J. Food and Dairy Sci., Mansoura Univ., Vol. 5 (10): 689 - 700, 2014

STUDY ON THE EFFECT OF DIFFERENT PROTEIN SOURCES ON SKELETAL MUSCLES OF MALE ALBINO RATS

Safaa A. Salem and Anaam K. Ahmed
Food Evalution and food Science, National Organization for Drug Control and Research (NODCAR)

ABSTRACT

The aim of this study was to investigate the effect of supplementation with different sources of protein; casein, soy protein concentrate(SPC) and chickpea protein concentrate(CPC) on whole body, skeletal muscle mass and composition in male albino rats after resistance exercise training. Three groups of male albino rats were fed on basal diet contains each of one of the three above protein sources(25%) in addition to glucose (20%) all rats swam for 60min / d for 30 days. Changes in body weight and serum biochemical analyses including glucose, protein, albumin and globulin were determined at each time interval 10,20 and 30 days during the experimental period. At the end of experiment muscle mass and composition including protein and glycogen were determined.

The results showed that the highest body weight gain was found in casein group followed by SPC group then CPC group , serum biochemical parameters showed non significant changes in glucose among all groups, also non significant changes in serum protein and globulin were found in between the vegetable protein sources SPC and CPC groups which showed significant increase in both parameters compared to casein group. The highest value of the relative muscles weight was found in casein group followed by SPC group then CPC group, the same trend was found in the content of muscle protein, on the other hand, depletion of glycogen was at the highest value in SPC group followed by CPC group while casein comment at the least value. In conclusion we can say that the three protein sources can be used in production of supplemented diet for athletes to prevent deficiencies, increase physical strength and enhancing performance, casein as animal protein was effective followed by soy protein concentration then chickpea concentrate, vegetable sources of protein was more effective in depletion of glycogen in muscles than casein.

INTRODUCTION

Nutrition is an important aspect of an athlete's training program. It is likely, however since athletes require more nutrients than the recommended daily allowance and for other reasons, not all athletes are able to consume a diet that meets their nutritional needs and thus they resort to nutritional supplements with the intention of preventing deficiencies and even enhancing performance. Such supplements contain carbohydrate, protein, vitamins and minerals which widely used in various sporting field (Aoi and Toshikatzu, 2006).

Protein proposed as a potential valuable adjuvant to resistance training; in the beneficial effect of resistance exercise are often suboptimal (Thomas, *et al* ., 2014). Protein requirements for athletic populations have been the subject of much scientific debate. Only recently has the notion that both strength / power and endurance athletes require a greater protein consumption than the general population arised. Despite the prevalence of high protein diets in athletic and sedentary populations, information available concerning the type of protein (animal or vegetable) to consume is limited(Jay and Michael , 2004).Also a variety of proteins and amino-acids blends are of popular use without sufficient scientific evidence (Ha and Zemel,2003). The maintenance of skeletal muscle mass is dependent on the balance between muscle protein synthesis and muscle protein breakdown. Both of the processes are responsive to exercise inactivity and nutrition (Murton and Greenhaff, 2013), furthermore many athletes believe that high intensity training creates a greater protein requirement, if more protein was available to the exercising muscle, it would enhance protein synthesis, (Layman,2009). Protein is available in a variety of dietary sources, which are seen as either being of animal or vegetable origin, animal sources such as casein contains all essential amino acids, (Butteiger *et al* .,2013). Casein is a strong stimulus for whole body net protein synthesis and splanchnic protein synthesis (Yvette, *et al.,* 2011), also casein carbohydrate meal would achieve a more prolong anabolic response, leading to high protein accretion in muscles.

Soy as a source of vegetable protein is a biologically active plant composed of soy protein (SP) plus several bioactive components; (Sites *et al.,* 2007). SP is used extensively in human foods because its beneficial characteristics relating to solubility, water absorption and binding, viscosity, emulsification, and fat absorption(Boniglia *at al .,* 2009). It contains all the essential amino acids including branched acids; leucine, isoleucein and valine. (Hessian *et al .,* 1998). Soy protein concentrate (SPC) is made by removing the carbohydrates from dehulled and defatted soybeans. Consumption of SPC with its naturally occurring isoflavones may help to protect the exercising individual against oxidative stress and resulting muscle injury and inflammation (Rossi *et al .,* 2000).

Chickpea is a good source of vegetable protein and carbohydrates; together constituting about 80% of the total dry seed mass (Chibbar *et al.,* 2010). It is a good source of dietary fiber, vitamins and minerals (Wood and Grusak , 2007), it has several potential health benefits, and in combination with other pulses and cereals, it could have beneficial effects on some of the important human diseases (Jukanti1 *et al.,* 2012). Information about the use of chickpea as a source of protein in athletes diet is limited.

One of the most important metabolic aspects that affects exercise is the enhanced uptake of blood glucose by skeletal muscles. Protein/ carbohydrate meal would achieve a more prolonged anabolic response. leading to higher protein accretion in muscle, Many studied reported a reduction of muscle protein breakdown after a protein- glucose meal(Yvette, *et al*., 2o11). Sometimes, in condition of intense exercise and training, there may be an increased consumption of carbohydrate rich foods or sport drinks containing insufficient doses of different nutrients such as vitamins and minerals (Luigi, 2008).

The aim of this work was to investigate the effect of supplementation with different sources of protein in addition to glucose on whole body, skeletal muscle mass and composition in male albino rats after resistance exercise training .Therefore the present investigation was designed to produce nutritional supplements as correct nutrition needs for athletes to improve their athletic performance and for prevention of injury. For this purpose, two vegetable protein sources ; soy protein concentrate (SPC) and chickpea protein concentrate (CPC) were used to serve in the production of these supplements in comparison to casein as animal source of protein.

MATERIALS AND METHODS

Defatted soy bean flour and chickpea were obtained from Soybean Products Pilot Plant, Food Research and Technology Institute, Agriculture Research center, Giza. Egypt . All chemicals used throughout this work were biochemical grades. Kits for biochemical assay were obtained from Sigma, Chemicals Company. P. O. Box 14506 St. Louis. MO 63178USA 314.

Male albino was obtained from the farm of the National Organization for Drug Control and Research, Giza, Egypt.

Preparation of soy and chickpea protein concentrate:-

Preparation of soy and chickpea protein concentrates were carried out according to the method of **Zheng *et al*., (2008).** The starting material was prepared by extraction of defatted soy and check flour with freshly prepared aqueous alcohol using 80% ethanol and stirring at room temperature for 30 minutes to dissolve the non protein components, then the slurry was filtered and the resultant cake was five times extracted and dried at room temperature for 2 hours to remove solvent , then kept overnight in a forced-air oven at 50Cº. The dried material was ground to pass through 200 mesh.

Analytical methods :-

Moisture, crude protein, lipids and ash contents were determined according to the standard procedures described by AOAC(2012). Total carbohydrates were calculated by difference.

Biological assay

Experimental design :-

Forty male albino rats weighing 130g±10 were used in this study. Eight rats, as initial group, were randomly chosen then weighed, blood samples were withdrawn from retrobulbar venous plexus of each rat according to the procedure of Shermer (1967). Serum was separated and its biochemical parameters were estimated, then rats were sacrificed, muscles were dissected then removed, weighed and stored at 3ºC until biochemical analysis. The remaining 32 rats were randomly divided into equal four groups each of eight rats as follows:-

Normal control group : Rats were fed on basal diet prepared according to AOAC(2012).

Group I:Rats were fed on basal diet which contains casein25% +glucose 20%.

Group II:Rats were fed on basal diet in which casein was replaced with soy protein concentrate(SPC) 25% + glucose 20%.

Group III:Rats were fed on basal diet in which casein replaced with chickpea protein concentrate(CPC) 25% + glucose 20%.

All groups of rats were housed in individual stainless steel cages and reversed 12h-light cycles, allowed free access to water through the experiment. All rats in the exercise trained swam without a load for 60 min/d for 30 days in a barrel filled with water maintained at 35°C to a depth of 50 cm. Changes in body weight were recorded and blood samples were obtained at time intravels 0 ,10, 20 and 30 days. Serum was separated, then subjected to the serum biochemical analysis. At the end of the experiment and 15h after the end of the last training session, all rats were sacrificed and organs were excised and weighed. The muscles of each rat were dissected and removed, weighed and subjected to biochemical analysis.

Biochemical analyses:-

Serum glucose was determined by colorimetric method according to Trinder (1969), whereas serum total protein and albumin were determined colorimetrically by the method of Doumas, *et al*., (1971). Globulin was calculated by subtracting .

Protein in muscles was determined by Kjeldahl method for total nitrogen using factor of 6.25 according to AOAC(2012). Glycogen was determined according to Shulman *et al.,* (1995).

Statistical analysis:-

The data were statistically analyzed according to statistical analysis system SAS(1996). Duncan's at 5% level of significance was used according to Sendecor and Cochran, (1980).

RESULTS AND DISCUSSION

Proximate chemical composition of legume flours and concentrate and casein :-

Proximate analyses of the three sources of protein SPC, CPC and casein were summarized in table (1).

The data show that the three studied protein sources containing high values of protein ranging between 70.86 and 84.10%. The data indicate that casein and SPC had the highest protein contents followed by CPC, the adverse relation was found in carbohydrate content which showed the highest value in CPC (25.14%) while the lowest value was found in casein (9.20%), the same table showed that the three sources of protein had close values of fat content ranging between 2.19 -2.86% also near values of ash content were observed in SPC and CPC 1.19 and 1.14% while a higher value was found in casein (4.20%).

Table(1): Proximate chemical composition of soybean ,chickpea flour and its concentrates on dry basis.

Component%	Flour		Protein concentrate		
	Soybean	Chick pea	Soybean	Chick pea	Casein
Moisture	8.8±0.1	12.00±0.2	13.20±0.6	12.50±0.6	8.70±0.10
Crude protein	42.43±1.3	21.02±0.8	84.10±1.8	70.86±2.2	84.00± 1.20
Crude fat	4.17±0.2	7.39±0.4	2.19±0.3	2.86±0.5	2.60±0.20
Ash	3.51±0.1	4.20±0.5	1.19±0.2	1.14±0.08	4.20±0.50
Total carbohydrate	49.89±1.4	67.39±0.4	12.52±2.2	25.14±1.19	9.20± 1.81

Mean± S.E

From the above data we can say that the three tested sources of protein contained high value of protein which can be used in addition to glucose and other components in basal diet to build, repair and maintain muscles tissue which is the main function of protein. Those involved in strenuous endurance or strength training may experience as light increase in protein requirement. The protein requirements for athletic population have been the subject of much scientific debate (Hoffman and Falvo 2004).

Biological evaluation:-

Change in body weight and organs weight:-

Body weight gain of exercised experimental groups of rats fed for 30 days on supplemented diets containing the aforementioned three sources of tested proteins; casein (group I), SPC(group II) and CPC (group III) in percentage value of 25% with addition to glucose (20%) are presented in Table (2).The data show a gradual increases in body weight of all animals during the experimental period in different values ranged between 14.17 and 40.83g at the end of the experimental period compared to 29.84 g in control group .The results show also that the highest increase in body weight of tested groups was observed in casein group which may be due to the high quality protein contains all essential acids (Butteiger *et al.,*2013) followed by SPC(group II) which may be due to the roll of the effect of isoflavones on body composition fat and lean mass distribution , that isoflavones may bind to estrogenic receptors of fat and lean tissues promoting gynoid fat deposition (Moeller *et al .,* 2003)., CPC group showed the lowest body weight gain.

Table (2) Body weight gain (g) of male albino rats during exercises and feeding on diet containing different protein sources for 30 days (n=8rats)

Animal* group	Feeding period (days)					
	Initial	10	20	30	Body weight gain (g) after 30 days	% of body weight gain
	Body weight (g)					
Control	132.16±7.76	137.66±8.70	147.66±5.82	162.00±6.93	29.84	22.58
Group I	136.33±7.13	150.00±8.45	165.33±5.40	177.16±0.57	40.83	29.90
II	131.83±8.93	134.33±9.66	141.16±5.79	152.66±7.73	20.83	15.80
III	139.66±7.73	142.00±8.20	146.33±5.64	153.83±5.28	14.17	10.15

Mean ± S.E Control : Rats fed on basal diet

Group I : Rats fed on basal diet contains casein 25% + 20% glucose

Group II : Rats fed on basal diet in which casein replaced with soy protein concentrate 25% + 20% glucose

Group III: Rats fed on basal diet in which casein replaced with chickpea protein concentrate25%+20%glucose

Data in Table (3) showed a little decrease in relative weight of lung in SPC group while CPC group showed a small decrease of heart and lung, increases in relative weight of all organs were observed when diet contained casein (group I) compard to those of the other groups, and control group.

Table (3): Percentage of organs weight/body weight of male albino rats after exercises and feeding on diet containing different protein sources for 30 days (n=8rats).

Animal group	Liver	Kidney	Heart	Lung	Spleen
Control	4.19±0.49[a]	1.34±0.11[a]	0.62±0.22[a]	1.60 ±0.13[a]	0.60±0.10[a]
Group I	5.83±0.32[b]	1.60 ±0.12[b]	0.72 ±0.11[b]	1.85 ±0.20[b]	0.70 ±0.02[b]
II	4.48±0.39[a]	1.41 ±0.13[a]	0.69±0.22[b]	1.30±0.19[c]	0.58±0.12[a]
III	4.46±0.36[a]	1.40 ±0.12[a]	0.53±0.29[c]	1.36 ±0.11[c]	0.60 ±0.12[a]

Mean ± S.E Group abbreviation seen in table (1)

Means having different superscripted letters are significantly different(p<0.05)

Biochemical parameters:

The obtained data in Table (4) show that serum glucose was not significantly changes during the experimental period and at the end of the experiment among all groups also in comparison with control group. Serum glucose ranged between 80.45-86.89 mg/ dl. Veldhorst *et al*., (2009) found that no changes were found in serum glucose concentration per type of protein, also there were no differences in the changes of glucose concentration within the groups which were fed on diet containing 10% of each protein sources; SPC,CPC and casein.

Non significant changes were observed in serum protein between SPC and CPC groups (II and III) in all time intervals during the experimental period, while significant increases in both groups compared to casein group (group I) and normal control group were found (Table 5) .These results are in agreement with those of Chan *etal.(*1988), and Laila and Ahmed (2009), who reported that substitution of soy protein for animal protein was recommended to decrease hyperfiltration.

Gradual decrease in serum albumin was observed in all groups compared to initial and control groups, also non significant changes in serum albumin of rats in SPC and CPC groups in all time intervals during the experimental period were observed (Table 5). Despite to this observation, it could be noticed that significant changes were found between both groups and casein and control group, meanwhile after 30 days, Sendra *et al.,* (2004) indicated that the consumption of vegetable protein, including soy protein reduces urinary albumin execration. Williams and walls (1987) also reportes that consumption of soy protein prevented the progression of renal disease in subtotally nephrectomized rats much more effectively than consumption of casein.

Table(4):Serum glucose (mg/dl) of male albino rats during exercises and feeding on different protein sources for 30 days(n= 8 rats).

Animal* group		Feeding period (days)			
	0	10	20	30	
Control	83.16±4.23[a]	96.53±3.54[a]	88.95±4.54[a]	80.65±3.61[a]	-
Group I	83.16±4.23[a]	88.75±3.74[a]	84.17±4.06[a]	86.89±4.50[a]	7.73
II	83.16±4.23[a]	86.76±3.39[a]	89.78±4.51[a]	80.45±3.56[a]	-0.24
III	83.16±4.23[a]	89.87±4.05[a]	89.75±3.57[a]	82.62±3.58[a]	2.44

Mean ± S.E. Group abbreviation seen in table (1).

Means having different superscripted letters are significantly different(p<0.05).

Concerning serum globulin, data in the same table indicate gradual significant increase in its concentration in SPC and CPC groups in all time intervals compared to initial and control group , also significant increase in both groups compared to casein group was found. On the other hand, group I which was fed on casein as a source of protein showed significantly the least serum globulin concentration at all time intervals.

Table (5): Serum protein, albumin and globulin of male albino rats during exercises and feeding on different protein sources for 30 days (n=8 rats)

Parameters	Animal* group	Feeding period (days)			
		0	10	20	30
Total protein	Control	7.32±0.22[a]	6.89±0.52[a]	6.79±0.74 [a]	7.11±0.55 [a]
	Group I	7.32±0.22[a]	6.94±0.51[a]	6.59±0.71 [a]	6.76±0.57[b]
	II	7.32±0.22[a]	7.67±0.56[b]	8.75±0.73[b]	8.66±0.58[c]
	III	7.32±0.22[a]	7.27±0.54 [b]	8.26±0.77 [b]	8.18±0.55 [c]
Albumin	Control	4.42±0.38[a]	3.97±0.22[a]	4.09±0.54[a]	4.46±0.35[a]
	Group I	4.42±0.38[a]	4.14±0.26[a]	4.14±0.50[a]	4.05±0.30[b]
	II	4.42±0.38[a]	4.36±0.27 [b]	4.18±0.51[a]	4.00 ±0.31[c]
	III	4.42±0.38[a]	4.24±0.28 [b]	4.18 ±0.54[a]	3.86±0.32 [c]
Globulin	Control	2.90±0.35[a]	2.92±0.52[a]	2.70±0.54[a]	2.65±0.61[a]
	Group I	2.90±0.35[a]	2.80±0.56[a]	2.45±0.60[a]	2.71±0.50[a]
	II	2.90±0.35[a]	3.31±0.57[b]	4.57±0.51 [b]	4.66 ±0.56 [b]
	III	2.90±0.35[a]	3.03±0.58[b]	4.08±0.57 [b]	4.32±0.58 [b]

Mean ±S.E. Group abbreviation seen in table (1).
Mean having different superscripted letters are significantly different ($P < 0.05$).

Muscles weight:

An increase in muscles weight and its relative weight to body weight in all test groups were found to be 0.564- 0.974g and 0.37- 0.55% compared to 0.407 and 0.25% for control group at the end of experimental period as seen in Table (6). The highest values of the both parameters were found in groups fed on casein followed by SPC group, while CPC group showed the least values, the same trend was found in percentage change from control in both parameters, higher protein intake have generally been shown to have a positive effect on muscles protein synthesis and gain (Lemon, 1995; Walberg *et al.,* 1998). Similarly, to prevent significant loss in lean tissue, endurance athletes also appear to require greater protein consumption (Lemon, 1995). Loss of lean tissue can have a significant effect on endurance performance, therefore; these athletes need to maintain muscle mass to insure adequate performance.

Table(6):Muscles weight and percentage of muscles weight to body weight of male albino rats after exercise and feeding on diet containing different protein sources for 30 days (n= 8 rats).

Animal Group	Body weight(g)	Muscle weight(g)	Muscle weight/ body weight%	change from control
Control	162.00±6.93	0.407±0.18	0.25	-
Group I	177.16± 6.57	0.974±0.25	0.55	139.31
II	152.83±7.73	0.686±0.24	0.45	68.55
III	153.83±5.28	0.564±0.16	0.37	38.57

Mean ±S.E Group abbreviation seen in Table (1).
Mean having different superscripted letters are significantly different (P< 0.05).

Composition of muscle:

Feeding the tested animals on supplemented diet containing high contents of different sources of protein, in addition to glucose after swam without a load for 60 min / d for 30 days affect the composition of muscles as seen in Table (7).

It was noticed that muscles protein content in all tested groups reached its maximum value at the end of experimental period; the highest content was found in casein group (87.06%) followed by SPC group (71.90%) while the least effect was found in CPC group (63.33%). In this respect, Parreira, (1993) indicated that increasing the concentration of proteins in the diet can elicit a higher deposition of protein in muscle of exercising rats. Volpi *et al*., (1998) reported a reduction of muscle protein breakdown after a protein glucose meal, probably related to the increasing of insulin induction that inhibited muscle protein breakdown. Also intake of carbohydrate with protein can accelerate the synthesis and inhibits its catabolism Borsheim *et al.,* (2004). Canada and American college of sports medicine concluded that intact high quality proteins such as casein or soy protein are effectively used for the maintenance, repair. synthesis of skeletal muscle protein in response to training (Butteiger *et al*.,2013), also soy protein was evaluated for its ability to affect muscle proteins synthesis.

The type of protein in diet play an important role in the increase in muscle mass and its protein content; diets containing soy protein prevent exercise-induced protein degradation in skeletal muscle, possibly through inhibition of the calpain-mediated proteolysis. The activation of muscle calpain due to the increase in intracellular free Ca^{+2} which resulted from the exercise was associated with release of CK in plasma. Calpain rather than the other proteases plays an important role in exercise induced injury or protein degradation in muscle (Nikawa *et al*., 2002). Therefore, the mechanism by which soy protein exert its benefits is linked to its content of isoflavones and its antioxidant activity (Elia *et al*., 2006).

An increase in muscles glycogen in percentage to control in all test groups were found in values of 8.9, 104.49 and 39.32 % in groups I, II and III respectively as seen in Table (7).The data clearly showed that rats fed on soy protein concentrate with glucose (group II) showed the highest muscle's glycogen followed by chickpea protein concentrate with glucose (group III) after 60 min/d /30 days swam in comparison to casein and control group. Depletion of glycogen stores is associated with fatigue during endurance exercise and therefore it is considered important to maintain adequate tissue stores of glycogen during exercise (Masashi *et al.,* 2011)

Table (7):Protein and glycogen content in muscles of male albino rats after exercise and feeding on diet containing different sources of protein for 30 days (n= 8 rats).

Animal group	Protein %	Percentage change from control	Glycogen %	Percentage change from control
Initial	58.67 ± 2.18^{d}	–	0.67 ± 0.18^{d}	–
Control	51.02 ± 2.18^{e}	–	0.89 ± 0.18^{c}	–
Group I	87.06 ± 2.15^{a}	70.63	0.97 ± 0.16^{c}	8.9
Group II	71.90 ± 4.14^{b}	40.92	1.82 ± 0.14^{a}	104.49
Group III	63.33 ± 3.16^{c}	24.12	1.24 ± 0.15^{b}	39.32

Mean ± S.E.
Group abbreviation seen in table (1).
Means having different superscripted letters are significantly different(p<0.05).

Glycogen is a fuel of major importance for the support of energy demands of muscle during high intensity exercise. Despite its importance the amount of glycogen stored in skeletal muscles is so small that it is just enough to sustain energy demands for only few hours of exercise. For this reason, it is recommended to ingest food after exercise to replenish rapidly muscle glycogen stores (Paul *et al.,* 2004). For rapid replenishment of glycogen stores for athletes during exercise, a high – carbohydrate diet can be effective, intake of protein along with carbohydrate can be more effective for the rapid replenishment in muscle glycogen after exercise compared with carbohydrate supplements alone (Masashi, *et al.,*2011). A higher consumption than average amount of energy intake as protein (soy 20% to 25% versus 15%) and adequate quantities of carbohydrate is useful to keep muscle glycogen relatively high for performance and support protein retention Farnsworth *et al.,* (2003).

Feeding with carbohydrate plus protein activates key proteins in skeletal muscles that determine glycogen synthesis, and glucose uptake during exercise, resulting in an attenuation of glycogen depletion during activity, it is possible that ingestion of carbohydrate plus protein increases the net balance of glycogen synthesis (Masashi,*et al.,*2011).Also Ivy *et al.,(*2008) showed that supplementation with a combination of carbohydrate and protein may alter the phosphorylated protein involved in muscle glycogen synthesis and glucose uptake resulting in an increase in muscle glycogen repletion.

In conclusion we can say that the three protein sources can be used in addition to glucose in production of supplemented diet for athletes to prevent deficiencies, increase physical strength and for enhancing performance. Casein as animal protein was more effective followed by soy protein concentrate then chickpea protein concentrate which was the best at all in glycogen depletion in muscles.

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دراسة عن تاثير مصادر بروتين مختلفة على الهيكل العضلى فى ذكور جرذان التجارب

صفاء عبد العزيز أحمد و انعام كمال أحمد
شعبة التقيم الغذائى و علوم الأغذية- الهيئة القومية للرقابة والبحوث الدوائية

يهدف البحث الى دراسة تاثير إستخدام مصادربروتينية مختلفة على وزن وتركيب الجسم والهيكل العضلى لحيوانات التجارب بعد إجراء التمرينات الرياضية المنتظمة حيث تم إستخدام ثلاث مصادر مختلفة من البروتين هى مركز بروتينات الصويا , مركز بروتينات الحمص كمصدر نباتى والكازين كمصدر حيوانى بنسبة ٢٥% وذلك بعد إجراء التحليل الكيميائى لها مع التدعيم بالجلوكوز بنسبة ٢٠% مضافة للغذاء الأساسى.

حيث تم إستخدام ثلاثة مجاميع من الجرذان غذيت كل مجموعة على غذاء أساسى مضافاًإلية إحدى المصادر النباتية سابقة الذكر مدعمة بالجلوكوز مع إجراء تمرينات السباحة اليومية لجميع الجرذان لمدة ٦٠ دقيقة وذلك لفترة ٣٠ يوماً.

أظهرت النتائج حدوث زيادة فى أوزان الجرذان بنسب مختلفة عند مقارنتها بالمجموعة المقارنة حيث كانت أعلاها فى المجموعة المغذاة على الكازين يليها مجموعة مركز بروتينات الصويا ثم مركز بروتينات الحمص. كما أظهرت النتائج عدم وجود فروق معنوية فى الجلوكوز بالسيرم للمجاميع الثلاثة أيضا عدم وجود فروق معنوية فى البروتين والجلوبيولين للمجاميع المغذاة على البروتينات النباتية والتى أظهرت زيادة معنوية فى كلا القياسين مقارنة بمثيلتها فى المجموعة المغذاة على الكازين.
ايضا اظهرت النتائج وجود زيادة معنوية فى وزن العضلات والمحتوى من البروتين بها حيث كانت أعلى زيادة فى مجموعة الكازين يليها مركز بروتينات الصويا ثم مركزبروتينات الحمص كما كانت أعلى زيادة فى المحتوى من الجليكوجين فى المجاميع التى غذيت على البروتينات النباتية يليها المجموعة المغذاة على الكازين.

يتضح من الدراسة السابقة امكانية استخدام مصادر البروتين الثلاثة السابقة مدعمة بالجلوكوز فى إنتاج مكملات غذائية للرياضين للمحافظة على اللياقة البدنية والحالة الصحية حيث أظهر إستخدام الكازين أفضل النتائج يلية مركز بروتينات الصويا ثم مركز بروتينات الحمص بينما أظهرت المصادر النباتية نتائج أفضل فى تكوين الجليكوجين بالعضلات.