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Original Research

Dietary tartary buckwheat intake attenuates insulin resistance and improves lipid profiles in patients with type 2 diabetes: a randomized controlled trial

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ABSTRACT

Tartary buckwheat (TB) is rich in protein, dietary fiber, and flavonoids and has been reported to affect type 2 diabetes mellitus (T2DM) in animal experiments, but limited information on the benefit of TB as a whole food in T2DM patients is available. Thus, we tested the hypothesis that a daily replacement of a portion of the staple food with TB will improve risk factors of T2DM, including fasting glucose, insulin resistance, and lipid profile. In a parallel, randomized, open-label, controlled trial, 165 T2DM patients were randomly assigned to a control diet group (DC group; systematic diet plans and intensive nutritional education) or a TB intervention group (TB group; daily replacement of a portion of staple food with TB food). Blood samples and diet information were collected at baseline and after 4 weeks of intervention. The TB group decreased fasting insulin (2.46-2.39 Ln mU/L), total cholesterol (5.08-4.79 mmol/L), and low-density lipoprotein cholesterol (3.00-2.80 mmol/L) compared with the DC group at 4 weeks ($P < .05$). No significant differences in blood glucose or glycated hemoglobin levels were noted between the TB and DC groups. In addition, subgroup analyses based on daily TB intake dose showed a reduction in insulin, total cholesterol, and low-density lipoprotein cholesterol, but also insulin resistance was observed when TB intake dose was greater than 110 g/d. These results support the hypothesis that TB may improve insulin resistance and lipid profile in T2DM patients.

Abbreviations: BMI, body mass index; CB, common buckwheat; DC, diet control; HbA1c, glycated hemoglobin; HDL-c, high-density lipoprotein cholesterol; HOMA-IR, homeostasis model assessment of insulin resistance; LDL-c, low-density lipoprotein cholesterol; MetS, metabolic syndrome; T2DM, Type 2 diabetes mellitus; TB, Tatary buckwheat; TC, total cholesterol; TG, triglycerides; WF, white wheat flour; WR, white rice.

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1. Introduction

Type 2 diabetes mellitus (T2DM) and its cardiovascular complications are global public health concerns and impose significant economic burden [1]. A growing body of evidence indicates that medical nutrition therapy improves diabetic outcomes, especially in terms of regulating fasting glucose, attenuating insulin resistance, and lowering serum lipids. Therefore, a dietary approach is highly recommended for the management of T2DM [2,3]. Rice and wheat are the traditional staple food of China, with the daily consumption of 170 and 100 g/capita, respectively, thereby accounting for more than 30% of the daily energy requirement [4]. However, several cohort studies have shown that the consumption of refined grains (eg, white rice [WR] and white wheat flour [WF]) is associated with an increased risk of diabetes as dietary fiber, micronutrients, and phytochemicals are lost during the processing steps [5,6]. Therefore, replacement of refined carbohydrates with coarse cereals has become an important component of medical nutrition therapy for the improvement of T2DM and other chronic diseases.

Tartary buckwheat (*Fagopyrum tataricum* Gaertn; TB) has attracted increasing attention from food scientists as an important functional food because of its healing effects on chronic diseases. Many studies have demonstrated the biological activities of various TB nutrients and phytochemicals, such as protein [7,8], dietary fiber [9], and polyphenols [10]. These nutrients and compounds have been shown to improve hypercholesterolemia, hyperlipidemia, and hyperglycemia in rodent models; however, few studies have examined the health benefits of buckwheat, as a whole food, in humans. The effective dose of buckwheat protein that could suppress hypercholesterolemia in rats was estimated to be 9 g/kg body weight (54.8% of experimental diet) [8]. Similarly, the polyphenol dose that could improve insulin resistance in mice was estimated to be 50 mg/kg body weight [10]. The cholesterol-lowering effect of dietary fiber from oats was observed at a dose of 14 g/d in human subjects [11]. However, it is difficult to obtain such a high content of these nutrients with a daily intake of TB. How TB food as a mixture of nutrients performs its bioactivity in humans is necessary to be demonstrated.

Given that refined rice and wheat are both widely consumed staples in China, replacing WR or WF with TB, rather than individual nutrient components, is a convenient, feasible, and medical nutrition therapy for T2DM. Tartary buckwheat grows in the poor mountainous regions of southwest China, and in addition to its beneficial effect on T2DM management, its use as a food supplement would also mean proper utilization of the region's limited resources. Therefore, in the present 4-week randomized controlled study, we tested the hypothesis that daily replacement of a portion of the staple food with TB will improve T2DM risk factors. To examine this hypothesis, our study objective was to assess changes in fasting glucose, insulin resistance, and lipid profile of T2DM patients, following a 4-week nutritional intervention period wherein refined grains (mainly WR and WF) were partially replaced with TB.

2. Methods and materials

2.1. Participants

Participant screening was conducted at the Pinggu Hospital of Traditional Chinese Medicine (Beijing, China) by reviewing annual physical examination data (collected in 2014). Patients with T2DM between 30 and 80 years of age who were diagnosed as having diabetes or using hypoglycemic agents were invited to participate in this study. Participants were eligible if they presented any one of the following characteristics: (1) fasting glucose greater than 6.1 mmol/L, (2) glycated hemoglobin (HbA1c) greater than 6.5%, (3) previously diagnosed as having diabetes, or (4) using hypoglycemic agents. Individuals with a history of severe kidney disease, cardiovascular disease, stroke, cancer, or psychological disorders, as well as pregnant or lactating women were excluded. The sample size was calculated based on a study of oat-induced glycemia improvement in Chinese T2DM patients [12] and changes in fasting glucose. A minimum sample size of 60 participants per group was calculated with a confidence level of 95% and a power of 90%. Considering a 10% study dropout rate, we aimed to recruit 134 participants totally. A total of 252 participants responded to the invitation and attended a subsequent face-to-face screening session. After the exclusions, 180 participants were randomly assigned (stratified by sex and age to obtain 38 men and 52 women per group of whom 22 were aged 30-50 years and 68 were aged 51-80 years) to the diet control group (DC group) or the TB food intervention group (TB group; Fig. 1). After the 4-week intervention, 165 participants completed the study for further estimation. There were 35 men (11 aged 30-50 years, 24 aged 51-80 years) and 50 women (9 aged 30-50 years, 41 aged 51-80 years) in the DC group, and 32 men (11 aged 30-50 years, 21

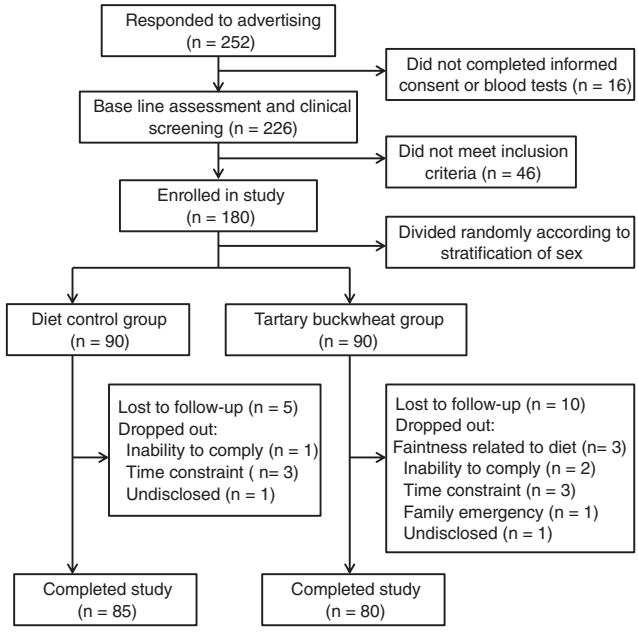

Fig. 1 – Illustration of participant selection and assignment to the control and TB groups.

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