protein, free radicals, antioxidant, leucocytes, neutrophils, lymphocytes, monocytes, aminotransferase (ALT, AST) creatine kinase, creatinine together with lactate, and muscle strength and physical tests.

Tools and devices used:

- Scuba apparatus.
- Syringes, cotton, alcohol, plasters.
- Test tubes + covers.
- Coulter counter for blood cells.
- Dynamometer for muscle strength.
- Spectrophotometer for free radicals, antioxidant.
- EDTA anticoagulant.
- Kits for T. protein, ALT, AST, CPK, creatinine.
- Centrifuge, Vortex.
- Balance weight, restameter.
- Coleman + ice, Deep freezer.
- Accusport for lactate.

Physical tests according to Raed (1995):

- Vertical jump.
- Zigzag running between obstacle.
- Running 30m x 5 times.
- Shuttling running.

Statistical Analysis:

All statistic were computed by SPSS

1. Mean and standard deviation of each variable was calculated.
2. T-Test was used to compare before and after ingestion.
3. Level of significance was fixed at 5% ($P < 0.05$).

3. Result and Discussion

The ingestion of milk serum whey (Table 4) revealed a significant increase in physical performance (Vertical jump, zigzag run, running 30m x 5 times, shuttling running) together with a significant increase in total protein, creatinine (Table 7) and muscle strength using Dynamometer for the sake of the experimental group divers (ingested milk serum whey) compared to control divers after the supplement nutritional program for 60 days. Which indicated that the supplement used for the experimental group affected body composition mainly muscle strength and the physical properties of the divers together with increased performance.

Dietary applications revealed that bovine colostrums supplementations (20 grams/day) during 12 weeks of resistant training resulted in an increase in lean body mass of 1.49 kgs than whey protein alone ***(Antonio et al., 2001).*** However, another study revealed that a whey and casein combination (75 grams/day) provided the same favorable strength, muscle fiber hypertrophy and body composition changes compared to two different colostrum supplements ***(Fry et al., 2003).*** In a study involving body builders undertaking, 10 week resistance training program. The group provided a pure whey isolated 1.5 grams/kg body weight/day) experienced a gain in fat free mass that was five times greater than a matched group receiving a casein supplement.

As for the effect of whey on muscle strength, ***Cribb et al., (2003)*** reported that four groups of trained men (20-35 years) were given either whey isolate, carbohydrate, creatine or a combination of creatine and whey supplementation (1.5 grams of protein/kg/body weight/day). Results indicated that when supplemented groups experienced double the gain in fat free mass after 11 weeks of resistance training compared to men given the carbohydrate supplement. Indicating that whey increased the size of the muscle fibers by up to 500% compared to carbohydrate supplementation. Also strength improvement was also registered. The study suggest that whey may be a catalyst that ensures better results from the training programs.

Lactate concentration (Table 7) decreased after milk serum (Whey) ingestion for 2 months of divers, which indicated a higher physical fitness and a lower lactate accumulation due to increase number and size of the mitochondria ***(Robergs, Roberts, 1997),*** as lactate accumulation determines the balance between lactate production and its clearance ***(Wilmore and Costill, 2005).***

Skeletal muscle damage is commonly estimated by measuring the concentration of the muscle proteins

creatine kinase, aspartate aminotransferase, alanine aminotransferase ***(Cordova et al., 2004).*** Table (7) revealed a significant lower concentration of CPK, AST, ALT which indicated that milk serum (whey) ingestion led to higher physical fitness due to decreased muscle damage in case of divers ingested milk serum (whey) compared with the control groups.

These results are in accordance with those of ***Cordova et al., (2004) and Clarkson et al., (1992), Apple et al., (1985).***

Stimulating protein synthesis and minimizing protein breakdown are the two cellular processes that are essential to recovery and muscle hypertrophy ***(Rennie and Tipton, 2000).*** Whey proteins are effective at stimulating muscle protein synthesis for a number of reasons: whey provides all the correct amino acids in approximate proportion to their ratio in skeletal muscle ***(Walfe, 2000),*** whey proteins contains a higher dose of the essential amino acids ***(Bucci and Unlu, 2000),*** Also whey contain high concentration it provide recovery to speed the adaptation process ***(Kimbal and Jefferson, 2002).***

Whey proteins contain high concentration of all the amino acids that are essential to creating and maintaining the optimal bio-environment that preserves muscle mass, specially glutamine and cysteine. Glutamine is the essential fuel that drives many processes within the body, including immune function ***(Walsh et al., 1998),*** and cysteine in the rate limiting amino acid in glutathione formation ***(Hack et al., 1997),*** a high concentration of cysteine is required to ensure correct protein metabolism that preserves muscle mass. The essential metabolism of cysteine by the liver is vital to maintain glutamine stores in muscle as well as synthesis of glutathione ***(Droge et al., 1998).*** In fact, whey is an effective cysteine donor that restores blood cysteine concentrations and boosts glutathione levels ***(Walzem et al., 2002; Zemel et al., 2000)***.

Table (8, 9) revealed that milk serum (whey) ingestion stimulate immunity process and increased antioxidant while decreased level of free radical. Also immune cells are increase due to the action of whey which is nature's richest source of branched chain amino acids, characteristically, 26% branched chain amino acid and 6% glutamate ***(Volpi et al., 2003). Mackinnon, (2000)*** reported that immunological alterations in response to a number of different exercise protocols are well documented. Published studies have investigated changes in circulating all populations in response to one bout of acute exercise ***(Bishop et al., 1999)*** or repeated exercise ***(Ronsen et al., 2001)*** or different exercises ***(Mohamed et al., 2012).***

Table (10) indicated a significant decreased concentration of Malondialdehyde after the end of the experiment in favor of the experimental group (milk serum/ Whey) ingestion, and a significant increased concentration of the antioxidant superoxide dismutase, which indicated the antioxidant effects of the milk serum (whey) which elevate the immunity of the divers. These results were also noted in the concentrations of leucocytes, neutriphils, lymphocyte, monocytes.

Robergs and Roberts, (1997) reported that the increase in circulating leukocytes that occurs in response to moderate to intense exercise has been will established. The increased circulating catecholamines being responsible relationship between leukocyte counts and exercise. The sites of action of catecholamines are to be a combination of systemic effects plus direct innervation of the spleen and pulmonary and blood vessels. As for the action of milk serum (whey) a number of studies confirms that the concentrations of some amino acids in milk serum may affect positively antioxidants ***(Hack et al., 1997; Volpi et al., 2003; Walsh et al., 1998; Malm et al., 2004; Malm et al., 2003).***

Amany and Mohamed (2011) reported that despite oxygen importance in producing energy during physical activity, it has some destructive effects resulting from the formed free radicals roots which is formed during the metabolic process inside the cell, which in turn scavended by different antioxidants enzyme, super oxide dismutase, glutathione, catalase or natural vitamins such as vitamin A, C, E.

Table (1): Basic characteristics of divers (Control & Experimental groups) (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
Age (y.)	26.9	2.9	27.5	3.6	NS
Weight (kg)	79.1	3.1	78.6	2.5	NS
Height (cm)	181.2	4.7	179.1	3.9	NS

$P < 0.05$

Table (2): Parameters of divers coaches (Control group) (Experimental groups) in physical performance before treatment with placebo, supplements (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
Vertical jump (cm)	49.4	3.6	49.1	3.7	NS
Zigzag run (Sec.)	5.8	0.7	5.7	0.3	NS
Running 30mx5 (sec.)	34.5	4.6	34.7	5.1	NS
Shuttling running (sec.)	14.8	0.6	14.4	0.7	NS
Muscle strength (kg)	77.9	6.7	78.0	7.1	NS

P < 0.05

Table (3): Parameters of divers coaches (Control, Exper.) in physical performance before & after treatment with placebo, supplements (n = 15)

Variables	Control		Sig.	Experimental		Sig.
	Before M±SD	After M±SD		Before M±SD	After M±SD	
Vertical jump (cm)	48.1±3.6	49.7±3.8	NS	49.1±37	53.1±2.3	S
Zigzag run (Sec.)	5.8±0.7	5.6±0.5	NS	5.7±0.3	4.9±0.4	S
Running 30mx5 (sec.)	34.5±4.6	33.2±4.2	NS	34.7±5.1	28.1±3.5	S
Shuttling running (sec.)	14.8±0.6	14.2±0.4	NS	14.4±0.7	13.8±0.5	S
Muscle strength (kg)	77.9±6.7	78.1±7.2	NS	78.0±7.1	84.3±5.5	S

P < 0.05

Table (4): Parameters of divers coaches (Control, Experimental) in physical performance after treatment with placebo, supplements (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
Vertical jump (cm)	49.7	3.8	53.1	2.3	S
Zigzag run (Sec.)	5.6	0.5	4.9	0.4	S
Running 30mx5 (sec.)	33.2	4.2	28.1	3.5	S
Shuttling running (sec.)	14.2	0.4	13.8	0.5	S
Muscle strength (kg)	78.1	7.2	84.3	5.5	S

P < 0.05

Table (5): T. Protein, creatinine, lactate, CPK, AST, ALT of (Control, Exper. group) before treatment with placebo, supplements (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
T. proteins (g/dl)	7.4	0.6	7.7	0.7	NS
Creatinine (mg/dl)	1.19	0.3	1.22	0.5	NS
Lactate (m.mol/L)	1.8	0.2	1.6	0.4	NS
CPK (IU/L)	307.4	22.6	298.3	17.3	NS
AST (IU/L)	29.6	4.4	28.3	3.1	NS
ALT (IU/L)	22.6	5.1	21.8	4.3	NS

P < 0.05

Table (6): T. Protein, creatinine, lactate, CPK, AST, ALT of (Control, Exper. group) before & after treatment, (n = 15)

Variables	Control		Sig.	Experimental		Sig.
	Before M±SD	After M±SD		Before M±SD	After M±SD	
T. proteins (g/dl)	7.4±0.6	7.6±0.3	S	7.7±0.7	7.9±0.5	S
Creatinine (mg/dl)	1.19±0.3	1.21±0.2	NS	1.22±0.5	1.46±0.4	S
Lactate (m.mol/L)	1.8±0.2	1.7±0.1	NS	1.6±0.4	1.2±0.05	S
CPK (IU/L)	307±22.6	312.2±21.2	NS	298.3±17.3	269.7±15.4	S
AST (IU/L)	29.6±4.4	30.7±3.1	NS	28.3±3.1	26.2±2.5	S
ALT (IU/L)	22.6±5.1	23.1±4.1	NS	21.8±4.3	21.2±3.2	NS

P < 0.05

Table (7): T. Protein, creatinine, lactate, CPK, AST, ALT of Control and Exper. group after treatment with placebo, supplements (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
T. proteins (g/dl)	7.6	0.3	7.9	0.5	S
Creatinine (mg/dl)	1.21	0.2	1.46	0.4	S
Lactate (m.mol/L)	1.7	0.1	1.2	0.05	S
CPK (IU/L)	312.2	1.2	269.7	15.4	S
AST (IU/L)	30.7	3.1	26.2	2.5	S
ALT (IU/L)	23.1	4.1	21.2	3.2	S

P < 0.05

Table (8): Change in some immunity parameters of the control and Experimental group before treatments (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
Malondialdhyde (mmol/ml)	3.17	0.17	3.21	0.15	NS
Superoxide dismutase (mmol/ml)	4.78	0.19	4.91	0.22	NS
Leucocyte cells x 10^3 ml	7.1	0.8	7.3	0.9	NS
Nutrophils x 10^3 ml	3.5	0.3	3.8	0.6	NS
Lymphocyte %	23.4	1.6	25.3	1.7	NS
Monocyte cells/ml	334	12.3	337	11.1	NS

P < 0.05

Table (9): Change in some immunity parameters of the control and Experimental group before & after treatments, (n = 15)

Variables	Control		Sig.	Experimental		Sig.
	Before M±SD	After M±SD		Before M±SD	After M±SD	
Malondialdhyde (mmol/ml)	3.17±0.17	3.11±0.15	NS	3.21±0.15	1.23±0.13	S
Superoxide dismutase (mmol/ml)	4.78±0.19	4.89±0.16	NS	4.91±0.22	5.37±0.14	S
Leucocyte cells x 10^3 ml	7.1±0.8	7.2±0.6	NS	7.3±0.9	8.8±0.7	S
Nutrophils x 10^3 ml	3.5±0.3	3.6±0.2	NS	3.8±0.6	4.9±0.4	S
Lymphocyte %	23.4±1.6	24.1±1.31	NS	25.3±1.7	18.3±1.5	S
Monocyte cells/ml	334±12.3	336±11.4	NS	337±11.1	344±10.2	S

P < 0.05

Table (10): Change in some immunity parameters of the control and Experimental group after placebo and milk serum treatments (n = 15)

Variables	Control		Experimental		Sig.
	M	SD	M	SD	
Malondialdhyde (mmol/ml)	3.11	0.15	1.23	0.13	S
Superoxide dismutase (mmol/ml)	4.89	0.16	5.37	0.14	S
Leucocyte cells x 10^3 ml	7.2	0.6	8.8	0.7	S
Nutrophils x 10^3 ml	3.6	0.2	4.9	0.4	S
Lymphocyte %	24.1	1.3	28.3	1.5	S
Monocyte cells/ml	336	11.4	344	10.2	S

$P < 0.05$

4. Conclusion

It may be concluded that:

- Milk serum (whey) demonstrates a beneficial effect on muscle strength and speed of the divers and limiting muscle loss.
- Milk serum may promote more efficient recovery of the muscle to speed the adaptation process of the divers couches.
- Milk serum may affect positively antioxidants and immunity of the divers coaches.

Recommendations

It is recommended to:

- Take a serving of milk serum (whey) 20-40 grams to improve muscle mass and preserve muscle damage to athletes.
- Take a serving of milk serum to boost immunity.
- verify the effect of milk serum on body composition and weight control.

References

1. Amani A and Mohamed S, (2011): Effect of concurrent training on $CD34^+$, blood component and some physical, Skill variables, Am. J. Sci., 21, 107.
2. Antonio I, Sanders MS and Van Gammeren D., (2001): The effects of bovine colostrum supplementation on body composition and exercise performance in active men and women. Nutrition 17: 243-247.
3. Barnes D, Cauley J, Yaffe K, (2007): Women who maintain optimal cognitive function into old age. J of Am. Geriatrics, Soc. 55, 259.
4. Bishop N, Blannin A, Robson P, (1999): The effects of carbohydrate supplementation on immune responses to a soccer specific exercise. J. Sports Sci. 17, 787.
5. Bounous G, (2000): Whey protein concentrate (WPC) and glutathione modulation in cancer treatment. Anticancer Res 20 (6C): 4785-92.
6. Bucci LR and Unlu L, (2000): Proteins and amino acids in exercise and sport. In: Energy-Yielding Macronutrients and Energy Metabolism in Sports Nutrition. Driskell J, and Wolinsky 1. Eds. CRC Press. Boca Raton FL, p. 197-200.
7. Calles-Escandon I, Arciero PI, Gardner AW, et al., (1995): Basal fat oxidation decreases with aging in women. J Appl Physiol 78(1):266-71.
8. Clarkson P, Nosaka D, Braun D, (1992): Muscle function after exercise induced damage, Med. & Sc., in Sport and Exerc. 24, 512.
9. Cordova A, Martin J, Reyes E. (2004): Protection against muscle damage in competitive sports, J. of Sports Sciences, 27, 827.
10. Cribb Pj, Williams AD, Hayes A and Carey MF, (2002): The effect of whey isolate on strength, body composition and plasma glutamine. Med Sci Sports Exerc 34;5: A1688.
11. Cribb PJ, Williams AD, Hayes A and Carey MF, (2003): The effects of whey isolate and creatine on muscular strength, body composition and muscle fiber characteristics. FASEB J 17; 5: a592. 20.
12. Cynthia B, (2006): Whey protein and body composition Dairy management inc, 1-8.
13. Dröge W and Holm E, (1997): Role of cysteine and glutathione in HIV infection and other diseases associated with muscle wasting and immunological dysfunction. FASEBI, 11:1077-1089.
14. Dröge W, Hack V, Breitkreutz R, Holm E, et al., (1998): Role of cysteine and glutathione in signal transduction, immunopathology and cachexia. BioFactors 8:97-102.
15. Erickson K, Prakash R, Voss M, (2009): Aerobic fitness is associated with hippocampal volume in elderly humans Hippocampus 19, 1030.
16. Evans W, (1997): Functional and Metabolic Consequences of Sarcopenia. J Nutr 127: 998S-1003S.
17. Fry AC, Schilling BK, Chiu LZF, et al., (2003): Muscle fiber and performance adaptations to MioVive, Colostrum, casein and whey protein supplementation. Res Sports Med 11:109-117.

18. Gilliam B, (2000): Technical diving international Nitrox Toshain, Maine, p. 33, USA.
19. Hack V, Schmid D, Breitkreutz R, et al., (1997) Cystine levels, cystine flux, and protein catabolism in cancer cachexia, HIV/SIV infection and senescence. FASEB J 11: 84-92.
20. Inelmen EM, Sergi G, Coin A, Miotto F, Peruzza S and Enzi G., (2003): Can obesity be a risk factor in elderly people? Obesity Reviews 4, 3:147-155.
21. Kimbal SR and Jefferson LS, (2002): Control of protein synthesis by amino acid availability. Opin Clin Nutr Metab Care 5: 63-67.
22. Lands LC, Grey VL and Smountas AA, (1999): Effect of supplementation with a cysteine donor on muscular performance. J Appl Physiol 87: 1381-1385.
23. Lori A, Hornsby W, Rye J (2013): The physiological effects of aquatic exercise on cognitive function in the aging population. Int. J. of Aquatic Research and Education, Vol. 7, 266.
24. Mac Kinnon, L. (2000): Chronic exercise training effects on immune function. Med Sci Sports Exerc. 32, 369.
25. Malm C, Ekblom O, Ekblom B, (2003): Immune system alteration in response to increased physical training during a 5 days training. Int. J. Sports Med., 25, 471.
26. Malm C, Ekblom O, Ekblom B, (2004): Immune system alteration in response to two consecutive soccer games. Acta physiol. Scand. 180, 143.
27. Micke P, Beeh KM and Buhl R., (2002): Effects of long term whey protein supplementation on plasma glutathione in HIV infected patients. Eur I Clin Nutr 41:12-18.
28. Mohamed S, (2012): The effect of aerobic and anaerobic exercise bouts on $CD34^{+}$ and some physiological parameters PHD, Bethune College Med., Jilin Univ., China.
29. Nagy TR, Goran MI, Weinsier RL, Toth MI, et al., (1996): Determinants of basal fat oxidation in healthy Caucasians. I Appl Physiol 80(5): 1743-8.
30. Raed T, (1995): Physical tests of soccer players. Fac. of phys. Ed., Suez Canal Univ.
31. Rennie MJ and Tipton KD, (2000) Protein and amino acid metabolism during and after exercise and the effects of nutrition. Annu Rev Nutr 20: 457-483.
32. Roberts R and Roberts S, (1997): Exercise physiology, Mosby, year book inc. USA.
33. Ronsen O, Pedersen B, Bahr R, (2001): Leukocyte counts and lymphocyte responsiveness associated with repeated bouts of strenuous endurance exercise. J Appl. Physiology 91, 425.
34. Volpi E, Kobayashi H, Sheffield-Moore M, et al., (2003): Essential amino acids are primarily responsible for the amino acid stimulation of muscle protein anabolism in healthy elderly adults. Am J Clin Nutr 78: 250-258.
35. Walsh NR Blannin AK, Robson PJ and Gleeson M, (1998): Glutamine, exercise and immune function. Links and possible mechanisms. Sports Med 26(3): 177-91.
36. Walzem RM, Dillard CJ and German JB, (2002): Whey Components: Millennia of Evolution Create Functionalities for Mammalian Nutrition: What We Know and What We May Be Overlooking. CriticalReviews in Food Science and Nutrition, 42; 4: 353-375.
37. Watanabe A, Okada K, Shimizu Y, et al., (2000): Nutritional therapy of chronic hepatitis by whey protein (non-heatedi. I Med 31;5-6: 283-302.
38. Withmore J and Costill D, (2005): Physiology of sport and exercise. 3rd Ed Human Kinetics, USA.
39. Wolfe RR, (2000): Protein supplements and exercise. Am J. Clin Nutr. 72: 551s-7s.
40. Zemel MB, Shi H, Greer B, DiRienzo D and Zemel PC, (2000): Regulation of adiposity by dietary caicium. FASEB J 14:1132-1138.

7/3/2016