Evaluation of 8-week body weight control program including sea tangle (*Laminaria japonica*) supplementation in Korean female college students[*]

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Abstract

This study was conducted to evaluate the effects of a body weight control program with supplementation of sea tangle (20 g/day) on 22 female college students. The contents of the program for 8 weeks contained diet therapy, exercise and behavioral modification through nutrition education. Body composition, dietary habit scores, serum lipid profiles, daily nutrient intakes and the quality of life were assessed at the beginning and at the end of the program. Average age of subjects and height were 20.8 years and 161.9 cm, respectively. After 8 weeks, there were significant reductions in body weight, body fat mass, percent body fat, waist-hip ratio and BMI. The dietary habit score such as a balanced diet, regularity of mealtime, overeating, eating while watching TV or using the computer and eating salty food were increased significantly. Serum lipid levels such as total cholesterol level, LDL-cholesterol level and triglyceride level were decreased but not significantly. There were decreases in intake of energy, protein and fat and increases in intakes of dietary fiber, folic acid, calcium and potassium from the beginning to the end of the program. There were significant improvements on subcomponents of quality of life; physical functioning, general-health and vitality. The limitation of this study was the fact that there was no control group, but an overall evaluation suggests the 8-week body weight control program consisting of diet therapy, exercise and behavioral modification with supplementation of sea tangle would be helpful to improve the body composition, dietary habits, daily nutrient intakes and quality of life in Korean female college students.

Key Words: Body weight control program, sea tangle, nutrient intake, serum lipid profiles, health-related quality of life

Introduction

Overweight and obesity rate are increasing and becoming a global issue. Obesity is associated with an increased risk of chronic diseases, such as type 2 diabetes and cardiovascular disease, including hypertension (Mokdad *et al.*, 2003). The most recent estimate by WHO shows that approximately 1.6 billion individuals aged 15 years or older in the world are overweight (BMI $\geq$ 25 kg/m^2), and approximately 400 million adults are classified as obese (BMI $\geq$ 30 kg/m^2) (WHO, 2006). The Third National Health and Nutrition Examination Survey for Koreans conducted in 2005 showed the prevalence of obesity (BMI $\geq$ 25.0 kg/m^2) in Korean adults aged at least 20 years was 35.2% for men and 28.3% for women (Ministry of Health & Welfare, 2005).

Female college students are very interested in the appearance of their bodies. When abnormal body weight loss is conducted without accurate knowledge, it can cause physiological risk and have a Yo-yo effect (Kim, 1998). When women lose body weight, they prefer a one-time method such as the fasting and pharmacotherapy (Leung *et al.*, 2003) or diet therapy (Kim *et al.*, 2007a) that includes a low calorie diet and a one food diet.

However, fasting or pharmacotherapy has been reported to have serious problems, which include adverse gastrointestinal effects and an increase of blood pressure and heart rates (Chanoine *et al.*, 2005; King & Devaney, 1988). Diet therapy has no limit of time or place whereas, it has several side effects such as dizziness, fatigue, indigestion, constipation, physical weakness, loss of concentration, dry skin and loss of motivation (Kim & Lee, 2006).

Seaweeds are easily available plants that have been utilized for dietary or traditional medicinal purposes as they are low in calories, with a high concentration of minerals, vitamins, proteins and indigestible carbohydrates, and have a low content of lipids (Jimenez-Escrig & Goni, 1999). There are some members of the red, brown and green algae. Sea tangle is one of the largest brown marine algae that are used as a seasoning or a dietary ingredient in China, Japan and Korea. It consists of polysaccharides with alginates, fucoidan, fucoxanthin, laminarin and insoluble cellulose which is rich in a dietary fiber (Ruperez & Saura Calixto, 2001). Kimura *et al.* (1996) stated that sodium alginate gained from *Laminaria* could be useful as a dietary fiber to prevent obesity in rats. It has been revealed that one of the active ingredients of sea tangle is fucoidan, which plays a role in decreasing fat

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accumulation in mice (Ahn *et al.*, 2006) and may play an effective role in reducing sociopsychological stresses in mice (Choi *et al.*, 1999). Furthermore, supplementation of fucoxanthin rich-seaweed extract improved lipid profile and suppressed body fat in mice (Woo *et al.*, 2008). Recently, useful roles of sea tangle supplementation as treatment for chronic idiopathic constipation (Oh & Lim, 2007) and improving blood glucose, serum lipids and antioxidant activity (Park *et al.*, 2007) have been published. However, there is not any published data to explain the dietary role of sea tangle in managing body weight of people.

Various body weight control programs such as diet therapy, exercise and nutrition education that focus on behavioral changes and other complex programs are being tried (Kang *et al.*, 2004; Lee *et al.*, 2005; Ross *et al.*, 2000). Because they largely depended on the individual's condition or the manner in which food is consumed, it is necessary that individualized body weight control program be employed (Ross *et al.*, 2000). However, in most of the complex programs, subjects are limited to children (Kim, 2007) or middle aged women (Kim *et al.*, 2007b; Lee *et al.*, 2005; Lee *et al.*, 2008). There are not any sufficient articles about the research pertaining to female college students.

Therefore, we conducted the 8-week body weight control program on female college students who want to lose body weight. This program consisted of diet therapy, exercise and behavioral modifications with supplementation of sea tangle. We studied the effectiveness in body composition, dietary habits, serum lipid profiles, nutrient intake and quality of life. Our study will provide fundamental data for the development of effective body weight control program using medicinal food such as sea tangle.

Subjects and Methods

Study subjects

Study subjects (26 female college students the aged between 19 and 24 years) were recruited from the nutrition education class in 2007 at a university located in Incheon, Korea. Because we recruited subjects after the confirmation of the registration of their course, we conducted an 8-week body weight control program from week 6 to week 13. All subjects submitted to the researcher a written and signed informed consent form to take part in the 8-week body weight control program. The subjects were free-living and they ate self-selected food. No medicine or other nutritional supplements were taken. Result analysis was conducted for the 22 students who completed the 8-week program (drop-out rate: 15.4%).

Body weight control program

The program consisted of diet therapy, exercise and behavioral modification with supplementation of sea tangle. All subjects attended an introductory class. At this class, subjects were recommended an individualized low calorie diet by a dietitian and instructed to walk more than 10,000 steps a day and to lift dumbbells of 1.5 kg in each hand (provided by the researchers) 20-30 minutes a day 4-5 times per week. These walking and exercises consumed about 200 ~ 300 kcal/day depending on each individual's body weight and strength. When the subjects wished to use a different method of exercise, they were instructed individually. To learn behavioral modification, subjects were provided an online nutrition lecture. In addition, the subjects were counseled with a face-to face meeting referring to the self-monitoring diary and via email once per week. Fresh raw sea tangle ("Super Dasima"), obtained from Incheon (Ongjin county, Korea) was dried and grounded into powder. According to the Korean rules and regulations for health functional foods, manufacturing standard of dietary fiber supplement is over 5 g/day. Because the total dietary fiber contents for dry sea tangle was about 30% (Hwang *et al.*, 1996; Kim *et al.*, 1993), we distributed 20 g sea tangle powder /day to each subject . Subjects consumed sea tangle powder diluted in water or a beverage 2 to 3 times before or during meals.

Body composition assessment

Anthropometric measurements were obtained from each subject. Each subject's height was measured with an anthropometer. Body composition (body weight, soft lean mass, body fat mass, percent body fat, waist-hip ratio and BMI) were assessed at least once per week using bioelectrical impedance (InBody 3.0, Biospace, Korea).

Dietary habit scores

All subjects were assessed by self-reported questionnaires at the beginning and at the end of the program. Dietary habit questionnaires consisted of 10 questions; eating breakfast, regularity of mealtime, speed of eating, overeating, eating while watching TV or using the computer, eating fatty food, snacks after dinner, eating sweet snacks, eating a balanced diet and eating salty food. Dietary habit was scored 1-3 points by each question and the maximum score was 30 points. The higher dietary habit score is, the better dietary habit of subject is.

Serum lipid profiles

Blood was collected after a fasting overnight at the same time in the morning at the beginning and at the end of the program. The collected blood was centrifuged at 3,000 rpm for 15 minutes. The supernatant serum was separated in micro tubes and stored under -70℃ until the determination of serum lipid concentrations. Serum total cholesterol (TC), high-density lipoprotein (HDL)-cholesterol and triglyceride (TG) levels were determined by using an automatic clinical analyzer (Kuadro, Italy). Serum low-density

lipoprotein (LDL)-cholesterol level was calculated from serum TC, HDL-cholesterol and TG levels (Friedewald *et al.*, 1972).

Nutrient intakes and diet quality

Information at the beginning the dietary intake of each subject was collected for three days by a 24-hour dietary recall method before the program. The subjects wrote down daily dietary intake records in a food diary. Three-day records of the last week were analyzed and compared with the beginning data. Each subject's food intake was converted into the daily nutrient intake by CAN-Pro 3.0 (Korean Nutrition Society, Korea). Change in energy and nutrient (protein, carbohydrate, fat, cholesterol, dietary fiber, folic acid, vitamin A, vitamin B_1, vitamin B_2, vitamin B_6, calcium, iron, phosphorus, potassium, zinc and niacin) intakes were compared between the beginning and the end of the program.

Nutrient adequacy ratio (NAR) and mean adequacy ratio (MAR) were the index of overall diet quality based on nutrients. The NAR is the ratio of intake of a nutrient in relation to its Recommended Dietary Allowance (RDA). The MAR is obtained by averaging the NARs.

The index of nutritional quality (INQ) was "developed from the nutrient density concept in order to compare the nutritive content of a quantity of food with its energy content in relation to the human requirement for the individual nutrients and energy" (Sorenson *et al.*, 1976). The INQ is the ratio of amount of nutrient in 1,000 kcal in relation to the RDA in 1,000 kcal.

Health-related quality of life

Health-related quality of life (HRQOL) of each subject was assessed by using an SF-36 health survey (Ware & Sherbourne, 1992). The SF-36 is a multipurpose, short form health survey with only 36 questions. It yields an eight-scale profile of scores as well as physical and mental health; physical function, role limitations due to physical problems, vitality, bodily pain, social function, role limitations due to emotional problems, mental health and general health perceptions (Ware & Sherbourne, 1992). The Korean translated version of SF-36 health survey questionnaire was administered at the beginning and at the end of the program. Each domain was scored independently from 0 (lowest level of function) to 100 (highest level of function).

Statistical analysis

All data are presented as means, standard error, frequency and percentage. Statistical Package for the Social Sciences (SPSS) for windows version 12.0 was used for the analysis. Simple descriptive statistics were used to describe the overall characteristics of the sample. Paired t-tests were conducted to examine changes in the variable of interests from beginning to end of the program. A value of $P < 0.05$ was considered statistically significant.

Results

General Characteristics

General characteristics of the subjects at the beginning of the program are presented in Table 1. Average age of the subjects is 20.3 years and height is 161.9 cm. The BMI was categorized into 4 groups (underweight, normal, overweight, obese) according to International Obesity Task Force (IOTF) classification of Asians. Nobody was underweight, 13 people were normal (18.5 $kg/m^2 \leq$ BMI $\leq$ 22.9 kg/m^2), 7 people were overweight (23.0 $kg/m^2 \leq$ BMI $\leq$ 24.9 kg/m^2) and 2 people were obese (BMI $\geq$ 25.0 kg/m^2). But most of the subjects were found to have over 30% body fat. Sixty-three point six percent of subjects lived with family and 40.9% had an allowance of 200,000 won less per

Table 1. General characteristics of the subjects at the beginning

Variables	
Age (year)	20.8 ± 0.2[1]
Height (cm)	161.9 ± 1.2
BMI[2] (kg/m²)	23.1 ± 0.5
BMI distribution	
Normal (18.5 ≤ BMI ≤ 22.9)	13 (59.1)[3]
Overweight (23.0 ≤ BMI ≤ 24.9)	7 (31.8)
Obese (BMI ≥ 25.0)	2 (9.1)
Residence type	
With family	14 (63.6)
Self-cooking	4 (18.2)
Boarding	1 (4.5)
Dormitory	3 (13.6)
Allowance (won/month)	
< 200,000	9 (40.9)
200,000-300,000	6 (27.3)
≥ 300,000	7 (31.8)
Self-perceived health status	
Good	5 (22.7)
Normal	17 (77.3)
Poor	0 (0)
Drinking habit	
Yes	15 (68.2)
No	7 (31.8)
Bed time	
Before 12 p.m.	2 (9.1)
12 p.m. - 1 a.m.	17 (77.3)
After 2 a.m.	3 (13.6)
Sleeping hours (/day)	
< 6 hr	2 (9.1)
6 - 8 hr	17 (77.3)
> 8 hr	3 (13.6)
Part- time job	
Yes	11 (50.0)
No	11 (50.0)

[1] Values are mean ± SE (n=22).
[2] BMI is body mass index.
[3] Values are number (%).

month.

Subjects who perceived their own health status as normal were 77.3% and most of the subjects did not have a smoking habit. However, 68.2% of the subjects reported to have a drinking habit. Bedtime was between 12 p.m.−1 a.m. and total sleeping hours were 6-8 hrs/day in most of them. Half of subjects reported to have a part-time job.

Body composition

Changes in body composition parameters from the beginning to the end of the program are presented in Table 2. Weight of the subjects was 60.6 kg in average and BMI was 23.1 kg/m^2 before they joined the program. After the 8-week program, the average weight and BMI were reduced to 58.6 kg and 22.3 kg/m^2. Body fat percent was reduced from 32.0% to 29.8%, but soft lean mass did not change. Among the subjects, 4 people (18.2%) lost > 3 kg weight, 11 people (50.0%) lost 1.0~2.9 kg weight and 7 people (31.8%) lost < 0.9 kg weight.

Table 2. Changes in body composition of the subjects

Body composition	Beginning	End
Weight (kg)	60.6 ± 1.7[1]	58.6 ± 1.5***[2]
BMI[3] (kg/m^2)	23.1 ± 0.5	22.3 ± 0.4***
Soft lean mass (kg)	38.8 ± 1.1	38.7 ± 1.0
Body fat mass (kg)	19.5 ± 0.7	17.5 ± 0.6***
Percent body fat (%)	32.0 ± 0.6	29.8 ± 0.6***
Waist-hip ratio	0.83 ± 0.01	0.81 ± 0.01***

[1] Values are mean ± SE (n=22).
[2] Values with superscripts are significantly different between beginning and end by paired t-test (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).
[3] BMI is body mass index.

Table 3. Changes in dietary habit scores of the subjects

Dietary habits	Beginning	End
1. Eating breakfast (0-2 days/week, 3-5 days/week, 6-7 days/week)	2.2 ± 0.2[1]	2.4 ± 0.1
2. Regularity of mealtime (3 regular meals/day, 1-2 regular meals/day, less than 1 regular meal/day)	1.7 ± 0.2	2.0 ± 0.1**
3. Speed of eating (less than 10 min, 10-20 min, more than 20 min)	1.9 ± 0.1	2.1 ± 0.1
4. Overeating (Over 6 times/week, 3-5 times/week, 0-2 times/week)	2.0 ± 0.1	2.4 ± 0.1**
5. Eating while watching TV or using the computer (Over 6 times/week, 3-5 times/week, 0-2 times/week)	1.7 ± 0.2	2.1 ± 0.2*
6. Frequency of eating fatty foods (3 times/day, 1~2 times/day, less than 1 time/day)	2.2 ± 0.1	2.4 ± 0.1
7. Frequency of snacks after dinner (6~7 days/week, 3~5 days/week, 0~2 days/week)	2.5 ± 0.1	2.7 ± 0.1
8. Frequency of eating sweet snacks (Over 4 times/day, 2~3 times/day, less 1 time/day)	2.5 ± 0.1	2.5 ± 0.1
9. Eating a balanced diet (Over 6 times/week, 3-5 times/week, 0-2 times/week)	1.5 ± 0.1	2.2 ± 0.1***
10. Eating salty food (0-2 times/week, 3-5 times/week, over 6 times/week)	1.7 ± 0.1	2.1 ± 0.2*
Total	19.9 ± 0.7	23.0 ± 0.8***

[1] Values are mean ± SE (n=22).
[2] Values with * superscripts are significantly different between beginning and end by paired t-test (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table 4. Changes in blood lipid profiles of the subjects

Serum Lipid	Beginning	End
Total cholesterol (mg/dl)	147.6 ± 5.1	144.8 ± 4.5[NS2]
HDL-cholesterol (mg/dl)	34.3 ± 1.2	34.1 ± 0.6
LDL-cholesterol (mg/dl)	101.1 ± 5.3	99.8 ± 4.9
Triglycerides (mg/dl)	62.2 ± 5.6	53.3 ± 3.5

[1] Values are mean ± SE (n=22).
[2] NS: Not significant.

Table 5. Changes in nutrient intakes of the subjects

Nutrients	Beginning		End	
		per 1,000 kcal		per 1,000 kcal
Energy (cal)	1528.5 ± 73.0[1]		1364.4 ± 29.7*[2]	
Protein (g)	57.3 ± 2.5	37.9 ± 1.1	51.7 ± 1.9*	38.0 ± 1.3
Carbohydrate (g)	207.5 ± 6.1	138.2 ± 3.4	200.7 ± 6.0	147.3 ± 3.6*
Fat (g)	48.5 ± 3.2	31.6 ± 1.2	40.1 ± 2.2*	29.2 ± 1.4
Cholesterol (mg)	326.6 ± 35.9	211.2 ± 23.3	279.2 ± 22.9	202.7 ± 15.4
Dietary fiber (g)	13.6 ± 0.9	9.0 ± 0.6	16.3 ± 0.6*	12.1 ± 0.6***
Folic acid (µg)	168.7 ± 15.5	112.1 ± 9.2	306.1 ± 19.7***	224.5 ± 15.2***
Vitamin A (mg)	653.1 ± 61.3	435.4 ± 35.8	584.4 ± 5.3.8	418.0 ± 32.9
Vitamin B$_1$ (mg)	1.1 ± 0.1	0.7 ± 0.06	1.0 ± 0.1	0.7 ± 0.04
Vitamin B$_2$ (mg)	0.9 ± 0.07	0.6 ± 0.04	1.0 ± 0.1	0.7 ± 0.04
Vitamin B$_6$ (mg)	1.6 ± 0.1	1.1 ± 0.07	1.5 ± 0.1	1.1 ± 0.06
Calcium (mg)	345.3 ± 25.0	229.4 ± 16.7	472.3 ± 22.3**	346.5 ± 16.8***
Iron (mg)	11.2 ± 1.0	7.3 ± 0.7	9.9 ± 0.4	7.3 ± 0.3
Phosphorus (mg)	783.0 ± 35.4	514.5 ± 20.0	721.6 ± 25.8	528.5 ± 17.0
Potassium (mg)	1881.7 ± 119.3	1240.9 ± 79.0	2560.2 ± 112.6***	1898.6 ± 101.3**[*]
Zinc (mg)	6.6 ± 0.4	4.3 ± 0.2	5.9 ± 1.1	4.3 ± 0.2
Niacin (mg)	13.5 ± 1.0	8.8 ± 0.6	12.5 ± 1.0	9.1 ± 0.6

[1] Values are mean ± SE (n=22).
[2] Values with superscripts are significantly different between beginning and end by paired t-test (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Table 6. Changes in diet quality of the subjects

Variables	Beginning	End
INQ[1]		
Protein (g)	1.7 ± 0.05[2]	1.8 ± 0.28
Vitamin A (mg)	1.4 ± 0.12	1.4 ± 0.11
Vitamin B_1 (mg)	1.3 ± 0.12	1.4 ± 0.08
Vitamin B_2 (mg)	1.0 ± 0.06	1.2 ± 0.08
Niacin (mg)	1.3 ± 0.08	1.4 ± 0.09
Folic acid (μg)	0.6 ± 0.05	1.2 ± 0.08***[3]
Calcium (mg)	0.7 ± 0.05	1.0 ± 0.05***
Phosphorus (mg)	1.5 ± 0.06	1.6 ± 0.05
Iron (mg)	1.1 ± 0.10	1.1 ± 0.05
Zinc (mg)	1.1 ± 0.05	1.1 ± 0.05
MAR[4]	0.75 ± 0.03	0.81 ± 0.02

[1] INQ is index of nutritional quality.
[2] Values are mean ± SE (n=22).
[3] Values with superscripts are significantly different between beginning and end by paired t-test (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).
[4] MAR is mean adequacy ratio.

Table 7. Changes in SF-36 scores of the subjects

Variables	Beginning	End
Physical functioning	83.6 ± 3.0[1]	90.7 ± 1.6**[2]
Role-physical	89.6 ± 2.9	83.1 ± 4.5
Bodily-pain	75.9 ± 3.9	78.4 ± 4.0
General-health	59.6 ± 3.2	68.1 ± 3.4**
Vitality	45.3 ± 2.5	55.8 ± 3.8**
Social-functioning	75.0 ± 4.5	79.8 ± 4.4
Role-emotional	77.8 ± 4.8	79.4 ± 5.4
Mental-health	64.3 ± 3.4	65.2 ± 4.6

[1] Values are mean ± SE (n=22).
[2] Values with superscripts are significantly different between beginning and end by paired t-test (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$).

Dietary habit scores and serum lipid profiles

The total score of dietary habits was increased significantly during the 8-week body weight control program ($P < 0.001$) (Table 3). By questions, the dietary habit score regarding a balanced diet increased significantly from 1.5 points to 2.1 points ($P < 0.001$). In addition, regularity of mealtime and overeating score increased significantly from 1.6, 2.0 to 2.0, 2.4, respectively ($P < 0.01$). The scores regarding to eating while watching TV or using the computer and eating salty food also significantly were increased ($P < 0.05$). The dietary habit scores such as eating breakfast, speed of eating, frequency of eating fatty foods and frequency of snacks after dinner were increased but not significantly.

Differences in serum lipid profiles between the beginning and the end of the program are shown in Table 4. The serum TC, LDL-cholesterol and TG were reduced during the 8-week body weight control program but not significantly.

Nutrient intakes and diet quality

The analysis of daily intakes of nutrients of the subjects is presented in Table 5. After the program, there was a significant decrease in intake of energy, protein and fat; and significant increase in the intake of dietary fiber, folic acid, calcium and potassium. In the results of nutrient density that was calibrated to a 1,000 kcal calorie intake, there was a significant increase in the intake of carbohydrate, dietary fiber, folic acid, calcium and potassium.

To assess diet quality quick and easily, we analyzed INQ and MAR (Table 6). At the beginning, the INQ of folic acid and calcium were less than 1.0. But after 8 weeks, those of folic acid and calcium were increased over than 1.0. MAR was increased but not significantly.

Health-related quality of life

Health-related quality of life (HRQOL) at the beginning and at the end of the program is shown in Table 7. The results show significant improvement in subcomponents of quality of life; physical functioning, general health and vitality ($P < 0.01$).

Discussion

This study evaluated the effects of a weight control program with supplementation of sea tangle (20 g/day) on 22 female college students. The contents of the program for 8 weeks contained diet therapy, exercise and behavioral modification through nutrition education.

Average weight and BMI of the subjects were 60.6 kg and 23.1 kg/m^2. According to the Third Korea National Health and Nutrition Examination Survey (Ministry of Health & Welfare, 2005), average weight of 20-24 years women and BMI of 20-24 years women were 55.4 kg, 21.7 kg/m^2, respectively. The average weight and BMI of our subjects were higher than that of the same age Korean women. This is why all of the subjects want to lose weight.

After the 8-week program, the subjects reduced average 2 kg of weight, 2 kg of body fat and 2.2 percent body fat, but soft lean mass did not change. According to the previous research (Kim *et al.*, 2007a), a low calorie diet that used meal replacements in obese women in their twenties reduced 3.56 kg of weight and 1.34 percent of body fat. Also, it was reported (Ha & Kim, 2003) that uncooked grains and vegetables with mainly brown rice for 8 weeks reduced 4.5 kg of weight. However on the completion of short term weight control program for female college students (Kang *et al.*, 2004), an average 1.1 kg of body weight was decreased. In addition, the body weight control program consisting of nutrition education and behavioral modification in college women (Lee & Chang, 2007) reduced from 61.1 kg to 60.5 kg body weight and from 32.5% to 32.1% of body fat.

The reduced body weight of the subjects who participated in this program was less than that of the subjects who participated in other body weight loss programs that used a low calorie diet

(Kim *et al.*, 2007a; Son & Kim, 2005). But the reduced body weight of this program subjects was more than that of other complex body weight loss programs (Jeon, 2006; Lee & Chang, 2007). Because our subjects used an autonomous diet, calorie consumption was relatively higher than low calorie diet therapy. In addition to, drop-out rate of this program is also lower (15.4 %) than other studies (Choi & Kim, 2006; Son & Kim, 2005). It seems that because of less burden to the subject due to self-selected food used by subjects and self-selected exercise schedule.

It is a known fact that a body weight loss program combined with exercise can change body compositions as well as increase the energy consumption (Garrow & Summerbell, 1995). It seems that a reduction in body fat was seen because the program included exercising. However, it seems that lean body mass did not change because of the short program period.

After the body weight control program, the dietary habit scores increased significantly in regularity of mealtime, overeating, eating while watching TV or using the computer, eating a balanced diet and eating salty food. In the previously reported study (Yang & Jang, 2007), an evaluation of body weight control programs in overweight or obese women also revealed an improvement in better dietary habits after the program. It can be interpreted that the improvement in the dietary habits of the subjects was caused because of behavioral change, the nutritional education class and weekly counseling by the researchers.

Serum lipid profile is one of the effective parameters of the measurement of obesity. Several body weight loss interventions have reported improvements on serum TC, HDL-cholesterol and LDL-cholesterol levels (Lee *et al.*, 2005) and improvements in TC and LDL-cholesterol levels (Seo, 2005), besides improvements in HDL-cholesterol levels (Lee *et al.*, 2007) with aerobic exercise in middle-aged women. In our study, the serum TC, LDL-cholesterol and TG were reduced during the 8 weeks but not significantly. Thus, a further long-term study may be needed to confirm the relationship among serum lipids with body weight control program of diet therapy, exercise and behavioral modification with sea tangle supplementation in female college students as well as other population samples.

Our subjects did not use any extreme method to control food intake (e.g. eating only one or two types of foods). Sea tangle powder was the only supplementation used. The distinct odor of the sea tangle was noticeable, since there was not any attempt to disguise it in any way. Nevertheless, after 1~2 days, subjects were able to adapt to it well. At the end of this program, although intake of calorie as well as fat was lower, protein and carbohydrate intake per 1,000 kcal and all INQ were the same or higher than it was before. Thus, the main achievement of our body weight control program was improvement in the dietary intakes of energy and diet quality. The improvements might be due to the increasing the feeling of fullness from dietary fiber in sea tangle and nutrition education and regular counseling once per week that might have helped the subjects to select the right foods. Our findings were similar to the previous study by Lee and Chang (2007) in which an 8-week body weight management program with nutrition education reduced intakes of energy, protein, fat and carbohydrate. Similarly, another study by Volek *et al.* (2002) showed a reduction in the intake of dietary fat and an increase in the intake of folic acid in an 8-week body weight loss program. In the database of CAN-Pro 3.0, sea tangle (20 g) has the dietary fiber capacity of 5.5 g, Ca 136 mg, Fe 1.2 mg, K 1500 mg and folic acid 272.8 μg and intakes of those nutrients were higher than those before the program. Especially, there is a serious lack of folic acid and Ca intake in Korean females (You *et al.*, 2008) as well as this study. INQ of folic acid and Ca at the beginning were 0.6 and 0.7, respectively, but those at the end of the program were 1.2 and 1.0. Therefore, our sea tangle powder might be beneficial not only in decreasing calorie intake but also in supplying folic acid and Ca.

HRQOL is "an individual's satisfaction or happiness with domains of life insofar as they affect or are affected by health" (Wilson & Cleary, 1995). We used SF-36, a well-known generic measure of HRQOL (Ware & Gandek, 1998). In a previous study (Fontaine *et al.*, 1996), the obese had a low quality of life. Cohort findings from the Nurse's Health Study suggested that body weight loss was associated with improvements in SF-36's physical functioning and vitality (Fine *et al.*, 1999). In addition, waist circumference, one of the parameters of obesity, effect the HRQOL in the domains of social function, change in health and bodily pain in Korean subjects (Park *et al.*, 2000). According to the result of group therapy during a 20 weeks period, body weight reduction improved HRQOL (Kang *et al.*, 2005). After our body weight control program, the average score of HRQOL was improved significantly in HRQOL subcomponent scores; physical functioning, general health and vitality, which is similar with previously reported studies (Fontaine *et al.*, 1999; Jensen *et al.*, 2004).

The major limitation of this study was the fact that there was no control group. If the purpose of this study was to examine the benefits of the sea tangle, a control group included a dietary therapy, exercise and behavioral modifications without the supplementation of sea tangle would have been used. But because this study was conducted to examine the effects of the overall body weight control program, we needed control group that did not have any dietary therapy, exercise and nutritional education without the supplementation of sea tangle. However, it assumed that whoever wanted to lose body weight would make an effort to adhere to those requirements. Conversely, if the subjects did not want to lose body weight, they could not be considered as the control group; which is the reasons why control group was not included.

We conducted the 8-week body weight control program on Korean female college students who want to lose body weight. This program would be beneficial to improve body composition, dietary habits, nutrient intakes such as folic acid and Ca, and HRQOL in Korean female college students. Therefore, our study

will provide fundamental data for developing effective body weight control program including sea tangle.

References

Ahn IS, Do MS, Choi BH, Kong CS, Kim SO, Han MS & Park KY (2006). Reduced leptin secretion by fucoidan-added Kochujang and anti-adipogenic effect of fucoidan in mouse 3T3-L1 adipocytes. *The Korean Journal of Food Science and Nutrition* 11:31-35.

Chanoine JP, Hampl S, Jensen C, Boldrin M & Hauptman J (2005). Effect of orlistat on weight and body composition in obese adolescents. *JAMA* 293:2873-2883.

Choi JH, Kim DI, Park SH, Kim DW, Kim CM & Koo JG (1999). Effects of sea tangle (*Laminaria japonica*) extract and fucoidan drinks on oxygen radicals and their scavenger enzymes in stressed mouse. *Journal of the Korean Fisheries Society* 32:764-769.

Choi MS & Kim MS (2006). The effect of nutritional education and exercise intervention on reducing weight of obese women. *The Korean Journal of Community Living Science* 17:57-66.

Fine JT, Colditz GA, Coakley EH, Moseley G, Manson JAE, Willett WC & Kawachi I (1999). A prospective study of weight change and health-related quality of life in women. *JAMA* 282:2136-2142.

Fontaine KR, Barofsky I, Andersen RE, Bartlett SJ, Wiersema L, Cheskin LJ & Franckowiak SC (1999). Impact of weight loss on health-related quality of life. *Qual Life Res* 8:275-277.

Fontaine KR, Cheskin LJ & Barofsky I (1996). Health-related quality of life in obese persons seeking treatment. *J Fam Pract* 43:265-270.

Friedewald WT, Levy RI & Fredrickson DS (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 18:499-502.

Garrow JS & Summerbell CD (1995). Meta-analysis: effect of exercise, with or without dieting, on the body composition of overweight subjects. *Eur J Clin Nutr* 49:1-10.

Ha TY & Kim NY (2003). The effects of uncooked grains and vegetables with mainly brown rice on weight control and serum components in Korean overweight/obese female. *The Korean Journal of Nutrition* 36:183-190.

Hwang SH, Kim JI & Sung CJ (1996). Analysis of dietary fiber content of some vegetables, mushrooms, fruits and seaweeds. *The Korean Journal of Nutrition* 29:89-96.

Jensen GL, Roy MA, Buchanan AE & Berg MB (2004). Weight loss intervention for obese older women: improvements in performance and function. *Obes Res* 12:1814-1820.

Jeon ER (2006). Effect of nutrition education and aerobic exercise program on weight control program of middle aged abdominal obese women. The *Korean Journal of Human Ecology* 9:65-73.

Jimenez-Escrig A & Goni CI (1999). Nutritional evaluation and physiological effects of edible seaweeds. *Arch Latinoam Nutr* 49:114-120.

Kang JG, Lee CB, Lee HS, Bae SC & Choi WH (2005). Effect of weight reduction after group therapy on the quality of life of patients with obesity *The Korean Journal of Obesity* 14:149-154.

Kang YH, Yi KO, Ha EH, Kim JY & Kim WY (2004). Evaluation of short term weight control program for female college students. *The Korean Journal of Nutrition* 37:493-501.

Kim EH, Maeng YS & Woo SJ (1993). Dietary fiber contents in some vegetables and seaweeds. The *Korean Journal of Nutrition* 26:196-201.

Kim JH (1998). A study on nutrition status by diet of female college students of masan city. *The Korean Journal of Food and Nutrition* 11:185-191.

Kim JY, Kim SY, Jung KA, Chang YK, Choi HS, Choi S, Park MH, Hong SG & Hwang SJ (2007a). Effects of very low calorie diet using meal replacements on psychological factors and quality of life in the obese women aged twenties. *The Korean Journal of Nutrition* 40:639-649.

Kim KH (2007). Changes of obesity indices, body satisfaction and self-esteem of obese children on weight control program. *Korean Journal of Community Nutrition* 12:449-461.

Kim MK & Lee GC (2006). Weight reduction dieting survey and satisfaction degree and diet related knowledge among adult women by age. *Journal of the Korean Society of Food Science and Nutrition* 35:572-582.

Kim NH, Kim JM, Kim HS & Chang NS (2007b). Effects of nutrition and exercise education on fat mass and blood lipid profile in postmenopausal obese women. *The Korean Journal of Nutrition* 4:162-171.

Kimura Y, Watanabe K & Okuda H (1996). Effects of soluble sodium alginate on cholesterol excretion and glucose tolerance in rats. *J Ethnopharmacol* 54:47-54.

King D & Devaney N (1988). Clinical pharmacology of sibutramine hydrochloride (BTS 54524), a new antidepressant, in healthy volunteers. *Br J Clin Pharmacol* 26:607-611.

Lee DT, Suh YS, Lee IY & Cha KS (2007). Body composition, blood lipids and blood coagulation factor-1 changes by community health promotion program in obese women. *The Korean Journal of Health Promotion and Disease Prevention* 7:205-212.

Lee JS, Lee HO, Yim JE, Kim YS & Choue RW (2005). Effects of medical nutrition therapy on changes of anthropometric measurements, dietary pattern and blood parameters in over weight or obese women. *The Korean Journal of Nutrition* 38:432-444.

Lee SH & Chang NS (2007). Effectiveness of nutrition education on dietary habits and diet quality in the weight loss and weight gain groups in college women. *The Korean Journal of Nutrition* 40:463-474.

Lee YA, Kim KN & Chang NS (2008). The effect of nutrition education on weight control and diet quality in middle-aged women. *The Korean Journal of Nutrition* 41:54-64.

Leung WYS, Neil Thomas G, Chan JCN & Tomlinson B (2003). Weight management and current options in pharmacotherapy: orlistat and sibutramine. *Clin Ther* 25:58-80.

Ministry of Health & Welfare (2005). The third korea national health & nutrition examination survey (KNHANES III). http://www. knhanes.cdc.go.kr. Accessed on 3/19/2009.

Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS & Marks JS (2003). Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 289:76-79.

Oh HK & Lim HS (2007). Effects of the Products of Raw Sea Tangle on Chronic Idiopathic Constipation. *Journal of the Korean Society of Food Science and Nutrition* 36:720-726.

Park MJ, Ryu HK & Han JS (2007). Effects of laminaria japonica extract supplement on blood glucose, serum lipids and antioxidant systems in type ii diabetic patients. *Journal of the Korean Society of Food Science and Nutrition* 36:1391-1398.

Park YW, Shin HC & Kim CH (2000). Health-related quality of life in people with overweigh and large waist circumference. *Journal of the Korean Academy of Family Medicine* 21:753-761.

Ross R, Dagnone D, Jones PJH, Smith H, Paddags A, Hudson R &

Janssen I (2000). Reduction in obesity and related comorbid conditions after diet-induced weight loss or exercise-induced weight loss in men A randomized, controlled trial. *Ann Intern Med* 133:92-103.

Ruperez P & Saura Calixto F (2001). Dietary fibre and physicochemical properties of edible Spanish seaweeds. *Eur Food Res Technol* 212:349-354.

Seo JH (2005). Evaluation of weight control program for obese female college students. *Journal of the Korean Society of Food Science and Nutrition* 34:1381-1387.

Son SM & Kim HJ (2005). Effect of 12-week low caorie diet and behavior modification on the anthropomeric indices and biochemical nutritional status of obese woman. *Korean Journal of Community Nutrition* 10:525-535.

Sorenson AW, Wyse BW, Wittwer AJ & Hansen RG (1976). An index of nutritional quality for a balanced diet. New help for an old problem. *J Am Diet Assoc* 68:236-242.

Volek JS, Gomez AL, Love DM, Weyers AM, Hesslink RJ, Wise JA & Kraemer WJ (2002). Effects of an 8-week weight-loss program on cardiovascular disease risk factors and regional body composition. *Eur J Clin Nutr* 56:585-592.

Ware JE & Gandek B (1998). Overview of the sf-36 health survey and the international quality of life assessment (IQOLA) project. *J Clin Epidemiol* 51:903-912.

Ware JE & Sherbourne CD (1992). The MOS 36-item short-form health survey (SF-36). *Med Care* 30:473-483.

WHO (2006). Obesity and overweight. Fact sheet N°311 http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed on 9/1/2006.

Wilson IB & Cleary PD (1995). Linking clinical variables with health-related quality of life. A conceptual model of patient outcomes. *JAMA* 273:59-65.

Woo MN, Jeon SM, Kim HJ, Yeo J, Shin YC & Choi MS (2008). Supplementation of fucoxanthin rich-seaweed extract improves lipid profiles and suppresses body fat in mice. *FASEB J* 22:698.

Yang KM & Jang JH (2007). Evaluation of herbal weight control program in the over weight or obese women. *Journal of the Korean Society of Cosmetology* 13:635-653.

You JS, Chin JH, Kim MJ & Chang KJ (2008). College students' dietary behaivior, health-related lifestyles and nutrient intake status by physical activity levels using international physical activity questionnaire (IPAQ) in Incheon area. *The Korean Journal of Nutrition* 41:818-831.