J Food Sci Nutr
Vol 11, p 226~231 (2006)

J Food Science and Nutrition

Weight Reduction Effect of Angook Cereal Mixture on Female College Students

Hyung Joo Suh[1†], Young Soon Kim[1], Eun Young Jung[1], Un Jae Chang[2] and Sung Hoon Oh[3]

[1]Department of Food and Nutrition, Korea University, Seoul 136-703, Korea
[2]Department of Food and Nutrition, Dongduk Women's University, Seoul 136-714, Korea
[3]Department of Food and Biotechnology, Ansan College of Technology, Gyeonggi 425-792, Korea

Abstract

This study evaluated the weight reduction effect of Angook cereal mixture. The cereal mixture was prepared with barley, unpolished rice, corn, soybean, Garcinia cambogia, guar-gum, maltodextrin, glucomannan and a vitamin mixture. Eighteen female college students participated in this 8 weeks weight control program. All subjects were randomly assigned to the treatment and placebo groups. Mean energy intake of the treatment group was 1,356.4±79.9 kcal (carbohydrate: 67.1%, protein: 18.7%, fat: 14.2%) and placebo group consumed 1,367.6±71.8 kcal (carbohydrate: 64.2%, protein: 19.7%, fat: 16.1%) during program. The placebo group lost 3.9±0.8 kg of body weight and the treatment group lost 5.9±0.7 kg of body weight. There were significant differences in the decrease of total body weight, absolute fat mass, waist circumference (WC) and hip circumference (HC) between the two groups ($p<0.05$), however, the lean body mass was not significantly decreased in the treatment group compared to the placebo group. There were no differences in the changes in blood glucose, total-cholesterol, HDL-choloesterol, LDL-cholesterol and triglycerides between groups. These findings suggest that the intake of Angook cereal mixture may be beneficial for the reduction of the body weight, absolute fat mass, WC and HC.

Key words: cereal, body weight, fat mass, lean body mass

INTRODUCTION

Obesity is a common disease associated both with its own risks for morbidity and mortality and with increased risk for other serious diseases including diabetes, cancer, hypertension, neurological disorders, and cardiovascular diseases (1,2). For this reason, estimates of the economic costs, prevalence, morbidity, and mortality associated with more modest degrees of being overweight, obese, and having diabetes are rising (3,4). Obesity and obesity-induced diabetes are characterized by increased number and size of fat cells and by elevated blood fat levels, which are regulated by genetic, endocrine, metabolic, neurological, pharmacological, environmental, and nutritional factors (4). Accordingly, a better understanding of the mechanism through which a particular dietary nutrient modulates obesity and diabetes would be of great benefit to persons who are undergoing initiation and progression of both diseases and associated morbidities.

Weight loss can be achieved by dieting, behavioral modification and exercise (5), as well as by pharmacotherapy or surgery. Pharmacological agents designed to suppress hunger succeeded in weight loss, but were often accompanied by unacceptable side effects. For example, Sibutramine, a medicine introduced recently, may increase blood pressure and heart rate in some patients (6).

Cereals are grown on 73% of the world's total cropland and comprise over 60% of world food production (7). Cereals have a higher content of certain essential vitamins, prebiotic dietary fiber, and minerals than milk, but have lesser quantities of readily fermentable carbohydrates (7).

The effects of various dietary supplements on human weight reduction, including several of the commonly consumed fibers, have been the subject of several reviews (8,9). Although Howarth et al. (8) report that the addition of 14 g/d of either soluble or insoluble fiber increases postmeal satiety and causes a modest decrease in body weight, both Pittler and Ernst (9) and Egger et al. (10) suggest that there is little evidence that the commonly available fiber supplements, such as barley, have any beneficial effects on human health.

Thus, the present study was carried out with an aim

†Corresponding author. E-mail: suh1960@korea.ac.kr
Phone: +82-2-940-2853, Fax: +82-2-941-7825

to investigate the weight loss effect of Angook cereal mixture in female college students under controlled caloric intakes.

MATERIALS AND METHODS

Subjects and study protocol

Healthy young women were recruited from the student and staff population of Korea University after complete medical and nutritional histories were obtained by use of a questionnaire. Women aged 20 to 28 years with a body fat above 25% were eligible to participate. Exclusion criteria included a history of cardiac disease, diabetes mellitus, hypertension (blood pressure>160 and >100 mmHg), or psychiatric disorders; use of monoamine oxidase inhibitors; pregnancy or lactation; thyroid disease; use of other dietary aids or enrollment in a weight loss program; and allergy to any of the ingredients used in the treatment.

Subjects (n=18) were instructed to use the internet site (www.dietcom.co.kr), which was a portal site for the weight loss program. Each subject selected the weight loss program for the weight loss of 0.5 kg/week, and made a suitable diet plan with their calories intake and exercise patterns. Subjects were randomized to the treatment group (Internet diet program + cereal mixture) or the placebo group (Internet diet program only) by drawing cards containing randomization codes. Every pouche of the cereal mixture was standardized to contain a proprietary blend of barley, unpolished rice, corn, soybean, Garcinia cambogia, guar-gum, maltodextrin, glucomanan and vitamin mixture, weighing 30 g. The treatment group (n=9) was asked to consume 2 pouches (60 g) of the cereal mixture per day as a meal replacement. To help ensure compliance, participants were asked to record the number of pouches taken at the end of each week and to return any unused pouches at the completion of the study. The mixture was suspended in distilled water and administered orally in a dose of 60 g, p.o. a day for 8 weeks. This dose was selected on the basis of our preliminary studies. The placebo group (n=9) received only the vehicle in the same volume and through the same route.

Each group consumed the mixture for a period of 8 weeks. Subjects were instructed to continue their regular diet and exercise patterns. They also received instructions on how to properly complete the daily dietary intake record; and they were asked to complete these records for periods during the diet program. The records were analyzed by Can-Pro (Korean Nutrition Society, Seoul, Korea). Subjects also completed a weekly activity log and side effect questionnaire.

Total body weight was assessed using a calibrated medical scale (Health-O-Meter, Continental Scale Corp., Chicago, Illinois) accurate to 0.1 kg. Body composition was determined using bioelectric impedance (Venus DX-200, Jawon Medical Co. LTD., Seoul, Korea). In addition, height, blood pressure (Dinamap Plus, Johnson & Johnson, New Brunswick, New Jersey), resting heart rate (Dinamap Plus), and waist and hip circumference of each subject was measured. Measurements at baseline and at week 8 were taken at approximately the same time of day by the same investigator.

The study was approved by the Ethical Committee for Human Experimentation of the Korea University and was conducted in accordance with its rules and regulations.

Angook cereal mixture

The dried powder cereal preparations were provided by the AG Health Company (Seoul, Korea). The constituents of cereal mixture included barley, unpolished rice, corn, soybean, Garcinia cambogia, guar-gum, maltodextrin, glucomannan and vitamin mixture. The chemical composition and calorie content of the cereal mixture was as follows; carbohydrate 63.4%, crude fat 3.8%, crude protein 25.2%, and 377.7 kcal/100 g.

Plasma parameter

After 12 hr fasting, blood samples were collected in 10-mL syringes fitted with 23-gauge, 1.9-cm disposable needles and EDTA was used as an anticoagulant. The blood samples were immediately centrifuged at 2,000 *g* for 10 min at 4°C. Plasma was stored at -80°C until used for determination of glucose and lipid concentrations. Glucose, triglycerides, total cholesterol, and high-density lipoprotein (HDL) cholesterol were assayed with a diagnostics analyzer (EKTACHEM DT 60 II System, Johnson & Johnson Clinical Diagnstics, USA). The low- density lipoprotein (LDL) cholesterol was estimated using the method validated by Friedewald et al. (11).

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 12.0 (SPSS Inc., Chicago, Illinois, USA). An unpaired *t* test was used to assess between-group differences in baseline characteristics and the delta change scores from baseline to 8-week. Differences between pretreatment and post-treatment dietary intake; body weight; percentage of body fat; absolute fat mass; lean body mass; BMI; waist, and hip circumference; skinfold thickness were evaluated statistically by the Mann-Whitney two-sample test. All data are reported as mean ± SD. $p<0.05$ was considered statistically significant.

RESULTS

Subject characteristics

Eighteen obese adults [mean±SD age, 22.1±3.2 years (range, 20~28 years); mean±SD BMI, 24.6±2.8 kg/m^2 (range, 20.5~30.5 kg/m^2)] were assigned to the treatment group (9 women) or the placebo group (9 women). No significant differences in age; body weight; percentage of body fat; absolute fat mass; lean body mass; BMI; waist, and hip circumference were found between the 2 groups at baseline (Table 1). No significant differences in blood pressure and mean resting heat rate were found between the 2 groups ($p>0.05$). Mean caloric intake and percentage of calories ingested as carbohydrates, fat, and protein are shown in Table 2. No significant differences in any of these variables at baseline were found between the treatment and placebo groups. However, there was a significant decrease in energy intake between tested time and baseline ($p<0.05$). During treatment, energy consumption was controlled for treatment and placebo group at 1356.4 and 1367.6 kcal (Table 2). Furthermore, supplementation with either placebo or the cereal mixture had no significant effect on mean total caloric intake or mean percentage of calories ingested as carbohydrates, fat and protein.

Body composition and plasma parameter

Body composition (mean body weight; percentage of body fat; absolute fat mass; lean body mass; BMI; and waist, and hip circumference; skinfold thickness) at baseline and week 8 are shown in Table 3. Both groups lost body weight during the study, but the loss in the placebo group was not significantly different between baseline and week 8. In the treatment group, BMI, body weight, fat mass, WC, HC and subscapular skinfold thickness decreased significantly after the 8-week treatment.

The decrease in mean body weight was significantly higher in the treatment group compared with the placebo group (5.9 kg vs 3.9 kg; $p<0.05$). The treatment group also achieved a significant reduction in WC and HC

Table 1. Baseline characteristic of the study subjects (N=18)

Characteristic	Treatment group (n=9)	Placebo group (n=9)
Age (year)	21.4±2.5	22.7±4.2
Body wight (kg)	64.8±7.4	65.7±1.8
Body fat (%)	29.3±2.2	29.5±3.0
Fat mass (kg)	19.1±3.5	16.8±8.5
LBM (kg)	45.8±5.5	46.3±17.9
BMI (kg/m^2)	24.5±2.8	24.6±3.1
WC (cm)	76.9±4.8	77.8±7.7
HC (cm)	100.3±5.1	100.1±5.4
Tricep (mm)	28.6±9.8	30.7±9.6
Subscapular (mm)	36.1±7.4	36.9±7.9
Abdomen (mm)	27.4±7.0	30.2±9.2

LBM: lean body mass; BMI: body mass index; WC: waist circumference; HC: hip circumference.

Table 2. Energy intake, carbohydrate, fat and protein intakes of the subjects during treatment

	Treatment group (n=9)			Placebo group (n=9)		
	Baseline	1~8 weeks	Δchange	Baseline	1~8 weeks	Δchange
Total calories (kcal)	1925.2±167.5	1356.4±79.9	-568.8±178.2	1954.3±155.8	1367.6±71.8	-586.7±183.5
Carbohydrate (%)	63.3±2.3	67.1±3.2	3.8±2.5	64.7±2.1	64.2±2.5	-0.5±0.2
Fat (%)	16.7±2.6	14.2±1.6	-2.5±1.3	17.0±1.6	16.1±2.2	-0.9±0.3
Protein (%)	20.0±1.5	18.7±3.3	-1.3±1.6	18.3±1.8	19.7±1.2	1.4±1.0

Table 3. Body composition of subjects during treatment

Characteristic	Treatment group (n=9)			Placebo group (n=9)			p[2] between group after 8 weeks
	Baseline	8-week	p vs baseline	Baseline	8-week	p vs baseline	
Body wight (kg)	64.8±3.4	58.9±2.8	<0.05	65.7±1.8	61.8±3.9	NS	<0.05
Body fat (%)	29.3±2.2	24.9±5.1	NS	29.5±3.0	28.0±2.9	NS	NS
Fat mass (kg)	19.1±3.5	12.8±3.3	<0.05	16.8±8.5	17.4±3.6	NS	<0.05
LBM (kg)	45.8±5.5	44.2±15.5	NS	46.3±17.9	44.5±20.7	NS	NS
BMI (kg/m^2)	24.5±2.8	20.5±1.7	<0.05	24.6±3.1	23.2±2.2	NS	NS
WC (cm)	76.9±4.8	65.9±1.2	<0.05	77.8±7.7	71.6±3.9	NS	<0.05
HC (cm)	100.3±5.1	90.5±3.9	<0.05	100.1±5.4	97.4±3.4	NS	<0.05
Tricep (mm)	28.6±9.8	24.7±5.5	NS[1]	30.7±9.6	27.8±2.9	NS	NS
Subscapular (mm)	36.1±7.4	23.8±6.0	<0.05	36.9±7.9	30.8±5.3	NS	NS
Abdomen (mm)	27.4±7.0	20.8±4.38	NS	30.2±9.2	23.5±5.0	NS	NS

LBM: lean body mass; BMI: body mass index; WC: waist circumference; HC: hip circumference.
[1]No significant differences versus baseline were found.
[2]p value between treatment and placebo group after 8 weeks.

Table 4. Changes in plasma glucose and lipids of subjects during treatment

Plasma (mg/dL)	Treatment group		Placebo group	
	Baseline	Week 8	Baseline	Week 8
Glucose	77.6±4.8	78.8±5.2	78.5±3.7	80.2±5.7
TG	55.6±22.2	49.9±19.6	48.7±10.1	52.3±18.9
Total cholesterol	198.6±31.2	201.3±21.3	197.8±20.8	199.6±15.8
HDL cholesterol	56.2±12.3	58.4±10.6	60.1±10.5	57.6±18.8
LDL cholesterol	131.2±15.3	132.9±22.3	127.9±13.2	131.5±21.4

TG: triglycerides, HDL: high-density lipoprotein, LDL: low-density lipoprotein.

compared with the placebo group (11.0 cm vs 6.2 cm and 9.8 cm vs 2.7 cm; $p<0.05$). In addition, the treatment group lost significantly more absolute fat mass compared with the placebo group (6.3 kg vs -0.6 kg; $p<0.001$). However, the percentage of body fat between treatment and placebo groups was not significantly different. Neither group experienced a significant change in LBM. In terms of anthropometric measurements, the treatment group experienced a significant reduction in waist circumference (11.0 cm vs 6.2 cm), and hip circumference (9.8 cm vs 2.7 cm) compared with the placebo group ($p<0.05$).

The changes in plasma glucose and lipid profiles are shown in Table 4. Plasma total cholesterol, HDL-cholesterol and LDL-cholesterol did not change throughout the period studied. No plasma parameters changed between treatment and placebo groups. The diet program with or without cereal mixture was not influenced physiological conditions of the subjects.

DISCUSSION

The results of the test 8-week stage of this study indicate that substituting the cereal mixture for a meal led to a significant reduction in weight in all subjects. In this study, this stimulant-free dietary supplement significantly reduced total body weight, absolute fat mass, and waist and hip circumference compared with placebo ($p<0.05$). This study investigated the combined effects of cereal mixture which included barley, unpolished rice, corn, soybean, Garcinia cambogia, gua-gum, maltodextrin, glucomannan and vitamin mixture, on body weight and fat loss and body composition in humans.

Other foods (*e.g.* milk and breakfast cereal) have been used to replace meals in weight loss diets (12-14). Summerbell et al. (12) conducted a 16-week, three-arm randomized trial of a conventional diet ~3.4 MJ, an isoenergetic diet of milk only, or the milk diet plus unlimited amounts of a single food (one for each day of the week) ~5.6 MJ. Participants bought all their own food and did not receive any payment. In the present study, weight loss of treatment group and placebo group were 5.9 and 3.9 kg, respectively (Table 3). WC and HC in the treatment group were also significantly reduced compared to those of the placebo group. After eight weeks on the cereal mixture, the 5.9 kg weight loss had been maintained and mean body weight remained significantly lower than at baseline. These changes were reflected in the mean BMI, which was also significantly lower at 8 weeks, compared with baseline. However, there were only minor reductions in percentage body fat and they failed to reach statistical significance (Table 3).

Waist circumference and BMI correlate directly with cardiovascular disease risk (15,16). The treatment group did not exhibit significant reductions in either total cholesterol or HDL cholesterol compared to placebo (Table 4). Because the subjects had normal levels of these parameters at baseline, these parameters were unchanged after 8 weeks. Chang et al. (17) was also reported no differences in changes of blood parameters between placebo and the group consuming fermented red pepper.

According to the food records (Table 2), both groups consumed very similar diets at baseline, with approximately 1,925 or 1,954 kcal, 63.3% or 64.7% as carbohydrate, 20% or 18.3% as protein and 16.7% or 17.0% as fat. Both groups of participants significantly decreased their average daily energy intakes during the program. The reduction was -568.8±178.2 kcal for treatment group, and -586.7±183.5 kcal for placebo group. There were no differences between the groups in reported energy intake throughout the study. However, the treatment group reduced their daily intake of fat significantly more than the placebo group (-2.5±1.3 vs. -0.9±0.36%, $p<0.05$). The treatment group increased their daily intake of carbohydrate significantly more than placebo group (3.8±2.5 vs. -0.5±0.2%, $p<0.05$). The differences in fat and carbohydrate percentages consumed by the two groups reflect the low-fat content of the prepared Angook cereal mixture.

Nutritionally balanced, low-energy diets sometimes make use of liquid meal replacements. These types of weight-loss diets have been showed to be effective, and

are easy to use. In a 6-week four-arm intervention study, all breakfast cereal was provided to the cereal eating groups (13). At 6 weeks the cereal intervention groups had lost ~2.5 kg (>1.5 kg of which was lost during the 2 weeks of meal replacement), the 4-week diet alone intervention group lost ~1.5 kg and the no advice group had not changed. It is not clear why the diet intervention group did not commence at the same time as the cereal interventions and run for a similar period of time and this difference confounds comparison between the groups.

In an uncontrolled study, 22 volunteers ate a standard breakfast (45 g cereal with 125 mL semi-skimmed milk) and replaced one main meal with the same food for 2 weeks followed by 4 weeks on a high carbohydrate diet (14). A variety of breakfast cereals were provided to the volunteers but the nutritional analyses of the cereals were not reported in the paper. After 2 weeks mean weight loss was 2 kg and reported energy intake was reduced by 3 MJ. This weight loss was maintained at 6 weeks after transition to a high carbohydrate diet (14).

Cereals are often classed as carbohydrate-rich foods, as they are composed of approximately 75% carbohydrate. Starches, the major component of the cereal, occur as starch granules in the endosperm. Among common varieties of cereals, 25~27% of starch is present as amylose, while in waxy varieties (*e.g.* rice and corn) most of the starch is amylopectin. However, in cereal products, a proportion of this starch is not digested and absorbed in the small intestine. This is referred to as resistant starch and it appears to act in a similar way to dietary fiber.

All cereals are a rich source of non-starch polysaccharide (NSP). There are two types of insoluble and soluble-NSP and, although both may help with weight control (by delaying food leaving the stomach), they have different effects in the body. The insoluble NSP content of most cereals is similar, while the water-soluble NSP content varies. Arabinoxylans are the main water-soluble NSP in wheat, rye and barley, while in oats it is the β-glucans. The amounts of β-glucans and arabinoxylans are higher in barley, oats and rye compared to wheat (on a dry weight basis, 3~11%, 3~7%, 1~2% and <1%, respectively) (18).

Cereal foods have a relatively low energy density, and foods rich in wholegrain cereals may help reduce hunger as they are relatively bulky (19,20). Cereals may also affect body weight regulation through effects on hormonal factors. The intake of whole-grain foods was inversely associated with plasma biomarkers of obesity, including insulin, C-peptide and leptin concentrations. Whole-grain foods tend to have low glycaemic index values, resulting in lower postprandial glucose responses and insulin demand. High insulin levels may promote obesity by altering adipose tissue physiology and by increasing appetite. The fiber content of whole grains may also affect the secretion of gut hormones, independent of glycaemic response, that may act as satiety factors (21). By focusing on increasing cereal intake, it is possible to achieve a reduction in consumption of other foods and a reduction in fat intake. The high fiber, carbohydrate-rich breakfast was the most filling meal and was associated with less food intake during the morning and at lunch. Hunger returned at a slower rate after this meal than after the low-fiber, carbohydrate rich meal. Fat-rich breakfasts were more palatable but less satiating than the carbohydrate-rich meals (19). The recent WHO/FAO expert committee report on nutrition and chronic diseases suggested that a high intake of NSP may be a protective factor against overweight and obesity (WHO/FAO 2003).

Therefore, this novel combination of cereals may both reduce caloric intake and lipid absorption, leading to body weight loss. Although the exact mechanism in body weight loss which the nutraceutical combination used in our study is unclear, our findings suggest that the individual compounds of the cereal mixture may be capable of delaying glucose absorption, eliciting lipid malabsorption, reducing caloric intake, and improving insulin sensitivity.

To investigate the therapeutic potential and underlying mechanism of body weight loss by the cereal mixture, further study is needed in terms of substrate oxidation, insulin sensitivity, fat malabsorption, fasting lipid levels, and 24-hour energy expenditure. Moreover, since the present trial assessed the effectiveness of a novel cereal mixture over a relatively short time period, long-term effects of this mixture on body weight loss and maintenance should be investigated.

ACKNOWLEDGMENT

We thank AG-Health Co. Ltd., Seoul, Korea for financial support of this study.

REFERENCES

1. Kopelman PG. 2000. Obesity as a medical problem. *Nature* 404: 635-643.
2. King H, Aubert RE, Herman WH. 1998. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care* 21: 1414-1431.
3. Allison DB, Fontaine KB, Manson JE, Stevens J, Vanitallie TB. 1999. Annual deaths attributable to obesity in the United States. *JAMA* 282: 1530-1538.

4. Wolf AM, Colditz GA. 1998. Current estimates of the economic cost of obesity in the United States. *Obesity Res* 6: 97-106.
5. Guy-Grand B. 1997. Pharmacological approaches to intervention. *Int J Obes* 21: S22-S24
6. King DJ, Devaney N. 1988. Clinical pharmacology of sibutramine hydrochloride (BTS 54 524), a new antidepressant, in healthy volunteers. *Br J Pharmacol* 26: 607-611.
7. Charalampopoulos D, Wang R, Pandiella SS, Webb C. 2002. Application of cereals and cereal components in functional foods: a review. *Int J Food Microbiol* 79: 131-141.
8. Howarth N, Saltzman E, Roberts S. 2001. Dietary fiber and weight regulation. *Nutr Rev* 59: 129-139.
9. Pittler M, Ernst E. 2004. Dietary supplements for body-weight reduction: a systematic review. *Am J Clin Nutr* 79: 529-536.
10. Egger G, Cameron-Smith D, Stanton R. 1999. The effectiveness of popular, non-prescription weight loss supplements. *Med J Aust* 171: 604-608.
11. 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.
12. Summerbell CD, Watts C, Higgins JP, Garrow JS. 1998. Randomised controlled trial of novel, simple, and well supervised weight reducing diets in outpatients. *BMJ* 317: 1487-1489.
13. Mattes RD. 2002. Ready-to-eat cereal used as a meal replacement promotes weight loss in humans. *J Am Coll Nutr* 21: 570-577.
14. Kirk T, Crombie N, Cursiter M. 2000. Promotion of dietary carbohydrate as an approach to weight maintenance after initial weight loss: a pilot study. *J Hum Nutr Diet* 13: 277-285.
15. Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL. 1998. Overweight and obesity in the United States: prevalence and trends, 1960-1994. *Int J Obes Relat Metab Disord* 22: 39-47.
16. Zhu SK, Wang ZM, Heshka S, Heo M, Faith MS, Heymsfield SB. 2002. Waist circumference and obesity-associated risk factors among whites in the third national health and nutrition examination survey: clinical action thresholds. *Am J Clin Nutr* 76: 743-749.
17. Chang UJ, Kim DG, Kim JM, Suh HJ, Oh SH. 2003. Weight reduction effect of extract of fermented red pepper on female college students. *J Korean Soc Food Sci Nutr* 32: 479-484.
18. Wood P. 1997. Functional foods for health: opportunities for novel cereal processes and products. In *Cereals Novel Uses and Processes.* Campbell GM, Webb C, McKee SL, eds. Plenum Press, New York. p 233-239.
19. Holt SH. 1999. The effects of high-carbohydrate vs high-fat breakfasts on feelings of fullness and alertness, and subsequent food intake. *Int J Food Sci Nutr* 50: 13-28.
20. Saltzman E, Moriguti JC, Das SK, Corrales A, Fuss P, Greenberg AS, Roberts SB. 2001. Effects of a cereal rich in soluble fiber on body composition and dietary compliance during consumption of a hypocaloric diet. *J Am Coll Nutr* 20: 50-57.
21. Koh-Banerjee P, Rimm EB. 2003. Wholegrain consumption and weight gain: a review of the epidemiological evidence, potential mechanisms and opportunities for future research. *Proceed Nutr Soc* 62: 25-29.

(Received August 14, 2006; Accepted September 8, 2006)