Can J Diabetes 40 (2016) 355–363

Contents lists available at ScienceDirect

Canadian Journal of Diabetes

journal homepage: www.canadianjournalofdiabetes.com

Review

The Role of Pulses in the Dietary Management of Diabetes

Dan Ramdath PhD [a,*], Simone Renwick [a,b], Alison M. Duncan PhD, RD [c]

[a] Guelph Research and Development Centre, Agriculture and Agri-Food Canada, Guelph, Ontario, Canada
[b] Department of Molecular and Cellular Biology, College of Biological Science, University of Guelph, Guelph, Ontario, Canada
[c] Department of Human Health and Nutritional Sciences, University of Guelph, Guelph, Ontario, Canada

ARTICLE INFO

Article history:
Received 14 April 2016
Received in revised form
4 May 2016
Accepted 22 May 2016

Keywords:
beans
diabetes
food intake
glucose
glycemic control
lentils
lipids
obesity
peas
pulses
satiety

Mots clés:
haricots et doliques
diabète
apport alimentaire
glucose
régulation de la glycémie
lentilles
lipides
obésité
pois
légumineuses
satiété

ABSTRACT

Pulses are highly nutritious foods that are included as part of Canada's Food Guide to promote healthful eating, and they have established health benefits that can contribute to the dietary management of diabetes. A review of studies that have examined the effects of pulse consumption on health outcomes, integral to the management of diabetes, provides credible evidence for improvements in glycemic control, reduction of blood lipids and regulation of body weight. Results from acute feeding trials suggest that postprandial blood glucose response is significantly attenuated by a single pulse serving of between three-quarters and 1 cup. At lower doses, pulses attenuate postprandial blood glucose response more than similar amounts of starchy foods. Long-term pulse consumption of 5 cups per week appears to result consistently in improvements in glycemic control. There is high-quality evidence that supports a role for pulse consumption in the reduction of risk for cardiovascular disease; this provides a sound rationale for the regular incorporation of pulses at about two-thirds of a cup daily in the management of hyperlipidemia in persons with type 2 diabetes. Pulse consumption can contribute to improving satiety, reducing food intake and regulating body weight, which can reduce obesity risk and, in turn, improve diabetes management. Collectively, available evidence provides very good support for a role of regular pulse consumption in the prevention and management of diabetes.

RÉSUMÉ

Les légumineuses sont des aliments à haute valeur nutritive qui font partie du Guide alimentaire canadien visant à promouvoir la saine alimentation et ont des bienfaits établis sur la santé qui peuvent contribuer à la prise en charge nutritionnelle du diabète. Une revue d'études qui portaient sur les effets de la consommation de légumineuses sur les résultats cliniques, partie intégrante de la prise en charge du diabète, fournit des données probantes crédibles sur les améliorations de la régulation de la glycémie, la réduction des lipides dans le sang et la régulation du poids corporel. Les résultats provenant d'essais à court terme sur l'alimentation suggèrent que la réponse glycémique postprandiale est significativement atténuée par une seule portion de légumineuses de 3/4 à 1 tasse. À de plus petites portions, les légumineuses atténuent la réponse glycémique postprandiale plus que des quantités similaires de féculents. La consommation à long terme de 5 tasses de légumineuses par semaine semble invariablement entraîner des améliorations dans la régulation de la glycémie. Il existe des données probantes de qualité supérieure qui appuient le rôle de la consommation de légumineuses dans la réduction du risque de maladies cardiovasculaires. Ceci donne une raison valable à l'incorporation régulière d'environ 2/3 à 1 tasse de légumineuses par jour lors de la prise en charge de l'hyperlipidémie chez les personnes atteintes du diabète de type 2. La consommation de légumineuses peut contribuer à l'augmentation de la satiété, la réduction de l'apport alimentaire et la régulation du poids corporel, lesquelles peuvent réduire le risque d'obésité et, en contrepartie, améliorer la prise en charge du diabète. Collectivement, les données probantes disponibles apportent un très bon soutien au rôle de la consommation régulière de légumineuses dans la prévention et la prise en charge du diabète.

* Address for correspondence: Dan Ramdath, PhD, Guelph Research and Development Centre, Agriculture and Agri-Food Canada, 93 Stone Road West, Guelph, Ontario N1G 5C9, Canada.
E-mail address: dan.ramdath@agr.gc.ca

1499-2671 Crown Copyright © 2016
http://dx.doi.org/10.1016/j.jcjd.2016.05.015

Introduction

A major goal in the management of persons with diabetes is the achievement of optimal glycemic control because chronic elevation of blood glucose is linked to organ and nerve damage and to increased risk for cardiovascular disease (CVD) (1). In 2015, it was estimated that about one-third of Canadians were affected by either diabetes or prediabetes, and this figure is expected to increase significantly in the next decade. Current estimates suggest that the Canadian healthcare system is burdened with an annual expenditure of about $3 billion for the management of diabetes and its related complications. Globally, the prevalence of diabetes is increasing, and there is good evidence to suggest that this is due largely to excessive weight gain and obesity, resulting from poor diets and lack of physical activity (2). As such, it is imperative that more emphasis be placed on dietary and lifestyle interventions to complement standard clinical management in order to achieve optimal glycemic control.

In the dietary management of diabetes, quantity as well as quality of fat and carbohydrate intake must be carefully considered because they may not always confer desirable health benefits (2). In particular, the consumption of high-fibre, low glycemic index (GI) carbohydrates has been shown to be associated with decreased risk for developing type 2 diabetes (2). One such source of carbohydrates is pulses, defined as dry, edible leguminous crops that include beans, chickpeas, peas and lentils (3). Pulses are rich in carbohydrates (50% to 65%), fibre (4% to 7%), protein (5% to 10%) and several micronutrients (3). They also contain natural enzyme inhibitors that could slow the breakdown of carbohydrates and lipids in the small intestines, partially explaining their low GI values. Given the agricultural, economical and nutritional importance of pulses and their production in an environmentally sustainable manner, the Food and Agriculture Organization of the United Nations has declared 2016 the International Year of Pulses.

The majority of the world's pulses are produced in North America, with Canada being the world's largest exporter of lentils and peas (3). However, human consumption in North America is relatively low; on average, only about 13% of Canadians consume pulses daily, with high pulse consumers, mainly of Asian heritage, also having higher intakes of carbohydrate, fibre, protein and several micronutrients. Health Canada has included pulses in the Canadian Food Guide as part of a well-balanced diet, with the recommendation that beans and lentils, as meat alternatives, provide useful approaches to reduce dietary intake of saturated fats. Both the Canadian Diabetes Association and the American Diabetes Association also recommend consumption of pulses as part of diet therapy in their clinical practice guidelines (1,3) but provide no guidance with respect to number of servings, serving size or frequency of intake.

This review summarizes recent observational studies that have examined dietary pulse intakes and risk for type 2 diabetes along with human clinical trials (acute and long-term) that have investigated the effectiveness of pulses in attenuating postprandial blood glucose responses (PBGRs) and overall glycemic control (Table 1). This review also provides estimates of the quantity of pulses used in the various studies and offers guidance about the minimum effective dose required for improved health outcomes, including reduction of blood lipids, satiety and body weight management, in persons with type 2 diabetes.

Epidemiologic studies

Several observational studies have examined the association between low-GI or high-fibre diets containing pulse, or pulse-rich diets, with the occurrence of type 2 diabetes. Inevitably, a major focus has been on the Mediterranean diet, which is rich in pulses, whole-grain cereals, fruits and vegetables and low in meats and highly processed foods. First introduced in the 1970s by Ancel Keys during the Seven Countries Study (4,5), the Mediterranean diet has been associated with a lower risk for developing several chronic diseases, including type 2 diabetes, CVD and obesity (4,6). A recent meta-analysis of 10 prospective studies, including 136,846 participants from Europe and the United States, found that the Mediterranean diet was associated with a 23% reduced risk for type 2 diabetes (4). Similarly, a meta-analysis of 50 studies, including 534,906 participants from Europe, Australia, Israel and the United States, reported that consumption of the Mediterranean diet correlated with lower fasting blood glucose (FBG) levels and reduced risk for metabolic syndrome (6). Using dietary data from the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) cohort of 23,349 persons committed to a traditional Mediterranean diet, associated median pulse consumption was estimated at 9.13 (95% CI, 5.75 to 13.32) grams per day among men and 6.66 (95% CI, 3.62 to 10.52) grams per day among women (5). Further, pulse consumption was 1 of the strongest predictors of diabetes risk, exerting a protective effect (7), with high consumption contributing 10% to 11% to the association of adherence to the Mediterranean diet score and lower mortality (5). A meta-analysis of 5 observational studies estimated that 4 weekly servings of 100 grams (~1/2 cup) of cooked pulses correlated with a 14% reduction in risk for ischemic heart disease, which is higher in persons with type 2 diabetes (8).

Pulses have been highlighted in many studies that examined the relationship between low dietary GI and glycemic load (GL) and risk for type 2 diabetes; however, the conclusions have not always been consistent. For example, a meta-analysis (9) of 10 studies of GI and type 2 diabetes and 14 studies of GL and type 2 diabetes, conducted in the United States, Europe, China and Japan, showed that persons with the highest dietary GI and GL had significantly higher relative risk for type 2 diabetes. In contrast, a cohort study in 8 European countries found no relationship between GI, GL and type 2 diabetes. It is likely that differences in study design, study population, dietary assessment tools and source of dietary fibre could account for these contrasting results (9). In China, a 15-year study of dietary patterns of 4096 adults reported that increased intake of pulses was associated with significantly lower levels of glycated hemoglobin (A1C) and lower incidence of type 2 diabetes (10). Similarly, the Tehran Lipid and Glucose Study, in which participants were followed for 20 years, concluded that increased intake of total dietary fibre, soluble and insoluble fibres, were inversely associated with metabolic syndrome (11). Importantly, of the forms of dietary fibre that contributed to this association, cereal and pulse fibres produced the strongest effects, whereas vegetable and nut fibres were unrelated (11).

Observations from several epidemiologic studies and meta-analyses have provided useful insights into the association between pulse consumption and risk for type 2 diabetes and, collectively, they have informed the design and execution of acute and long-term human clinical studies to better define the relationship between pulse consumption and improved glycemic control.

Acute studies of pulse consumption and glycemic response

Pulses have been found to attenuate PBGR, also referred to as the incremental area under the blood glucose response curve (AUC), relative to similar amounts of starchy foods in healthy persons as well as in those with type 2 diabetes. Not only is this inherent property of pulses highly desirable in the management of diabetes, it may also be useful in delaying the onset of overt diabetes in persons with impaired glucose tolerance. The short-term effect of pulses on postprandial glycemia in individuals with diabetes was recently reviewed by Augustin et al in a meta-analysis of 32 acute clinical studies conducted from 1983 to 2003 (12). Trials were examined