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Effect of Functional Beverage on Weight Control and Body Fat Mass in Overweight Women

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Abstract – Carnitine, hydroxycitric acid, and soy peptide have been known to be anti-obesity agents. The purpose of this study was to evaluate the combined effects of carnitine, hydroxycitric acid, and soy peptide mixture as a potential anti-obesity supplement in overweight women. Overweight premenopausal women (n=33; PIBW >110; 20 to 39 years) were randomized into two groups: the placebo group and the functional beverage group (the test group). Functional beverage was composed of 2000 mg soy peptide, 20 mg L-carnitine and 300 mg garcinia (40% hydroxycitric acid). Body weight and 3 day food diaries, biochemical measurements and computerized tomography were measured at baseline and 8-week. After 8-week consumption of functional beverage with usual diet and exercise, body weight fell an average of 1.4 kg (2.1%). Visceral fat area reduced an average of 7.8% at L1 (69.6 ± 8.7 vs 64.2 ± 7.5 cm^2) and 5.1% (60.7 ± 4.9 vs 57.6 ± 4.8 cm^2, $p<0.05$) at L4 level after weight loss in the test group. Calf fat area in the test group showed about 10% reduction (31.0 ± 2.7 vs 27.7 ± 1.7 cm^2, $p<0.05$) after weight loss. These reductions in fat areas were not shown in the placebo group. There were tendencies of increase in serum levels of β-hydroxybutyrate, acetoacetate, and total ketones in the test group. There were 7% and 17% insignificant increase in fasting free fatty acid (FFA) and response area of FFA during oral glucose tolerance test (OGTT), respectively, in this group. In addition, little weight loss in the test group showed 8% but not significant reduction in insulin response area during OGTT. In conclusion, this study shows that taking a mixture of carnitine, hydroxycitric acid, and soy peptide as a potential anti-obesity supplement for 8-week produced advantageous changes in the weight and visceral fat accumulation of overweight women.

Key words □ obesity, weight loss, body fat mass, lipid profiles, visceral fat, carnitine, hydroxycitric acid, soy peptide

INTRODUCTION

Until the 1960s, undernutrition and starvation were major causes of disease and mortality in Korea. Diseases resulting from undernutrition, such as tuberculosis, were severe problems until the 1970s. But now, we are facing opposite problem, that of energy surplus. Over the past decade, Korean adults have increased the percent of fat in their diets from 14% in 1990 (Ministry of Health & Social Affairs, 1990) to 18% in 1998 (Ministry of Health & Social Affairs, 2000). For adults aged 20-49 yr, daily fat intake increased from about 35g in 1990, to 45g in 1998. Average calorie intake of adults was slightly below 2,000 kcal in 1998, close to the recommended 2,000 kcal per day for women. The prevalence of obesity-related diseases continues to increase. Being overweight leads to major health hazards and it is associated to most of the chronic diseases that affect industrialized populations, such as type 2 diabetes and cardiovascular disease (CVD), including hypertension, stroke, and coronary artery disease (CAD) (Field *et al.*, 2001; Perusse and Bouchard, 1999). Compared with western populations, the risk factors for CVD at a given BMI are generally higher among Korean people. In addition, the health consequences of intra-abdominal fat accumulation appear to occur at much lower levels of BMI and are more intense than in those of western origin.

Although overweight and obese people are struggling with weight and looking for easy ways to lose weight, the fact is that wt loss is a hard work for most individuals. For this reason, the

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possible approaches for weight loss are introduced, such as information about anti-obesity agents, dietetics for weight loss and maintenance, use of medications and other scientifically proved program, etc (Noel and Pugh, 2002; Klauer and Arinne, 2002; Shick *et al.*, 2002; Bray and Greenway, 1999). Hydroxycitric acid, an extract from garcinia, was shown to be a potent inhibitor of ATP citrate lyase, which catalyzes the extramitochondrial cleavage of citrate to oxaloacetate and acetyl-CoA (Jena *et al.*, 2002; Clouatre and Rosenbaum, 1994; Thom, 1996). And carnitine is a water-soluble nutrient, found predominantly in meat, and is essential for fat burning (Crayhon, 2001). It was published that soy peptide was regarded as a stimulant of fatty acid oxidation, therefore lean body mass was increased significantly after soy peptide supplementation (Muramatsu *et al.*, 1994).

A large number of food components for weight loss are currently promoted to the public that incorporate a wide range of dietary and exercise strategies to achieve weight reduction. With few exceptions, the efficacy of those components promoted to the public and specific product claims have not been validated in scientific studies. Reliable information on expected outcomes and potential benefits may provide motivation and help set goals in weight management. Therefore, the purpose of this study was to examine the effects of weight loss focusing on functional beverage containing L-carnitine, hydroxycitric acid, and soy peptide on blood lipid profiles and regional body fat distribution in overweight and obese women.

MATERIALS AND METHODS

Subjects

Overweight or moderately obese premenopausal women with a percent ideal body weight more than 110%, 20 to 39 years old, were recruited. After being screened by telephone or visiting questionnaire, 50 interested women were selected with 42 targeted for completion (22 control; 20 test). All subjects were in good health as assessed by a medical history and physical examination. They had stable body weight (< 2 kg change) over the past 12 months and did not take any medications known to influence the variables measured. This study was carried out by randomized trial, consisting of two phases; a 2-week washout phase and an 8-week intervention phase of placebo or functional beverage. During the 2-week washout period, all participants were advised to continue their usual diet and exercise and baseline measurements were performed. After the washout period, subjects were randomly subdivided into 2 groups and assigned to consume either placebo beverage or the functional beverage during 8-week intervention without any change in diet and physical activity. To check participant's compliance during the study period, the dietitian checked by personal interviews on weekly visit-basis, whether they were following the program well. Taste and performance for functional beverage were checked together with energy intake and expenditure and weight changes. After first interviewing, all of subjects gave their written informed consent to participate in the study.

Three subjects in the placebo group did not complete the 8-week study because of the complaint of diarrhea and other private reasons. Five subjects in the test group did not complete the weight loss intervention; the reasons were diarrhea for 1 subject and private problems for 4 subjects.

Functional beverage and dietary intake

Subjects consumed 120 ml functional beverage or placebo beverage in 8 weeks with usual food intake and physical activity. Functional beverage (CJ Corp.) was composed of 2000 mg soy peptide, 20 mg L-carnitine and 300 mg garcinia (40% hydroxycitric acid). All subjects were instructed portion size of foods for accurate recording of daily dietary intakes. Usual food intake was assessed with a semi-quantitative food frequency questionnaire and 24 h recall. Three-day food diaries (2 week days and 1 week-end) were recorded. A dietitian reviewed and analyzed physical activity and calorie intake using Can pro 2.0 (Korean Nutrition Society, Seoul, Korea).

Anthropometric parameters

Milestone measures were taken at baseline and 8 week and included weight, height, waist and hip circumferences and body composition (skinfold thickness and bioelectrical impedance). Certified technicians took body composition measurements. Weight measurements (nearest 0.1 kg) were taken using the same calibrated balance beam scale with subjects dressed in light clothing without shoes. Height measurements (nearest 0.5cm) were taken using a mounted wall stadiometer, and BMI (kg/m^2) was calculated. Waist and hip circumferences were measured at the narrowest point of the torso (nearest 0.1 cm) using a non-stretchable tape measure. Skinfold thickness was measured by electrical caliper (Skindex, Caldwell, Justiss & Com, Inc., AR, USA). Bioelectrical impedence (Tanita, Tokyo, Japan) was used to calculate the percentage of body fat.

Computerized tomography (CT) scanning

To quantify fat and muscle areas, computerized tomography

(CT) scanning was performed on all subjects using a General Electric (GE) High Speed Advantage 9800 scanner (Milwaukee, WI, USA). Four cross-sectional images were made for each subject: abdomen at the levels of 1st lumbar (L1) vertebra and 4th lumbar (L4) vertebra, thigh (midway between patella and pubis), and calf (at the most protruding area). Each CT slide was analyzed for the cross-sectional area of fat using a density control program available in the standard GE computer software. Parameters for total abdominal fat density at the levels of L1 and L4 were selected between the range of -150 and -50 Hounsfield Units (HU). Total abdominal fat area was divided into visceral and subcutaneous fat areas, then each area was calculated. Parameters for thigh and calf muscle areas were selected as between the range of -49 and +100 HU and for fat areas between -150 and -50 HU.

Biochemical analysis

Fasting venous blood was taken in EDTA-treated and plain tubes after a 12-hour fast and stored at -70°C until analysis after plasma and serum were separated for measuring serum lipids (triglyceride, total cholesterol and HDL cholesterol), glucose, GOT, GPT, BUN and creatinine by a certified phlebotomist. Blood values were analyzed by standard methods at a nationwide, certified clinical laboratory. For laboratory assay, all measurements were done in a single batch at the end of the study, and the laboratory staff was blinded to the clinical data.

Serum total cholesterol, HDL cholesterol, and triglyceride were measured with commercially available kits on a Hitachi 7150 Autoanalyzer (Hitachi Ltd., Tokyo, Japan). After precipitation of serum chylomicrons, LDL, and very low-density lipoprotein (VLDL) with dextran sulfate-magnesium, HDL cholesterol left in the supernatant was measured with an enzymatic method. LDL cholesterol was estimated indirectly using the Friedwald formula, i.e., LDL cholesterol = total cholesterol {HDL cholesterol + (triglycerides/5)}, for subjects with serum triglyceride levels <400 mg/dL (Friedman *et al.*, 1972). Serum apolipoproteins AI and B were measured in Immunoturbidimetric Autoanalyzer (Cobas Integra, Roche, Switzerland). Precipitations of serum apolipoprotein AI and B were determined turbidimetrically at 340nm using a specific anti serum agent (Roche, Switzerland).

All subjects ingested a 75 g glucose solution after an overnight fast. Serum samples were collected before and 30, 60, and 120 min after the glucose load. Glucose was measured by a glucose oxidase method using a Beckman Glucose Analyzer (Beckman Instruments, Irvine, CA, USA). Insulin was measured by radioimmunoassays with commercial kits from Immuno Nucleo Corporation (Stillwater, MN, USA). Free fatty acid (FFA) was analyzed with a Hitachi 7150 Autoanalyzer (Hitachi Ltd., Tokyo, Japan).

Immunoradiometric assays (IRMA) were used to measure sex hormone-binding globulin (SHBG) using RIAMAT 280 (Byk-Santec Diagnostica, Germany) with IRMA-Count SHBG (EURO/DPC, UK) and luteinizing hormone (LH) was also estimated by the same method with Coat-A-Count LH IRMA (EURO/DPC, UK). Total testosterone was measured by radioimmune assay (RIA) using RIAMAT 280 with Coat-A-Count Total Testosterone (DPC, USA). Leptin and insulin like-growth factor-1 (IGF-1) were also measured by the same method using Packard Cobra 5005-Counter with Human Leptin RIA kit (Linco, USA) or Biosource IGF-1-D-RIA-CT Kit, respectively (Biosource, Belgium)

Statistical analysis

Statistical analysis was performed with Win SPSS version 10.0 (Statistical Package for the Social Science, SPSS Ins, Chicago, IL, USA). Results were expressed as mean ± SE. Paired t-test was used to test the significance of differences between the 2 groups for continuous variables. A two tailed value of $p<0.05$ was considered statistically significant.

RESULTS

Of the 50 initial female subjects who met the inclusion criteria and agreed to be randomly assigned to the test group (n=25) and the placebo group (n=25). Forty-two (84%) completed the 8-week study. Retention rates between the 2 treatment groups were indifferent: i.e., the test group, n=20 (80%); the control group, n=22 (88%). Although 42 subjects completed this study, 5 subjects in the test group and 4 subjects in the placebo group, respectively, were not successful in losing the weight (weight gain more than 1kg after 8-week intervention). Therefore, the evaluation of anthropometric parameters and other biochemical changes in 33 subjects (15 subjects for the test group and 18 for the placebo group) was also performed.

Changes of anthropometries and dietary intake

Age and anthropometric measurements of the remaining study subjects at baseline are shown in Table I. There were no significant differences in age, BMI and percent of body fat at baseline between two groups and also no significant differences in body weight, waist to hip circumference and percent of body

Table I. Anthropometric parameters and daily dietary intake before and after functional beverage supplementation in overweight women.

	Control (n=18)		Test (n=15)	
	0 week	8 week	0 week	8 week
Age	28.7 ± 1.28		27.5 ± 1.34	
Height(cm)	159.9 ± 1.43		159.8 ± 1.58	
Weight(kg)	66.7 ± 1.99	66.4 ± 1.93	66.8 ± 2.33	65.5 ± 2.23**
Body mass index(kg/m^2)	26.1 ± 0.74	26.0 ± 0.70	26.1 ± 0.61	25.6 ± 0.58*
PIBW(%)	124.2 ± 3.79	123.9 ± 3.58	124.2 ± 2.78	122.1 ± 2.63**
Waist to hip circumference	0.84 ± 0.01	0.84 ± 0.01	0.84 ± 0.01	0.83 ± 0.01*
Lean body mass(kg)	44.1 ± 1.05	43.8 ± 0.95	43.7 ± 1.14	43.2 ± 0.98
Fat(%)	33.5 ± 1.18	33.7 ± 1.07	34.2 ± 1.09	33.6 ± 1.05
Triceps skinfold(mm)	25.9 ± 0.73	26.0 ± 0.97	25.5 ± 1.06	24.4 ± 0.93
Estimates of daily nutrient intake[1]				
TCI[2] (kcal/d)	2255 ± 32	2247 ± 31	2118 ± 26	2055 ± 53
Percent of carbohydrate(%)	59.0 ± 1.39	58.3 ± 1.65	61.1 ± 2.14	60.3 ± 1.78
Percent of protein(%)	16.0 ± 0.58	16.3 ± 0.43	15.8 ± 0.74	15.2 ± 0.70
Percent of fat(%)	25.0 ± 1.37	25.4 ± 1.60	23.1 ± 1.93	24.5 ± 1.66
BMR[3](kcal/d)	1439 ± 43	1433 ± 41	1443 ± 50	1415 ± 48*
TEE[4](kcal/d)	2152 ± 28	2142 ± 28	2090 ± 30	2100 ± 31
TEE/TCI	0.96 ± 0.01	0.95 ± 0.01	0.99 ± 0.01	1.03 ± 0.03

Values are mean ± S.E., *p<0.05, **p<0.01 compared with initial value in each group.
[1] Nutrient intakes, obtained from weighed food records and calculated using the database of the computerized Korean food-code
[2] Total calorie intake; [3] Basal metabolic rate; [4] Total energy expenditure

fat before and after placebo beverage consumption in the control group. Subjects in the test group had significant changes in body weight (2.1%, p<0.01) (Figure 1) and waist to hip circumference (p<0.05), and reduction in body fat percent (0.9%) was not significant.

Dietary food intake and energy expenditure were also showed in Table I. Daily energy intakes in the control group were not changed from 2255 ± 32 to 2247 ± 31 kcal and in the test group from 2118 ± 26 to 2055 ± 53 kcal before and after each beverage supplementation. Carbohydrate, fat and protein intakes as a percentage of total dietary energy were 59, 25 and 16% in the control group and 61, 23 and 16% in the test group, respectively, and no differences between two groups at baseline. Total energy expenditure in the control group was 2152 ± 28 to 2142 ± 28 kcal and in the test group 2090 ± 30 to 2110 ±31 kcal.

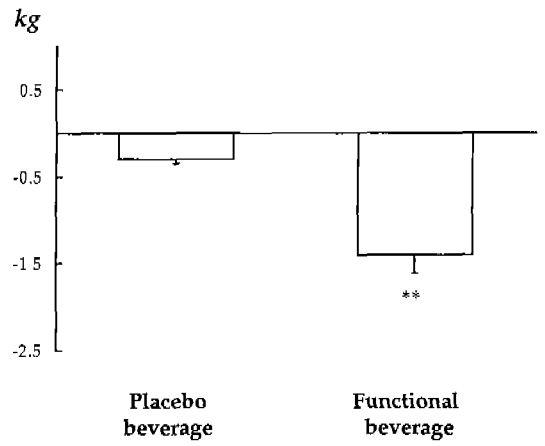

Fig. 1. Body weight changes in overweight women before and after the functional consumption. **p<0.01 compared with initial value in placebo group.

Changes of body fat distribution

Table II represents fat and muscle area at different levels of the control and the test group between baseline and 8-week. Baseline levels of visceral and subcutaneous fat at LI and L4 did not differ between two groups. Compared with initial mean fat areas of the test group, total fat at L1 (4.2%) and L4 (2.8%), subcutaneous fat at L1 (2.3%) and L4 (2.1%) and visceral fat at L1 (7.8%) and L4 (5.1%, p<0.05) decreased at 8-week (Figure 2). And fat areas at mid-calf also showed a tendency to decrease at 8-week in the test group.

Results of biochemical analysis

Lipid profiles and other biochemical index between baseline

Table II. Fat and muscle areas at different levels of body before and after functional beverage supplementation in overweight women.

	Control (n=18)		Test (n=14)	
	0 week	8 week	0 week	8 week
1st lumber(L1) vertebra				
Total fat(cm^2)	209.2 ± 14.6	215.4 ± 14.0	196.8 ± 13.9	188.5 ± 12.9
Visceral fat(cm^2)	76.3 ± 7.12	80.9 ± 6.64	69.6 ± 8.66	64.2 ± 7.48
Subcutaneous fat(cm^2)	132.9 ± 8.72	134.5 ± 8.74	127.2 ± 8.61	124.3 ± 9.06
Visceral/subcutaneous fat	0.58 ± 0.04	0.61 ± 0.04	0.55 ± 0.07	0.53 ± 0.07
Visceral/thigh muscle	0.68 ± 0.07	0.76 ± 0.07	0.62 ± 0.08	0.58 ± 0.07
Visceral/thigh fat	0.91 ± 0.07	0.94 ± 0.07	0.87 ± 0.13	0.77 ± 0.10
1st lumber(L4) vertebra				
Total fat(cm^2)	265.4 ± 13.3	270.1 ± 13.4	263.4 ± 11.6	256.0 ± 9.34
Visceral fat(cm^2)	65.6 ± 5.34	62.5 ± 4.92	60.7 ± 4.90	57.6 ± 4.75*
Subcutaneous fat(cm^2)	199.8 ± 10.6	207.5 ± 10.8**	202.7 ± 9.05	198.4 ± 7.99
Visceral/subcutaneous fat	0.34 ± 0.03	0.31 ± 0.03*	0.30 ± 0.03	0.30 ± 0.03
Visceral/thigh muscle	0.58 ± 0.05	0.58 ± 0.05	0.54 ± 0.04	0.52 ± 0.04
Visceral/thigh fat	0.80 ± 0.06	0.73 ± 0.06*	0.73 ± 0.07	0.68 ± 0.06
Mid thigh				
Fat(cm^2)	83.4 ± 3.11	86.7 ± 3.26**	85.8 ± 4.30	86.9 ± 3.30
Muscle(cm^2)	113.8 ± 2.78	109.0 ± 3.00*	113.0 ± 2.86	110.4 ± 3.34
Calf				
Fat(cm^2)	29.4 ± 1.87	28.7 ± 1.87	31.0 ± 2.71	27.7 ± 1.70
Muscle(cm^2)	70.7 ± 1.94	67.9 ± 2.66	65.0 ± 3.46	63.9 ± 2.75

Values are mean ± S.E., $p<0.1$, *$p<0.05$ compared with initial value in each group.

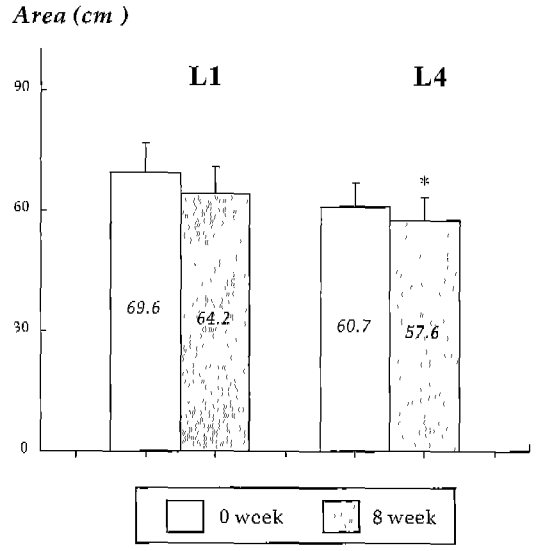

Fig. 2. Visceral fat distribution at L1 and L4 vertebra levels in the functional beverage group before and after intervention. *$p<0.05$ compared with initial area in each level.

and week 8 as classified by each supplementation are shown in Table III. The group with functional beverage consumption did not show any significant change in serum lipid profiles. Therefore, for the subjects in the test group, the differences in the atherogenic index and total to HDL cholesterol ratio between baseline and 8-week were not changed. However, the placebo beverage group showed a significant increase in triglyceride concentrations at 8-week ($p<0.05$), compared with initial values. GOT and GPT as markers of liver function were not changed in the test group before and after supplementation, and those values were included within the normal ranges (Table III).

Table IV shows that subjects in both groups had no significant change in serum glucose, insulin, and FFA concentrations and their response areas during OGTT. Mean values of fasting insulin levels in the test group were decreased (12.2 ± 1.42 vs 11.5 ± 2.05 U/ml, 5.7%) and those of insulin resistance index were also decreased (2.55 ± 0.35 vs 2.44 ± 0.47), but not significantly. Fasting FFA levels were slightly increased by 7.8% at 8-week. Sex hormone concentrations including testosterone, SHBG, estradiol, and LH in the control group showed no changes, whereas mean values of ketone bodies, β-hydroxybutyrate and acetoacetate were increased by 37.6% and 11.6%, respectively, in the test group (Table V).

DISCUSSION

Subjects in this study were randomly assigned to one of two

Table III. Serum lipid profiles and other biochemical index before and after functional beverage supplementation in overweight women

	Control (n=18)		Test (n=15)	
	0 week	8 week	0 week	8 week
Triglyceride(mg/dl)	94.4 ± 9.74	127.2 ± 16.8*	99.6 ± 11.0	100.7 ± 14.4
Total cholesterol(mg/dl)	193.1 ± 11.6	196.6 ± 12.2	169.9 ± 6.89	174.9 ± 4.48
LDL cholesterol(mg/dl)	125.6 ± 10.5	123.8 ± 11.6	101.9 ± 6.68	106.3 ± 3.80
HDL cholesterol(mg/dl)	48.7 ± 2.39	47.3 ± 2.44	48.1 ± 2.56	48.5 ± 2.21
Atherogenic index	3.02 ± 0.20	3.22 ± 0.22	2.66 ± 0.23	2.70 ± 0.17
Total/HDL cholesterol	4.02 ± 0.20	4.22 ± 0.22	3.66 ± 0.23	3.70 ± 0.17
Apolipoprotein A I (mg/dl)	119.7 ± 5.36	124.3 ± 3.99*	122.7 ± 6.37	122.5 ± 5.34
Apolipoprotein B(mg/dl)	73.8 ± 4.67	78.1 ± 5.29	62.8 ± 4.21	67.9 ± 2.92
GOT(U/L)	13.8 ± 1.14	14.5 ± 1.12*	13.6 ± 1.18	13.1 ± 0.65
GPT(U/L)	10.4 ± 1.39	10.5 ± 1.58	7.72 ± 0.87	7.59 ± 0.50
BUN(mg/dl)	12.0 ± 0.75	11.7 ± 0.60	12.1 ± 0.63	12.2 ± 0.74
Creatinine(mg/dl)	0.67 ± 0.02	0.68 ± 0.02	0.76 ± 0.02	0.76 ± 0.02

Values are mean ± S.E., *$p<0.05$ compared with initial value in each group.

Table IV. Fasting glucose, insulin, and FFA concentrations and response areas before and after functional beverage supplementation in overweight women

	Control (n=18)		Test (n=15)	
	0 week	8 week	0 week	8 week
Glucose				
Fasting (mg/dl)	79.9 ± 2.25	80.0 ± 2.50	83.3 ± 2.06	84.1 ± 2.38
Response area (mg/dl × hr)	242.3 ± 10.8	240.0 ± 12.2	240.1 ± 5.95	238.4 ± 9.84
Insulin				
Fasting (μU/ml)	11.8 ± 0.97	10.5 ± 0.77	12.2 ± 1.42	11.5 ± 2.05
Response area (μU/ml × hr)	99.7 ± 13.7	98.6 ± 10.4	95.9 ± 9.99	88.0 ± 7.90
Insulin resistance index	2.30 ± 0.18	2.08 ± 0.17	2.55 ± 0.35	2.44 ± 0.47
Free fatty acid				
Fasting (μU/ml)	514.3 ± 60.9	486.6 ± 49.9	517.8 ± 57.7	558.1 ± 82.0
Response area (μU/ml × hr)	470.7 ± 46.1	491.5 ± 52.6	492.8 ± 61.1	54.3 ± 84.7

Values are mean ± S.E.

treatment groups; the control group (placebo beverage supplementation) and the test group (functional beverage supplementation containing L-carnitine, soy peptide, and hydroxycitric acid). Actual changes of calorie intake and total energy expenditure during the study were not found in both groups. The main finding of this study was that for premenopausal overweight-obese women, this functional beverage consumption had an efficacy on weight loss and visceral fat reduction, but insufficient to produce significant improvement of lipid profiles and glucose metabolism.

Carnitine, which is considered to be essential for the transport of fatty acids from the cytosol into the mitochondria, where they are oxidized, seems to play an important role in lipid catabolism (Elisaf *et al.*, 1998; Bremer, 1983). Carnitine helps to lower cholesterol and triglycerides readings and may enhance immune function as well (Hoppel and Genuth, 1980). The usual dose in clinical trial was from 2 to 3 grams per day (Crayhon, 1999). However the results of studies in which L-carnitine has been administered in an attempt to correct the lipid abnormalities are also inconclusive. It was published that the beneficial effect of L-carnitine administration on serum triglycerides was more evident in patients with baseline hypertriglyceridemia (Elisaf *et al.*, 1998). McCarty presented information on how carnitine, especially when combined with chromium, pyruvate, biotin, and garcinia extract, as well as exercise and a healthy diet, can be a very useful overall pro-

Table V. Sex hormones and ketone bodies levels before and after functional beverage supplementation in overweight women

	Control (n=18)		Test (n=15)	
	0 week	8 week	0 week	8 week
Testosterone(ng/ml)	0.43 ± 0.03	0.46 ± 0.04	0.35 ± 0.04	0.38 ± 0.04
SHBG[1](nmol/l)	39.3 ± 6.13	39.1 ± 4.82	45.5 ± 4.15	48.4 ± 3.93
FAI[2]	4.83 ± 0.66	5.01 ± 0.73	2.93 ± 0.34	2.99 ± 0.45
IGF-1[3](ng/ml)	407.9 ± 21.0	402.9 ± 20.9	401.4 ± 35.3	416.0 ± 37.0
Estradiol(pg/ml)	68.8 ± 8.35	76.1 ± 12.9	84.5 ± 10.5	61.5 ± 10.5
LH[4](mlU/ml)	3.71 ± 0.74	4.05 ± 1.03	3.45 ± 0.78	4.72 ± 1.24
Leptin(ng/ml)	12.6 ± 0.91	13.1 ± 0.96	11.3 ± 1.38	10.4 ± 1.39
Ketone bodies				
β-hydroxybutyrate(μmol/L)			26.8 ± 5.34	41.0 ± 17.5
Acetoacetate(μmol/L)			1.64 ± 0.16	1.83 ± 0.34
Total ketone(μmol/L)			28.5 ± 5.47	42.8 ± 17.9

Values are mean ± S.E.
[1] Sex hormone-binding globulin
[2] Free androgen index = {testosterone(ng/ml) × 3.467}/SHBG(nmol/l) × 100
[3] Insulin-like growth factor-1
[4] Luteinizing hormone

gram for reducing body fat levels (Crayhon, 1999). It also appears that this approach can help to increase lean muscle mass levels. But 8-week of L-carnitine ingestion for 2 g twice daily and walking for 30 min 4 days/week did not significantly alter the body weight, fat mass, and resting lipid utilization in overweight women (Villani *et al.*, 2000).

These disparate results concerning the effect of carnitine on serum lipid profiles and body mass may be partly related to the dose given or the route of administration (Elisaf *et al.*, 1998). In cases of some trials with hemodialysis patients, it has been reported that even in the subjects in receiving too high a carnitine supplementation, an increase in serum triglycerides may be found (Chan *et al.*, 1982; Guarnieri *et al.*, 1980; Weschler *et al.*, 1984; Wanner *et al.*, 1989). The duration and inclusion criteria are also of potential interest, since it has been reported that the hypolipidemic effect of L-carnitine may take a long time to appear in hypertriglyceridemic patients and lipid profiles of subjects with normolipidemia or mild hyperlipidemia are not easily changed for a relatively short-term treatment (Vacha *et al.*, 1985).

Hydroxycitric acid, the active ingredient in the herbal compound garcinia cambogia recently known as a new anti-obesity agent, competitively inhibits the extramitochondrial enzyme adenosine triphosphate-cirate-lyase (Jena *et al.*, 2002; Clouatre and Rosenbaum, 1994; Thom, 1996). As a citrate cleavage enzyme that may play an essential role in lipogenesis inhibition, it is claimed to lower body weight and reduce fat mass in humans. Extensive animal studies indicated that hydroxycitric acid suppresses the fatty acid synthesis, lipogenesis, food intake, and induces weight loss. In vitro studies revealed the inhibitions of fatty acid synthesis and lipogenesis from various precursors (Jena *et al.*, 2002). Preliminary research based on laboratory and animal experiments suggests that hydroxycitric acid may be a useful weight loss aid (Lowenstein, 1971; Triscari and Sullivan, 1977). Although hydroxycitric acid appears to a promising experimental weight control agent, results of many studies have been contradictory (Badmaev and Majeed, 1995; Conte, 1993; Thom, 1996). In a clinical trial performed by Heymsfield and his colleagues, after treatment group was supplemented 1500 mg of hydroxycitric acid per day with a high-fiber and low-calorie diet during the 12-week, body weight and fat mass change did not differ significantly compared with placebo consumption group (Heymsfield *et al.*, 1998). It represented that a prospective double-blind study failed to detect either weight loss or fat-mobilizing effects of hydroxycitric acid beyond those of a placebo.

The present study explained that the functional beverage containing hydroxycitric acid had a beneficial effect on weight control and visceral fat loss although very slightly changed. Possible concern is related to the duration and dosage considerations of this composition. Human doses ranging between 750 and 1500 mg per day of hydroxycitric acid are at the extreme low and of the *in vivo* dose-response range established by Sullivan and colleagues (Sullivan *et al.*, 1973).

In summary, the benefit of using this functional beverage has been shown subsequent successful weight loss for 8-week.

Although the small subject numbers, short duration, and relatively low dosage of functional ingredients of this study may be insufficient to draw a definitive conclusion, the benefits of weight loss and visceral fat reduction may be useful in the development of other therapeutic programs with caloric restriction, exercise, or lifestyle modification to combat obesity. A question, what ingredients had the strongest anti-obesity efficacy among them, is still remained. We conclude that the functional beverage supplementation, containing relatively low doses of carnitine, hydroxycitric acid, and soy peptide, could contribute to the management of overweight-obese men. And additional studies, potentially with larger subject groups, are needed to gather specific information on the long-term safety of combined agents and to evaluate anti-obesity effects according to various dosages of each compound.

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