The Effect of β-hydroxy-β-methylbutyrate Supplementation on Low Intensity Training Men and Its Effect on Body Composition and Blood Biochemistry

補充β-羥基-β-甲基丁酸鹽對低強度訓練者的身體組成和血液生化值的影響

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Abstract

The present randomized and double-blinded study investigated whether β-hydroxy-β-methylbutyrate (HMB) supplementation on low intensity training subjects had an effect on body composition and blood biochemistry. Fourteen recreational untrained college students participated in an eight-week low intensity resistant training. They were divided into two groups either an HMB group or a placebo group at the 5th week. Prior to beginning of the study a 1 RM max was performed at 1st week and again at the 4th week. 80% of 1 RM max was used as the training weight. The HMB group received 3g of HMB supplements per day from the 5th week to the 8th week. The body composition, blood biochemistry, and strength at 0 week and 8th week were measured. There were no significant differences ($P<0.5$) between the two groups in fat free mass, creatine kinase, endocrine profile, blood lipid profile and strength. Results indicated that low intensity training men ingesting HMB for 4 weeks did not provid any ergogenic benefit.

Key words: β-hydroxy-β-methylbutyrate, strength, resistance training

摘 要

本研究主要探討補充β-羥基-β-甲基丁酸鹽 (HMB) 對低強度訓練者的身體組成和血液生化值是否有影響。研究對象為14位未受訓練的大學生參與8周的阻力訓練。在實驗開始前與第四周測量受試者的最大肌力，之後以80%最大肌力進行肌力訓練。HMB組於第5周至第8周每天補充3克的HMB，安慰劑組則補充安慰劑。於第1周和第8周測量每位受試者的身體組成、血液生化值和肌力。研究結果顯示這兩組在體脂肪百分比，肌酸激酶，內分泌，血脂和肌力沒有顯著性的差異($P<0.05$)，即低強度之阻力訓練，再予以補充4周HMB並無增強作用。

關鍵字：β-羥基-β-甲基丁酸鹽、肌力、阻力訓練

Introduction

Beta-hydroxy beta-methylbutyrate (HMB) is a metabolite of leucine. Moderate amounts can be found in both plant and animal origin such as alfalfa, grapefruit, some fish. The body is capable of producing 0.3 grams to 1 gram of HMB daily depending on ones nutritional intake. HMB's precursors are the amino acid leucine and the keto acid. During demanding exercise and stress, the need for the three branched-chain amino acids: leucine, isoleucine, and valine increases dramatically. Studies have reported significantly greater gains of FFM and strength in untrained men (Nissen et al., 1996) and women (Panton, Rathmacher, Baier, & Nissen, 2000) initiating resistance-training when administering 1.5 to 3g/d of HMB supplementation for 3 to 4 weeks. However, Hoffman et al. have reported that HMB supplement didn't show the difference in fat free mass, strength, creatine kinase activity and testosterone concentration in trained or competitive athletes (Hoffman, Cooper, Wendell, IM, & Kang, 2004). The popularity of HMB used in the gymnasium by all levels of sporters in Taiwan is growing. As to date research considering the recreational people while training by lower exercise intensity and subsequently ingest HMB have not been investigated sufficiently. Taking this into account the focus of this research was to investigate the effectiveness of the HMB supplement on muscle performance, hormonal change, biochemical parameters and renal function after an eight week period of low intensity resistant exercise in recreational untrained college students. The ingestion period of HMB supplementation for this study started at the 5th week, unlike other research which started at the 1st week.

Methods

Subjects

Fourteen recreational male collegiate students, 19-22 years of age participated in this study. Subjects were excluded from the study if they had evidence or history of any of the following: diabetes mellitus; cardiac, liver, renal, or pulmonary diseases, the habituation of smoking and drinking alcohol. The purposes and risks of the study were explained to all subjects, and their voluntary written informed consents were obtained. The study was approved by the Human Subject's Review Committee of National Taiwan Sport University.

Experimental Design

The subjects were randomly assigned into two groups starting at the 5th week. At this time, the HMB group (n=7, 20.9±1.4years, 171.8±5.4cm, 68.0±5.4kg) began supplementing 3g of HMB per day. The HMB supplement was provided by Powerhouse International. The placebo group (n=7, 19.5±1.2years, 175.5±6.4cm, 69.1±9.1kg) began supplementing with the placebo (methylhydroxycellulose) in the same manner as the HMB group. A double blind study design was used. The subjects were instructed not to alter their lifestyle or dietary practices during the study.

Prior to starting the investigation each subject was measured for maximum lifting capacity using a one repetition maximum (1RM) in the bench press, parallel squat, seated row and leg extension. Care was taken to minimize the number of lifts during testing so as not to constitute a training effect. The subjects trained three times per week with at least 1 day of rest between sessions. The initial weight used for the subjects training session was determined using 80% of their 1 RM. The warm-up consisted of 10 minutes of jogging and then stretching. The bench press and parallel squats were performed using 5 sets of 5 repetitions per set. The seated rows and leg extension were performed using 3 sets of 5 repetitions per set. During the fourth week 1 RM for each of the lifts were measured again for individual and then 80% of this was used for the fifth week to eighth week training sessions.

Testing Procedure

Prior to the study, at the 4th week and the 8th week of the study each subject underwent body composition measurements, blood collection, and testing for strength. The body composition, fat free mass (FFM) and fat percent were measured using Bioelectrical Impedance Analysis. All strength tests used a 3-5 repetition range to predict each subject's 1RM effort (Mayhew et al., 1995).

Blood samples were collected from a superficial forearm vein after an overnight fast. Blood was drawn and divided into two parts. One of which was put into a test tube containing heparin as an anticoagulant and then centrifuged at 3,000 rpm for 10 min at 4°C to obtain plasma for assays of cholesterol, HDL-C(high density lipoprotein fraction of cholesterol), LDL-C(low density lipoprotein-cholesterol), triglyceride, CK(creatine

kinase), AST(alanine aminotransferase), ALT(aspartate aminotransfferase) and BUN(blood urea nitrogen). The second part was put into a tube containing EDTA as an anticoagulant and then centrifuged at 3,000 rpm for 10 min at 4°C to obtain plasma assays for testosterone and cortisol. Cholesterol and triglyceride were analyzed by enzymatic techniques using a Johnson & Johnson DT-60 II analyzer (Ortho Clinical Diagnostics, Rochester, NY, USA) according to the manufacturer's protocol. The HDL-C was measured after precipitation of the VLDL-C and LDL-C fractions with phosphotungstic acid. LDL-C was precipitated with a Biomerieux reagent. Creatine kinase, AST, ALT, and BUN were determined by using a protocol edited for Johnson & Johnson DT-60 II analyzer. Testosterone and cortisol plasma levels were determined by an automated chemiluminescence system.

Statistics

SPSS for Windows version 10.0 software package was used for all data analysis. Data was analyzed using a 2-way ANOVA (group × time) with repeated measures. There were 2 levels for the group factor and 3 levels for time (week 0, week 4 and week 8) factor. The level was set at $p<.05$. Values are presented as mean ± SD.

Results

The creatine kinase, testosterone, cortisol, testosterone-to-cortisol (T/C) changes, total cholesterol, HDL-C, LDL-C, triglyceride, fat, FFM, BUN, AST, ALT are listed in Table 1. No differences were observed in these variables at any time between the two groups. The strength changes of the subjects are listed in Table 2. Although there was significant difference from week 0 to week 4 and week 8 in leg extensions and parallel squat, there were no significant differences observed in each exercise at any time between the two groups. The levels of AST, ALT and BUN were within normal range.

Discussion

Testosterone concentration and testosterone/ cortisol (T/C) ratios reflect anabolic capacity and are good indicators for evaluating the stress levels of athletes during periods of high-intensity exercise and assessing the risk of overreaching or overtraining (Kuoppasalmi & Adlercreutz, 1985). This study showed T concentration and T/C ratios were not significantly different. In another study though collegiate football players during training camp (Hoffman et al., 2004) supplemented with HMB and showed no decrease in T concentrations and T/C ratios. This also gives indication why the training volume of this study was not sufficient high to make changes. Furthermore, in our study C concentration indicated no significant difference. The testosterone concentrations, T/C ratios and were not significantly different. Looking at Ostrowski et al. (1997) research, we can see that 10 weeks of resistance training using 27 subjects recorded no significant difference on cortisol concentration, but the other study reported that 12 weeks high resistance training using 11 subjects had significant decreases in C concentration (Mccall, Byrnes, Fleck, Dickinson, & Kraemer, 1999). Previous studies have reported that C concentration is sensitive to change in both exercise intensity and volume (Costill et al., 1991; Tikkanen et al., 1999). This indicates that methodology of training protocols has influence. For example, our study employed a 4-wk training period with subjects performing 3-5 sets of 5 repetitions at 80% 1 RM on 4 exercises, but other study employed subjects performing 3 sets of 3-5 repetitions at 90% 1 RM using 14 exercises (Nissen et al., 1996). In addition, the exercise intensity was increased 2 kg every week (Gallagher et al., 2000), but in our study the same intensity was maintained during the 5th week through the 8th week. This leads to the indication that the exercise intensity and volume of our study may not have been sufficient to elicit a hormonal secretion. Because the lack of a significant difference between two groups that indicated ingesting HMB supplementation does not provide any effect in reducing muscle protein breakdown or anabolic capacity in our study.

Tikkanen et al. (1999) reported that 12 months resistance-training significantly increased 21% of HDL-C concentration. But other studies reported that 10 to 12 weeks of resistance training had no significant change in HDL-C concentration (Crowder, 1993). This indicates that HDL-C was influenced by the training volume. In our study the placebo group showed no significant difference in HDL-C during 8 week. Thus, the training volume was not enough to change HDL-C. HMB is a metabolite of β-hydroxy-β-methylglutaryl CoA (HMG-CoA) which is used for cholesterol synthesis (Nissen et al., 1997) to produce an inhibition of liver cholesterol synthesis (Beg & Lupien, 1972). The changes in cholesterol synthesis could elicit an alteration in blood cholesterol levels (Beg &

Lupien, 1972). The lipoprotein cholesterol results in this study were of no significant difference. The results were different from other studies which resulted in a lowering of LDL cholesterol (Nissen & Abumrad, 1997; Ostrowski et al., 1997). Other studies using professional trained or football players agree. Those studies using professionally trained or football players used high exercise intensity and volume in each session agree with this (Hoffman et al., 2004; O'Connor & Crowe, 2003). This reported that high exercise intensity and volume exercise elicited a greater demand for the use of HMB (and HMG-CoA) than in previous studies, thus attenuating the inhibition of liver cholesterol synthesis (Gallagher, Carrithers, Godard, Schulze, & Trappe, 2000). So the intensity and volume of exercise may be an important factor that influences cholesterol synthesis. Lipoprotein cholesterol had no significant difference between the two groups in this study. Possibly due to exercise intensity and volume in this study was lower than previous studies (Nissen & Abumrad, 1997; Ostrowski et al., 1997).

HMB supplementation with resistance exercise did not have any significant effect on fat percent and FFM in this study. Previous studies using trained men or competitive athletes also get the same conclusion as this study (Ransone et al., 2003; Slater et al., 2001) but in contrast with those studies which used untrained men and women they found significant changes in FFM (Kreider et al., 1999; Paddon-Jones, Keech, & Jenkin, 2001). It is well documented that professionally trained athletes have a lower percentage of fat and high percentage of fat free mass when compared with untrained subjects. This study showed no difference in fat percent and FFM, the subjects of this study had a low fat percentage and this may explain the result. Resistance exercise can increase strength, but ingesting HMB supplementation didn't elicit more strength.

Conclusion

In conclusion, this study showed that ingesting HMB supplementation from the 5th to the 8th week of the low intensity resistant training period in recreational collegiate subjects did not significantly alter concentration of T, C, blood lipids, body composition and strength. The benefit of HMB to provide an anabolic effect seems to be related to the exercise experience of the subjects and exercise intensity and volume.

Table 1. The Biochemical Parameters during 8 weeks for β-hydroxy-β-methylbutyrate Supplement (HMB) and Placebo Supplement.

	group	Week 0	Week 4	Week 8
Creatine kinase (ng/mL)				
	HMB	191.2±96.0	203.8±62.3	179.8±124.6
	Placebo	214.0±56.8	199.6±95.3	316.6±209.4
Testosterone (ng/mL)				
	HMB	652.3±286.7	651.7±260.9	659.7±215.2
	Placebo	629.4±80.9	730.0±158.4	607.7±148.6
Cortisol (ng/mL)				
	HMB	17.9±3.6	19.6±3.3	18.4±3.3
	Placebo	16.3±3.8	16.7±4.0	16.4±4.4
Testosterone-to-cortisol ratio				
	HMB	37.7±18.7	34.5±15.4	36.8±13.8
	Placebo	39.8±6.6	45.4±12.6	39.2±15.1
Total cholesterol (mg/dL)				
	HMB	163.23±34.5	175.4±27.1	171.9±27.3
	Placebo	146.0±26.1	149.4±24.5	148.4±19.3
HDL-C (mg/dL)				
	HMB	60.9±14.5	60.3±9.5	62.1±11.6
	Placebo	61.0±12.5	61.3±14.5	61.9±14.2
LDL-C (mg/dL)				
	HMB	89.9±42.4	87.9±33.5	87.9±32.0
	Placebo	85.9±32.8	85.6±27.0	84.9±31.3
Triglyceride (mg/dL)				
	HMB	54.0±23.5	58.3±9.9	61.6±16.1
	Placebo	56.1±34.4	46.7±30.7	65.4±43.6
Fat (%)				
	HMB	13.1±2.9	12.5±2.2	13.7±2.7[bc]
	Placebo	12.8±3.6	12.4±4.1	14.2±4.1[bc]
FFM (kg)				
	HMB	58.8±4.3	59.9±5.0[a]	59.2±5.4
	Placebo	53.7±16.9	54.9±17.1[a]	53.6±17.9
BUN (mg/dL)				
	HMB	13.4±2.2	-	14.7±2.6
	Placebo	12.4±2.0	-	12.9±2.7
AST (U/dL)				
	HMB	18.7±11.1	-	24.7±7.8
	Placebo	16.6±4.7	-	21.7±6.8
ALT (U/dL)				
	HMB	27.0±14.1	-	28.0±16.5
	Placebo	26.7±10.6	-	27.6±11.8

Values are expressed as the mean ± SD. HDL-C: high-density lipoprotein cholesterol; LDL-C: low-density lipoprotein cholesterol; FFM: fat free mass; BUN: blood urea nitrogen; AST: alanine aminotransferase; ALT: aspartate aminotransfferase

a: Significantly different between week 0 and week 4 (P<.05).

b: Significantly different between week 0 and week 8 (P<.05).

c: Significantly different between week 4 and week 8 (P<.05).

-: data were not measured.

Table 2. The Strength Changes of β-hydroxy-β-methylbutyrate Supplement (HMB) and Placebo Supplement.

	group	Week 0	Week 4	Week 8
Bench press (kg)				
	HMB	59.3±10.6	70.0±7.1[a]	74.3±8.9[b]
	Placebo	57.9±152.0	64.3±14.3[a]	67.6±14.8[b]
Leg press (kg)				
	HMB	45.7±42.4	261.4±46.7[a]	292.1±38.1[bc]
	Placebo	32.9±49.9	252.9±48.9[a]	279.3±43.4[bc]
Seated rowing (kg)				
	HMB	79.3±7.3	81.4±10.3	88.6±6.3[bc]
	Placebo	80.0±13.8	81.4±15.7	85.0±12.3[bc]
Parallel squat (kg)				
	HMB	124.3±18.1	135.7±22.1[a]	145.0±19.2[bc]
	Placebo	125.0±26.0	137.9±27.4[a]	140.7±26.2[bc]

Values are expressed as the mean ± SD.
a: Significantly different between week 0 and week 4 (P<.05).
b: Significantly different between week 0 and week 8 (P<.05).
c: Significantly different between week 4 and week 8 (P<.05).

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