Journal of Animal and Veterinary Advances 11 (16): 3000-3007, 2012
ISSN: 1680-5593

Effect of Movement Training on the Amino Acids Distribution and Intestines Morphosis in Rats

[1]Min Gong, [4]Wenkai Ren, [3]Huijing Qi, [4]Yulong Yin,
[2]Dehua Wang, [4]Gang Liu and [4, 5]Guoyao Wu
[1]Jiangxi Science and Technology Normal University, 330013 Nanchang, China
[2]Nanchang Centre for Disease Control and Prevent, 330038 Nanchang, Peoples R. China
[3]Department of Acupuncture and Moxibustion,
Jinan Frist People's Hospital, 250013 Shandong, China
[4]Key Laboratory for Agro-Ecological Processes in Subtropical Region,
Research Center for Healthy Breeding of Livestock and Poultry,
Hunan Engineering and Research Center of Animal and Poultry Science,
The Chinese Academy of Sciences, Institute of Subtropical Agriculture, 410125 Hunan, China
[5]Department of Animal Science, Texas A&M University, College Station, 77843 Texas, USA

Abstract: This research was conduct to study the effect of high intensity movement raining on the amino acids metabolism and distribution in internal organ and ntestinal morphosis. About 40 Sprague-Dawley male rats were randomly divided intoexercised group and sedentary group. On day 10 after the initiation treatment average daily feed intake became significant lower and the average weight became significantlower on day 12 compared with the sedentary group. There was not significant difference about amino acids in the serum but valine which was significant lower than sedentary groups. Movement training increased significantly all amino acids content except cysteine in the intestinal tissue but failed in the liver and muscle eventhough all amino acids were higher in the muscle than sedentary group but cysteine. Amino acids digestibility was lower in exercised group and it became significant lower when it comes to lysine and histidine. Additionally, movement training decreased the numbers of lymphocyte but had no effect on the goblet cell villi height and crypt depth in middle jejunum.

Key words: Movement training, amino acids, intestinal morphosis, villi height, jejunum

INTRODUCTION

Recent research indicate that movement training have various advantages on the people such as has a protective effect on subsequent cerebral ischemia (Moseley *et al*., 2005; Ding *et al*., 2006). However, body provided large amount of energy to cover the expenditure during exercise including 5-15% come from protein metabolism (Lawrence, 1994). Amino acid served as the monomer units form to construct the ploypeptide chain of protein also play an important role in promoting growth ameliorating the reproductive perform and regulating the immune function (Li *et al*., 2007; Wu, 2009, 2010). For example, glutamine has been tested to be important in optimal proliferation and function of lymphocytes and for the normal function of nonproliferation cells (Andrews and Griffiths, 2002). Meanwhile the effect of a glutamine supplement in the diets on multiple injury trauma burn and tumor patients have also been studied (Sacks, 1999; Xi *et al*., 2006). So much, attention has been paid to ensure enough amino acids level in the body or in the plasma during exercise or training.

Fatigue is a by products of exercise or training caused mainly by imbalance between training and recovery. As exercise can increase the plasma Free Fatty Acids (FFAs) level and decrease the content of some Large Neutral Amino Acids (LNAA) such as leucine, methionine, valine, phenylalanine and tyrosine (Westermann *et al*., 2010). The primarily mechanism of fatigue caused by exercise is that the accumulation of lactic acid (acidification) and other metabolic by products during intense exercise versus substrate depletion (fuel shortage) (Poso-Reata *et al*., 2004). Research indicate several amino acids are related to fatigue such as glutamine, tryptophan, tyrosine and the Branched-Chain Amino Acids (BCAA) (Assenza *et al*., 2004;

Corresponding Author: Gang Liu, Key Laboratory for Agro-Ecological Processes in Subtropical Region,
Research Center for Healthy Breeding of Livestock and Poultry,
Hunan Engineering and Research Center of Animal and Poultry Science,
The Chinese Academy of Sciences, Institute of Subtropical Agriculture, 410125 Hunan, China

Bergero *et al*., 2005). According to this chronic beta-alanine supplementation which presumably increased muscle carnosine content can attenuate the fall in blood pH during high-intensity exercise (Baguet *et al*., 2010). Furthermore, consuming carbohydrate and protein or amino acids during the early phases of recovery performed positively affect on subsequent exercise performance and could be of specific benefit for athletes involved in multiple training or competition sessions on the same or consecutive days (Beelen *et al*., 2010).

Other papers reported that intense exercise can increase blood neutrophil counts and decrease lymphocyte counts and lead to inflammation and immunosuppression (Lakier, 2003; Nimmo and Ekblom, 2007; Gleeson and Bishop, 2005; Murakami *et al*., 2010). However, intestine is the largest immune organ. So, the objective of this study is to asses the effect of high intensity movement training on the amino acids metabolism and distribution in internal organ and intestinal morphosis.

MATERIALS AND METHODS

Animal and movement train protocol: About 40 Sprague-Dawley male rates at 3 months of age with an average initial Body Weight (BW) of 247±11. About 6 g were obtained from Laboratory Animal Center of Central South University, Hunan, China. The rats were housed in the pathogen-free mouse colony (temperature, 20-30°C relative humidity 45-60% lighting cycle 12 h day^{-1}) and had free access to food and drinking water. The feed contains 0.1% titanium oxide as the exogenous indicator. The rats were randomly assigned into the experiment group (exercised group n = 27) or the control group (sedentary group n = 13) balanced for weight. The exercised group received movement training with 70% VO_{2max}-80% VO_{2max} day^{-1} in the JD-PT treadmill system (JiDe Co. Shanghai, China). The intensity of the exercise refers to the Bedfords program after 3 days accommodation training with 18 m min^{-1}, 15 min day^{-1} every other day increasing the charge with regard to 3 m min^{-1} and 10 min day^{-1} until the speed reached 30 m min^{-1}, 60 min day^{-1} and then lasted this intensity equaling to 70% VO_{2max} -80% VO_{2max}, for 4 weeks, 6 days per week. During training 7 of the exercise group died due to injury or infection while the control group has no mortality. All animal experiments were performed according to the guidelines of the Laboratory Animal Ethical Commission of Nanchang University.

Sample collection and preparation: The rats were weighed and the feed intake was calculated every 2 days. The 1 day after training serum was collected and stored at −20°C until further use meanwhile chyme samples from jejunum and ileum were prepared and stored additionally, 5 g of the quadriceps femoris were stored at the benzylpenicillin container with 10% formalin and other 5 g of the quadriceps femoris and liver were stored at the 20°C as spare.

Amino acids in serum, chyme, muscle, liver and intestinal: To detect the amino acids in serum 2.5 mL 7.5% trichloroacetic acid were added into every milliliter serum samples and mixed together the supernatant were harvested by centrifugation with 18000 r min^{-1} for 15 min at 4°C and used to determinate the amino acid content with LA 8800 Automatic AA Analyzer (Hitachi, Japan). In order to analysis amino acids in chyme, muscle, liver and intestinal 0.25 g of samples were put into a 15 mL ampere flask after stoved and milled then after a 10 mL 6 mol of hydrochloric acid were added placed the sealed flask in the surrounding of 110°C about 22-24 h further diluted and filtrated the mix according to the requirements of the machine finally, researchers used the liquid to analysis the amino acids by the same machine.

Amino acid digestibility: Dry matter was measured according to the methods introduced by AOAC (2003). Titanium dioxide was determined with reference to Fan *et al*. (2005). Amino acid content in the feeds was measured referring to it of Yin *et al*. (2009). Finally, the amino acid digestibility was calculated in accordance with the way of Yin *et al*. (2009).

Intestine morphosis: Intestinal villi length and crypt depth was measured by using the method of HE Staining Moditec Photo Processing Software and pathological image system. After that five typical fields (complete and straight fluff) were selected to measure the number of lymphocytes in every 200 columnar intestinal epithelial cells and the number of columnar cells in every 100 epithelial goblet cells.

Data statistics: Data from the experiment was processed by Excel 2003 and analyzed by Statistic Software SPSS 13.0. The result was expressed with mean±standard deviation.

RESULTS AND DISCUSSION

Exercise training and feed intake body weight: Exercise training can significantly effect feed intake in rats the daily feed intake of exercise training group was significant lower than the control group and was manifestly related to the exercise training time. The difference between the

Table 1: Dietary intake in response to days of exercise

Days	Sedentary (n = 13)	Exercised (n = 20)	t-value	Sig. (2-tailed)
2nd	26±6.1	25±6.4	0.437	0.665
4th	26±6.8	26±5.3	0.062	0.951
6th	28±6.6	27±4.3	0.515	0.610
8th	28±3.6	25±5.2	1.748	0.090
10th	29±3.4	22±7.3	3.191	0.003
12th	32±3.0	24±7.4	3.568	0.001
14th	30±3.0	23±8.0	3.132	0.004
16th	30±4.5	24±3.3	4.394	0.000
18th	30±4.5	24±5.3	3.414	0.002
20th	30±3.9	25±3.6	3.837	0.001
22nd	33±3.5	27±3.0	5.318	0.000
24th	32±4.5	26±6.6	2.870	0.007
26th	31±5.2	26±6.0	2.256	0.031
28th	31±5.7	27±4.3	2.095	0.044
30th	33±4.6	28±3.0	3.753	0.001
32th	31±4.5	26±3.8	3.495	0.001

Table 2: Weight loss in response to days of exercise

Days	Sedentary (n = 13)	Exercised (n = 20)	t-value	Sig. (2-tailed)
2nd	250±9.10	246±12.9	0.977	0.336
4th	262±17.9	256±15.1	0.909	0.371
6th	271±22.7	266±16.0	0.662	0.513
8th	283±29.3	273±16.3	1.310	0.200
10th	287±22.5	277±18.9	1.434	0.162
12th	309±19.6	288±21.3	2.817	0.008
14th	316±20.0	289±27.6	3.068	0.004
16th	330±19.8	286±32.2	4.366	0.000
18th	337±24.3	296±31.7	3.965	0.000
20th	344±28.2	302±33.2	3.797	0.001
22nd	357±31.2	308±33.6	4.212	0.000
24th	371±26.4	313±32.9	5.272	0.000
26th	375±31.8	314±34.4	5.127	0.000
28th	378±32.2	325±33.3	4.540	0.000
30th	395±37.3	333±32.4	5.053	0.000
32th	404±34.1	336±33.4	5.639	0.000

exercise group and the control group become remarkable ($p<0.05$) after 10 days exercise training (Table 1). Meanwhile, exercise training had effect on the weight of the rats to a certain degree, the weight of the exercise group became apparently lower than the control group ($p<0.01$) on day 12 after exercise treatment (Table 2).

Exercise training and amino acid distribution: Although, serum valine is evidently lower than the control group ($p<0.05$) exercise training has little influence on serum amino acids. Arginine, lysine, phenylalanine, threonine, aspartate, glycine histidine in exercise group were a little higher than the control group the isoleucine, leucine, methionine, alanine, glutamine, serine, tyrosine, proline and cysteinethe in exercise group were a little lower than the control group (Table 3).

Exercise training has an significant influence on intestinal tissue amino acid content apart from cysteine other amino acids in the exercise group are significantly higher than the control group ($p<0.05$). Isoleucine, leucine, lysine, phenylalanine, threonine, valine, alanine,

Table 3: Effect of exercise on Amino acid composition of blood

Amino acids	Sedentary (n = 6)	Exercised (n = 6)	t-value	Sig. (2-tailed)
Essential amino acids				
Arginine	38.066±5.7050	40.329±8.5030	0.541	0.600
Isoleucine	55.326±5.3690	55.138±6.6580	0.054	0.958
Leucine	29.450±3.7850	26.478±6.4480	0.974	0.353
Lysine	52.080±7.2430	60.524±6.5330	2.121	0.060
Methionine	18.112±2.0470	16.946±4.0660	0.627	0.545
Phenylalanine	21.161±2.5310	21.995±3.8090	0.446	0.665
Threonine	45.829±4.4760	50.927±7.0470	1.496	0.166
Valine	33.999±2.3040	29.160±3.1660	3.028	0.013
Non-essential amino acids				
Alanine	71.626±7.5760	68.547±12.207	0.525	0.611
Aspartic acid	14.431±2.0790	16.444±2.3100	1.586	0.144
Glutamine	50.675±7.1710	44.013±21.306	0.726	0.484
Glycine	31.571±4.2400	37.756±6.5340	1.945	0.080
Serine	106.02±26.4010	82.795±30.079	1.422	0.185
Tyrosine	29.173±5.9080	26.172±9.8820	0.638	0.538
Proline	33.177±5.0520	32.116±6.6290	0.312	0.761
Cysteine	29.699±1.6710	28.617±1.7110	1.109	0.294
Histidine	69.575±17.947	70.595±6.9620	0.130	0.899

Table 4: Effect of exercise on amino acid composition of intestine

Amino acidss	Sedentary (n = 6)	Exercised (n = 6)	t-value	Sig. (2-tailed)
Essential amino acids				
Arginine	1.359±0.456	1.952±0.228	2.851	0.017
Isoleucine	1.130±0.370	1.715±0.149	3.594	0.005
Leucine	2.263±1.063	3.920±0.477	3.483	0.006
Lysine	1.929±0.597	2.898±0.248	3.677	0.004
Methionine	0.883±0.306	1.261±0.073	2.940	0.015
Phenylalanine	1.255±0.411	1.990±0.114	4.222	0.002
Threonine	1.429±0.354	2.020±0.195	3.579	0.005
Valine	1.374±0.369	1.977±0.081	3.905	0.003
Non-essential amino acids				
Alanine	1.400±0.442	2.129±0.232	3.576	0.005
Aspartic acid	2.228±0.588	3.179±0.285	3.567	0.005
Glutamine	3.478±0.895	5.131±0.509	3.934	0.003
Glycine	1.498±0.441	2.135±0.171	3.297	0.008
Serine	1.106±0.293	1.606±0.124	3.850	0.003
Tyrosine	1.260±0.342	1.822±0.113	3.828	0.003
Proline	1.084±0.345	1.500±0.127	2.778	0.020
Cysteine	0.331±0.107	0.409±0.149	1.047	0.320
Histidine	2.927±0.788	4.085±0.269	3.405	0.007

aspartate, glutamine, glycine, serine, tyrosine, histidine in the exercise group were apparently higher than the control group ($p<0.01$) (Table 4). Exercise training has little influence on liver amino acid concentration. Apart from methionine, threonine, tyrosine, cysteine in the exercise group were a little higher than the control group the rest of the amino acids content were almost the same (Table 5).

Amino acid in both group has no significant difference yet exercise training has some effect on muscle amino acid content. Apart from cysteine the rest amino acids in the exercise group were all higher than the control group (Table 6).

Exercise training and amino acid digestibility, intestinal morphosis: Digestibility of lysine histidine in the exercise group was significantly lower than the control group ($p<0.05$). In the exercise group apart from the digestibility

Table 5: Effect of exercise on amino acid composition of liver

Amino acids	Sedentary (n = 6)	Exercised (n = 6)	t-value	Sig. (2-tailed)
Essential amino acids				
Arginine	2.243±0.199	2.240±0.218	0.029	0.977
Isoleucine	2.018±0.184	1.976±0.155	0.426	0.679
Leucine	4.781±0.473	4.644±0.492	0.490	0.635
Lysine	3.406±0.222	3.392±0.317	0.090	0.930
Methionine	1.467±0.130	1.517±0.055	0.861	0.409
Phenylalanine	2.234±0.140	2.258±0.201	0.246	0.810
Threonine	2.276±0.225	2.730±0.235	0.343	0.739
Valine	2.505±0.192	2.490±0.185	0.137	0.894
Non-essential amino acids				
Alanine	3.124±0.242	3.040±0.336	0.494	0.632
Aspartic acid	4.382±0.387	4.381±0.376	0.006	0.995
Glutamine	6.721±0.535	6.587±0.681	0.377	0.714
Glycine	2.476±0.223	2.451±0.270	0.175	0.865
Serine	2.166±0.172	2.138±0.187	0.270	0.793
Tyrosine	1.854±0.089	1.901±0.146	0.669	0.518
Proline	2.125±0.273	2.045±0.386	0.416	0.686
Cysteine	0.613±0.149	0.711±0.009	1.611	0.138
Histidine	4.581±0.344	4.470±0.383	0.532	0.607

Table 6: Effect of exercise on amino acid composition of muscle

Amino acids	Sedentary (n = 6)	Exercised (n = 6)	t-value	Sig.(2-tailed)
Essential amino acids				
Arginine	3.641±0.506	4.105±0.557	1.508	0.162
Isoleucine	2.583±0.379	2.825±0.327	1.183	0.264
Leucine	5.482±0.799	6.128±0.794	1.404	0.190
Lysine	4.995±0.584	5.510±0.636	1.463	0.174
Methionine	1.834±0.341	1.997±0.211	0.992	0.345
Phenylalanine	2.287±0.288	2.541±0.256	1.612	0.138
Threonine	3.201±0.414	3.589±0.493	1.473	0.172
Valine	2.724±0.288	2.971±0.323	1.399	0.192
Non-essential amino acids				
Alanine	3.780±0.495	4.120±0.579	1.096	0.299
Aspartic acid	6.411±0.867	7.210±0.987	1.490	0.167
Glutamine	10.546±1.434	11.880±1.623	1.509	0.162
Glycine	3.232±0.445	3.703±0.419	1.890	0.088
Serine	2.754±0.336	3.060±0.409	1.416	0.187
Tyrosine	2.367±0.259	2.527±0.401	0.819	0.432
Proline	2.307±0.536	2.776±0.374	1.761	0.109
Cysteine	0.612±0.179	0.549±0.125	0.715	0.491
Histidine	5.157±0.491	5.565±0.620	1.263	0.235

of threonine, glutamine, glycine and serine is slightly higher than the control group the digestibility of other amino acids is lower than the control group (Table 7). Movement training had no effect on the goblet cell villi height and crypt depth in middle jejunum but decreased significantly the numbers of lymphocyte ($p<0.01$) (Table 8 and Fig. 1). The experimental results show that exercise training has a significant influence on the feed intake in rats which cause the loss of weight. (Martins *et al*., 2007) shows that hypointensity exercise could stimulate appetite and feed intake however hyperintensity exercise could lead to temporary inhibition of feed intake. In competitive sports the coaches athletes and researchers in ultimate strength sports take the attitude that the appetite and feed intake of athletes would decrease dramatically after exercise training or competition. Donnelly *et al*. (2003) also found that food

Table 7: Effect of exercise on digestion rates of amino acid

Amino acids	Sedentary (n = 6)	Exercised (n = 6)	t-value	Sig. (2-tailed)
Essential amino acids				
Arginine	76.033±19.159	83.044±7.5470	0.944	0.365
Isoleucine	66.387±11.235	59.562±12.113	1.034	0.321
Leucine	63.567±17.524	61.874±14.871	0.192	0.851
Lysine	81.385±8.5720	59.704±18.156	2.487	0.029
Methionine	70.826±15.873	63.439±11.520	0.865	0.410
Phenylalanine	79.963±12.441	72.413±14.199	1.057	0.310
Threonine	60.147±14.679	64.957±11.891	0.700	0.496
Valine	63.702±13.520	57.149±13.469	0.922	0.373
Non-essential amino acids				
Alanine	79.034±4.9100	77.605±7.5280	0.408	0.690
Aspartic acid	79.974±11.974	54.678±14.610	0.590	0.568
Glutamine	65.966±10.371	66.359±10.857	0.070	0.945
Glycine	48.507±12.999	49.427±17.755	0.107	0.917
Serine	57.480±11.210	60.356±13.731	0.392	0.703
Tyrosine	77.727±10.586	62.718±22.849	1.483	0.164
Proline	72.175±13.714	66.121±11.344	0.933	0.368
Cysteine	85.224±7.7070	73.458±14.712	1.735	0.113
Histidine	78.360±4.1820	67.740±9.5330	2.325	0.040

Table 8: Effect of exercise on intestinal morphology

Parameters	Sedentary (n = 6)	Exercised (n = 6)	t-value	p-value
Villi height (um)	390.65±47.360	387.81±50.210	0.116	0.909
Crypt depth (um)	342.18±46.900	340.76±48.940	0.059	0.954
Villi height/Crypt depth	1.146±0.063	1.142±0.069	0.118	0.908
Goblet cell number	7.88±5.3800	8.38±3.2900	0.224	0.826
Intraepithelial lymphocyte number	140.75±52.470	71.13±11.360	3.668	0.003

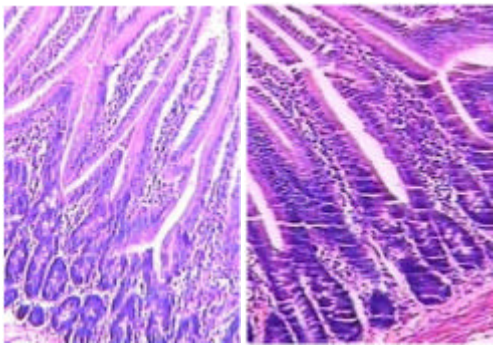

Fig. 1: Seanning electronic microscope photograph (20×10) of the jejunum morphology

consumption of obesity doesn 't increase obviously after movement. Organisms hydrolyze lipid to afford energy in the movement but the food intake will not increase and even decrease slightly then energy appeared negative balance and weight begin to decrease (Bensimhon *et al*., 2006). Once the body formed a new energy balance and the weight would be kept in a new balance until the new energy balance was broken. That is when the amount of exercise continue to increase whereas the food intake does not increase, the energy intake can not satisfy the assumption of exercise it may lead to the decrease of

weight due to the increase of energy consumption (Sullo *et al*., 2004) the loss of body fat (Coutinho *et al*., 2006) feeding inhibition (Lattanzio and Eikelboom, 2003). Eventually, the body will appear a series of over-training syndrome symptoms fatigue, weight loss, sleep and mood disorders Walberg *et al*. (1988) believed that the energy consumption of endurance athletes were exceedingly high and the negative energy balance could not be averted by food intake so endurance athletes should increase protein intake. The results showed that exercise training has a significant influence on the amino acid concentration of intestinal tissue and muscle tissue but has little influence on the liver tissue Lemon (1991) held the perspective that exercise training can spark off enormous changes in body protein metabolism. Further, Chesley *et al*. (1992) found that the protein synthesis become more active than the decomposition of protein after 24 h of exercise training. Holloszy and Coyle (1984) took the view that endurance exercise mainly increase the mitochondrial enzymes concentration instead of increasing the protein synthesis which will decrease the dependence on carbohydrates but increase fat metabolism which makes amino acid oxidation is more significant.

The serum free amino concentration was a crucial biochemical parameter reflecting the state *in vivo* protein metabolism. Although, the complement of protein in the field of exercise nutrition has always been the most concerned problem the current literatures (Kingsbury *et al*., 1998; Ha and Zemel, 2003) were not consistent in the effect of exercise training on serum free amino acid concentration. The reason may be associated with differences in exercise intensity exercise time and exercise ways. The condition of tissue protein metabolism could be directly observed through the changes of which are the results of changes of liver and muscle metabolism where serum free amino acid levels were considered to be relative to the state of exercise intensity and exercise time. Researchers found that apart from serum valine in exercise group was apparently lower than the control group ($p<0.05$), the difference of the other amino acids were not significant several amino acids concentration decreased, probably because exercise training increased the absorption of amino acid from blood by liver and muscle which decreased the corresponding amino acid concentrations in plasma. The study also found that some amino acids increased slightly and the mechanism needs further study.

Human tissues contain small amounts of free amino acids but skeletal muscle and liver was the critical repository of free amino acids which contain 80% free amino acids. When exercise changes the metabolism of amino acids and proteins the composition distribution and number of free amino acids will change correspondently. In the quiet state amino acids are not involved in oxidation for energy but in a long time endurance exercise the body starts to mobilize protein and oxidize to offer energy Lemon (1991) consider that in the long time of endurance exercise the energy from the amino acids oxidation is 4-8% of the total energy consumption. This study found that apart from cysteine in the exercise group the rest amino acids content were higher than the control group but there was no significant difference the reason may be the movement or deformation of cells subjected to stretch increased which increased the membrane permeability and the amount of free amino acids which provided several raw materials for the synthesis of protein. However, the study also found that the influence that exercise training had on liver amino acids content was not evident and the difference was not significant probably because liver was the place for nutritive substance metabolic transformation which could be kept balance by other substance metabolism transformation or other ways of obtaining.

Small intestine is a significant place for regulation of intestinal absorption of amino acids into the portal vein. For a long time it is assumed that all the amino acids absorbed from small intestine mucosa and used by outside tissue without metabolism by small intestine mucosa. However, recent study found that the amount of amino acids in the blood of portal veinthe did not equal to absorbed amount in the intestine tract but significant less than the latter. That indicated that the amino acids absorbed by small intestine did not all enter the portal vein but participated in metabolism in small intestine mucosa (Yin *et al*., 2003). The 40% of the arginine absorbed in the intestine tract of adult rats was metabolized by small intestine mucosa firstly and 38% arginine in the food was utilized by the small intestine mucosa for adults (Castillo *et al*., 1993). All these results indicated amino acids rather than blood sugar were the main fuel for small intestine mucosa. Meanwhile, some other studies also show that amino acids participated in metabolism in the small intestine some amino acids were the main resources of intestinal tract mucosa and joined the synthesis of excretion proteins of intestinal mucosa and even transformed them into other amino acids through deamination or transamination (Dudley *et al*., 1998; Stoll *et al*., 1998). This study found that the effect of movement training on the amino acid content in intestinal tissue were significantly apparent, apart from cysteine, other amino acids in the exercise group was significantly higher than the control group. This may be associated with the shortage of blood of gastrointestinal tract when the body was in kinestate which indicated that amino

acids probably were the main resource of intest inal mucosa. With the redistribution of blood in the strenuous exercise most blood centralized in the skin and somatic muscles so the blood support decreased relatively and leaded to the shortage in gastrointestinal tract. Researchers found that splanchnic blood flow of the human body would decrease 60-70% in the 70% VO_{2max} intensity exercise while it decrease 80% in ultimate training. This study found that digestibility of lysine and histidine were obviously lower than the control group ($p<0.05$) which was correlative to the decrease of splanchnic blood flow. Rehrer *et al*. (1990) had reported that the emptying time of the stomach did not change or accelerated slightly in the low intensity exercise while the time would be greatly delayed when the intensity of exercise beyond the 70% VO_{2max} which leaded to several indispositional symptoms in the stomach ignition pain and so on. Connor reported that the concentration of various gut hormones such as blood vessel polypeptide, gastrin, motilin, changed in the exercise which inhibited the absorption of nutritive substance from stomach intestine tract.

The length of villus and depth of intestine crypt can reflect small intestine functional. In details shorter villi decreased ability on digestion and absorption of nutrients. The depth of intestine crypt reflected the update rate. Slower renewal process indicated that depth of intestine crypt became shallow which indicated maturation rate of epithelial cells raised and secretion increased. The ratio of small intestinal villus height and crypt depth is the structural basis to determine digestion and absorption. Larger ratio meant larger intestinal lining endothelium and stronger digestion while smaller ratio showed the intestinal lining endotheliums allergy was larger and digestion and absorption was poor.

So far, the relationship between exercise and intestines morphosis is seldom reported but was concerned gradually by the majority of sports medical workers. Recent research showed medium intensity exercise can improve intestinal function but resistance to infection of intestinal decreased after prolonged endurance exercise or a long period of strengthening of the training. Other papers reported that intestinal epithelial cells emerged a edema after rats finished 8 weeks of treadmill over-training. In accordance with that this study found that effect of movement training on the middle jejunum villi length, crypt depth and goblet cell numbers was not significant but the number of lymphocyte was reduced significantly in training group ($p <0.01$). Although, most researchers believe immune barrier can injury by exercise stress or intestinal microbes and endotoxin translocation the mechanism of intestinal immune barrier damage was not sample and its need further study.

CONCLUSION

This is the first study to report that hyperintensity movement training can affect appetite and caused weight loss significantly affect the amino acids distribution *in vivo*. It also decrease amino acids digestibility and damage intestinal immune function.

REFERENCES

AOAC, 2003. Official Methods of Analysis of the Association of Official's Analytical Chemists. 17th Edn., AOAC, Arlington, Virginia.

Andrews, F.J. and R.D. Griffiths, 2002. Glutamine: Essential for immune nutrition in the critically ill. Br. J. Nutr., 87: S3-S8.

Assenza, A., D. Bergero, M. Tarantola, G. Piccione and G. Caola, 2004. Blood serum branched chain amino acids and tryptophan modifications in horses competine in long distance rides of different length. J. Anim. Physiol. Anim. Nutr., 88: 172-177.

Baguet, A., K. Koppo, A. Pottier and W. Derave, 2010. Beta-alanine supplementation reduces acidosis but not oxygen uptake response during high-intensity cycling exercise. Eur. J. Applied Physiol., 108: 495-503.

Beelen, M., L.M. Burke,M.J. Gibala and J.C. Van Loon, 2010. Nutritional strategies to promote postexercise recovery. Int. J. Sport. Nutr. Exerc. Metab., 20: 515-532.

Bensimhon, D.R., W.E. Kraus and M.P. Donahue, 2006. Obesity and physical activity: A review. Am. Heart J., 151: 598-603.

Bergero, D., A. Assenza, A. Schiamone, G. Piccione, G. Perona and G. Caola, 2005. Amino acid concentrations in blood serum of horses performing long lasting low-intensity exercise. J. Anim. Physiol. Anim. Nutr., 86: 146-150.

Castillo, L., T.E. Chapman, Y.M. Yu, A. Ajami, J.F. Burke and V.R. Young, 1993. Dietary arginine uptake by the splanchnic region in adult humans. Am. J. Physiol., 265: 532-539.

Chesley, A., J.D. MacDougall, M.A. Tarnopolsky, S.A. Atkinson and K. Smith, 1992. Changes in human muscle protein synthesis following resistance exercise. J. Appl. Physiol., 73: 1383-1388.

Coutinho, A.E., S. Fediuc, J.E. Campbell and M.C. Riddell, 2006. Metabolic effects of voluntary wheel running in young and old Syrian golden hamsters. Physiol. Behav., 87: 360-367.

Ding, Y.H., Y. Ding, J. Li, D.A. Bessert and J.A. Rafols, 2006. Exercise preconditioning strengthens brain microvascular integrity in a rat stroke model. Neurol. Res., 28: 184-189.

Donnelly, J.E., E.P. Kirk, D.J. Jacobsen, J.O. Hill, D.K. Sullivan and S.L. Johnson, 2003. Effects of 16 mo of verified, supervised aerobic exercise on macronutrient intake in overweight men and women: The Midwest exercise trial. Am. J. Clin. Nutr., 78: 950-956.

Dudley, M.A.,L.J. Wykes, A.W. Dudley, D.G. Burrin and B.L. Nichols *et al*., 1998. Parenteral nutrition selectively decreases protein synthesis in the small instine. Am. J. Physiol., 274: 131-137.

Fan, M.Z., T.J. Li,Y.L. Yin, R.J. Fang and Z.Y. Tang *et al*., 2005. Effect of phytase supplementation with two levels of phosphorus diets on ileal and faecal digestibilities of nutrients and phosphorus, calcium, nitrogen and energy balances in growing pigs. Anim. Sci., 81: 67-75.

Gleeson, M. and N.C. Bishop, 2005. The T cell and NK cell immune response to exercise. Ann. Transplant., 10: 44-49.

Ha, E. and M.B. Zemel, 2003. Functional properties of whey, whey components and essential amino acids: Mechanisms underlying health benefits for active people (review). J. Nutr. Biochem., 14: 251-258.

Holloszy, J.O. and E.F. Coyle, 1984. Adaptations of muscle to endurance exercise and their metabolic consequences. J. Applied Physiol., 56: 831-838.

Kingsbury, K.J., L. Kay and M. Hjelm, 1998. Contrasting plasma free amino acid patterns in elite athletes: association with fatigue and infection. Br. J. Sports. Med., 32: 25-32.

Lakier, S.L., 2003. Overtraining, excessive exercise and altered immunity: Is this a T helper-1 versus T helper-2 lymphocyte response?. Sports Med., 33: 347-364.

Lattanzio, S.B. and R. Eikelboom, 2003. Wheel access duration in rats: Effects on feeding and running. Behav. Neurosci., 117: 496-504.

Lawrence, L.M., 1994. Nutrition in the Athletic Horse. W.B. Saunders Co., Philadelphia, pp: 205-230.

Lemon, P.W.R., 1991. Prortein and amina acid needs of the strength athletes. Int. J. Sports Nutrl., 1: 145-147.

Li, P., Y.L. Yin, D. Li, S.W. Kim and G. Wu, 2007. Amino acids and immune function. Br. J. Nutr., 98: 237-252.

Martins, C., L.M. Morgan, S.R. Bloom and M.D. Roberston, 2007. Effects of exercise on gut pep tides, energy intake and appetite. J. Endocrinol., 193: 251-258.

Moseley, A.M., A. Stark, I.D. Cameron and A. Pollock, 2005. Treadmill training and body weight support for walking after stroke. Cochrane Database Syst. Rev.

Murakami, S., S. Kurihara, C.A. Titchenal and M. Ohtani, 2010. Suppresion of exercise-induced neutrophilia and lymphopenia in athletes by cystine/theanine intake: A randomized, double-blind, placebo-controlled trial. J. Int. Soc. Sports Nutr., 7: 23-24.

Nimmo, M.A. and B. Ekblom, 2007. Fatigue and illness in athletes. J. Sports Sci., 25: S93-S102.

Poso-Reeta, A., S. Hyyppa and R.J. Geor, 2004. Metabolic Responses to Exercise and Training. In: Equine Sports Medicine and Surgery, Hinchcliff, K.W., A. Kaneps and R.J. Geor (Eds.). Saunders Press, China, pp: 771-792.

Rehrer, N.J., E. Beckers, F. Brouns, F. Ten Hoor and W.H. Saris, 1990. Exercise and training effects on gastric emptying of carbohydrate beverages. Med. Sci. Sports Exerc., 21: 540-549.

Sacks, G.S., 1999. Glutamine supplementation in catabolic patients. Ann. Pharmacother., 33: 348-354.

Stoll, B., J. Henry, P.J. Reeds, H. Yu, F. Jahoor and D.G. Burrin, 1998. Catabolism dominates the first-pass intestinal metabolism of dietary essential amino acidsin milk protein-fed piglets. J. Nutr., 128: 606-614.

Sullo, A., G. Brizzi and N. Maffulli, 2004. Triiodothyron inedeiod in ating activity in brown adipose tissue after short cold stimulation testintrained and untraind rats. Physiol. Res., 53: 69-75.

Walberg, J.L., M.K. Leidy, D.J. Sturgill, D.E. Hinkle, S.J. Ritchey and D.R. sebolt, 1988. Macronutrient content of a hypoenergy diet affects nitrogen retention and muscle function in weight lifters. Int. J. Sport Med., 9: 251-266.

Westermann, C.M., L. Dorland, I.D. Wijnberg, M.G. De Sain-van Der Velden and E. Van Breda *et al*., 2010. Amino acid profile during exercise and training in Standardbreds. Res. Vet. Sci., 91: 144-149.

Wu, G., 2009. Amino acids: Metabolism, functions and nutrition. Amino Acids, 37: 1-17.

Wu, G., 2010. Recent advances in swine amino acid nutrition. J. Anim. Sci. Biotechnol., 1: 118-130.

Xi, P., H. Yan, Z. You, P. Wang and S. Wang, 2006. Glutamine granule-supplemented enteral nutrition maintains immunological function in severely burned patients. Burns, 32: 589-593.

Yin, F.G., Y.L. Liu, Y.L. Yin, X.F. Kong and R.L. Huang *et al*., 2009. Dietary supplementation with *Astragalus polysaccharide* enhances ileal digestibilities and serum concentrations of amino acids in early weaned piglets. Amino Acids, 37: 263-270.

Yin, Y., R. Huang, J.T. Yen, A.J. Libao-Mercado and C.F.M. De Lange, 2003. Net portal appearance of amino acids and glucose and energy expenditure by portal vein-dirained organs in growing pigs fed casein based diet or wheat shorts based diet. Proceedings of the International Symposium on Digestive Physiology in Pigs, March 14, 2003, Canada, Alberta, pp: 340-342.