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Randomized Controlled Trial

Effect of partially-abraded brown rice consumption on body weight and the indicators of glucose and lipid metabolism in pre-diabetic adults: A randomized controlled trial

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SUMMARY

Background and aims: The partially-abraded brown rice (PABR) was produced by abrading the surface of brown rice (BR) to improve its water absorption and texture. Although PABR is expected to have the same health benefits as BR, this remains to be elucidated. We examined the effects of continuous intake of PABR compared to white rice (WR) on body weight and the indicators of glucose and lipid metabolism in overweight participants with pre-diabetes.
Methods: In this 12-week randomized controlled trial, 40- to 64-year-old overweight participants with pre-diabetes were allocated to receive either PABR or WR. The primary outcome was body weight at the end of the study; secondary outcomes were waist circumference (WC) and indicators of glucose and lipid metabolism.
Results: After the 12-week intervention, changes in body weight and WC in the PABR group were -2.4 ± 2.0 kg and -3.1 ± 2.9 cm, whereas in the WR group, they were -0.2 ± 1.1 kg and -0.4 ± 1.3 cm, respectively. There was significant difference between the two groups (body weight: $p < 0.001$, WC: $p < 0.01$). The triglyceride levels of low-density lipoprotein (LDL), small LDL, and very small LDL in the PABR group decreased more than those in the WR group (all $p < 0.01$). Additionally, daily defecation frequency was increased only in the PABR group ($p < 0.05$).
Conclusions: The present study suggested that continuous intake of PABR could be effective for body weight reduction and lipid metabolism improvement. This study was registered in the University Hospital Medical Information Network-Clinical Trials Registry as UMIN000016293.

1. Introduction

White rice (WR) is considered a major staple food, especially in Asian countries [1]. Brown rice (BR) contains various phytochemicals such as dietary fiber, polyphenols, oryzanol, and gamma-aminobutyric acid (GABA), and it has been suggested to be effective in obesity prevention and glucose and lipid metabolism improvement [2]. In previous studies, the replacement of WR with BR resulted in beneficial effects on metabolic syndromes [3–6]. However, BR is rarely consumed, possibly due to its long cooking time [1] and poor taste quality [7].

Abbreviations: BDHQ, brief self-administered diet history questionnaire; BMI, body mass index; BR, brown rice; CM, chylomicrons; GABA, gamma-aminobutyric acid; GPAQ, global physical activity questionnaire; HDL-C, high-density lipoprotein cholesterol; HOMA-IR, homeostasis model assessment-insulin resistance; ITT, intention-to-treat; LDL-C, low-density lipoprotein cholesterol; MVPA, moderate-to-vigorous physical activity; n.d., not detected; PA, physical activity; PABR, partially-abraded brown rice; TC, total cholesterol; TG, triglycerides; VLDL, very low density lipoprotein; WC, waist circumference; WR, white rice.

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Thus, we focused on partially-abraded BR (PABR), which was prepared by abrading the surface of BR to 99.8% of its original weight to improve water absorption and texture of BR [8,9].

Since the nutritional contents of PABR are almost the same as those of BR [9], PABR may also have the same beneficial effects on metabolic syndrome. Previously, we performed an exploratory randomized crossover trial with two 4-week periods to compare the eating duration and palatability of PABR with those of BR [9]. The study suggested that PABR might be readily accepted by many consumers and be effective as a supplement for body weight reduction.

Other research groups observed the changes in clinical parameters during a 12-week or longer period of continuous BR consumption in participants with type 2 diabetes or mild glucose intolerance [4–6]. Therefore, we examined the effects of 12-week continuous intake of PABR and WR on body weight and the indicators of glucose and lipid metabolism in overweight participants with pre-diabetes.

2. Methods

2.1. Study population

Participants were recruited via posters in the university and the hospital, or by advertisement in local newspapers. The inclusion criteria were as follows: 40–64 years old, body mass index (BMI) of 25.0–29.9 kg/m^2, and pre-diabetes status (fasting plasma glucose level of 100–125 mg/dL and/or HbA1c level of 5.7%–6.4%). Subjects who had received pharmacotherapy for diabetes, dyslipidemia and/or alimentary disease, who participated in other interventional studies, or were current smokers were excluded from the study. Written informed consent was obtained from all participants before entering the study. If a participant decided to withdraw consent, the intervention was terminated. Recruitment by research staff occurred between February 7 and April 5, 2015. The 12-week intervention and data collection took place between February 21 and July 2, 2015. The study was performed at the University of Tsukuba according to the guidelines laid down in the Declaration of Helsinki, and it was approved by the Ethics Committee University of Tsukuba Hospital and registered on January 28, 2015 at University Hospital Medical Information Network-Clinical Trials Registry (http://www.umin.ac.jp/ctr) as UMIN000016293.

2.2. Study design

The present study was a parallel group randomized controlled trial with the goal of comparing the effects of PABR and WR on body weight and the indicators of glucose and lipid metabolism in overweight participants with pre-diabetes. The participants were allocated to receive either PABR or WR with an allocation table prepared by a data coordinator based on simple randomization method with stratification by sex and low-density lipoprotein cholesterol (LDL-C) levels (>140 mg/dL or not). The test rice samples were “Koshihikari” obtained from the same farmers (Ibaraki, Japan). From the same rice samples, PABR was prepared. Although PABR is indistinguishable from BR before cooking to the human eye, the steamed PABR is significantly softer than BR when cooked with the same rice:water ratio and cooking mode. The WR and PABR samples were prepared using the method previously reported [8] at Yamato Sangyo Co. Ltd. (Aichi, Japan). These rice samples were then processed into packed rice samples at another company. During the study, each participant was instructed to eat 200 g of the cooked rice twice a day, and was permitted to eat staple food ad libitum for the remaining one daily meal.

In the initial protocol, packages of cooked rice were given to each participant. However, on March 23, 2015, a moldy test meal was detected during the preparations for shipment to the participants. Therefore, the present study was immediately suspended and the test meals were salvaged from all participants. Then, the protocol on providing test meals was modified with ethics committee approval. The 14 participants (6 WR group and 8 PABR group) who had already started the intervention program before the protocol change had an approximately 3-week suspended period during the intervention.

In the revised protocol, each participant received an electric rice-cooker and un-cooked rice. Participants were required to cook test meals by themselves with the instructed method. When cooking, the rice:water ratios were 1:1 and 1:2 in weight for WR and PABR, respectively. Both types of rice were steamed using the cooking mode for WR. The nutritional composition of the WR and PABR were measured at Japan Food Research Laboratories (Tokyo, Japan). As shown in Table 1, the total energy in 100 g of the raw edible portion was 347 kcal and 352 kcal in the WR and PABR, respectively. The dietary fiber, oryzanol, and GABA content in PABR were higher than in WR.

As shown in Fig. 1, 106 participants were assessed for eligibility, and 42 were randomly assigned to either the WR (n = 21) or PABR (n = 21) groups. One participant of the PABR group withdrew consent for personal reason before the intervention. Individuals were requested to record the following daily information in study diaries: consumption of test meals, stool frequency, any signs or symptoms of illnesses, use of medication, and any other complaints.

2.3. Clinical measurements

Body weight and height were measured with the subjects wearing light indoor clothing without shoes. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Waist circumference (WC) was obtained at the mid-point between the lowest rib and the iliac crest. Blood pressure was measured on the right arm using an electronic blood pressure monitor (Omron HEM-7120) with participants in a comfortable seated position after at least a 5-min rest period. These data were collected at baseline, and at 6 and 12 weeks.

2.4. Blood sampling and analyses

After an overnight fast, blood samples were taken at baseline, and at 6 and 12 weeks. Levels of serum triglycerides (TG), total cholesterol (TC) and HDL-cholesterol (HDL-C) were measured using the enzymatic method. Serum LDL-C levels were measured directly. Plasma glucose levels were measured using the glucose dehydrogenase method. Insulin levels were measured using chemiluminescence immunoassays. The homeostasis model assessment–insulin resistance (HOMA-IR) was calculated according to the following formula: fasting insulin (μU/mL) × fasting

Table 1
Nutritional composition of the test meals in 100 g of raw, edible portion.

	WR	PABR
Energy (kcal)	347	352
Protein (g)	5.0	5.6
Fat (g)	1.3	3.1
Carbohydrate (g)	78.8	75.5
Dietary fiber (g)	1.1	3.2
Insoluble (g)	0.4	2.6
Soluble (g)	0.7	0.6
Oryzanol (g)	4.2	34.3
GABA (g)	n.d.	2.0

GABA, gamma-aminobutyric acid; n.d., not detected; PABR, partially-abraded brown rice; WR, white rice.

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