Factsheet Plant-based nutrition in (pre-)diabetes

This factsheet provides information on dietary recommendations for diabetes management, which includes the prevention and remission of DM2. It focusses on what existing diabetes guidelines suggest regarding plant-based nutrition and contains findings from scientific research on plant-based nutrition in relation to (pre-)diabetes.

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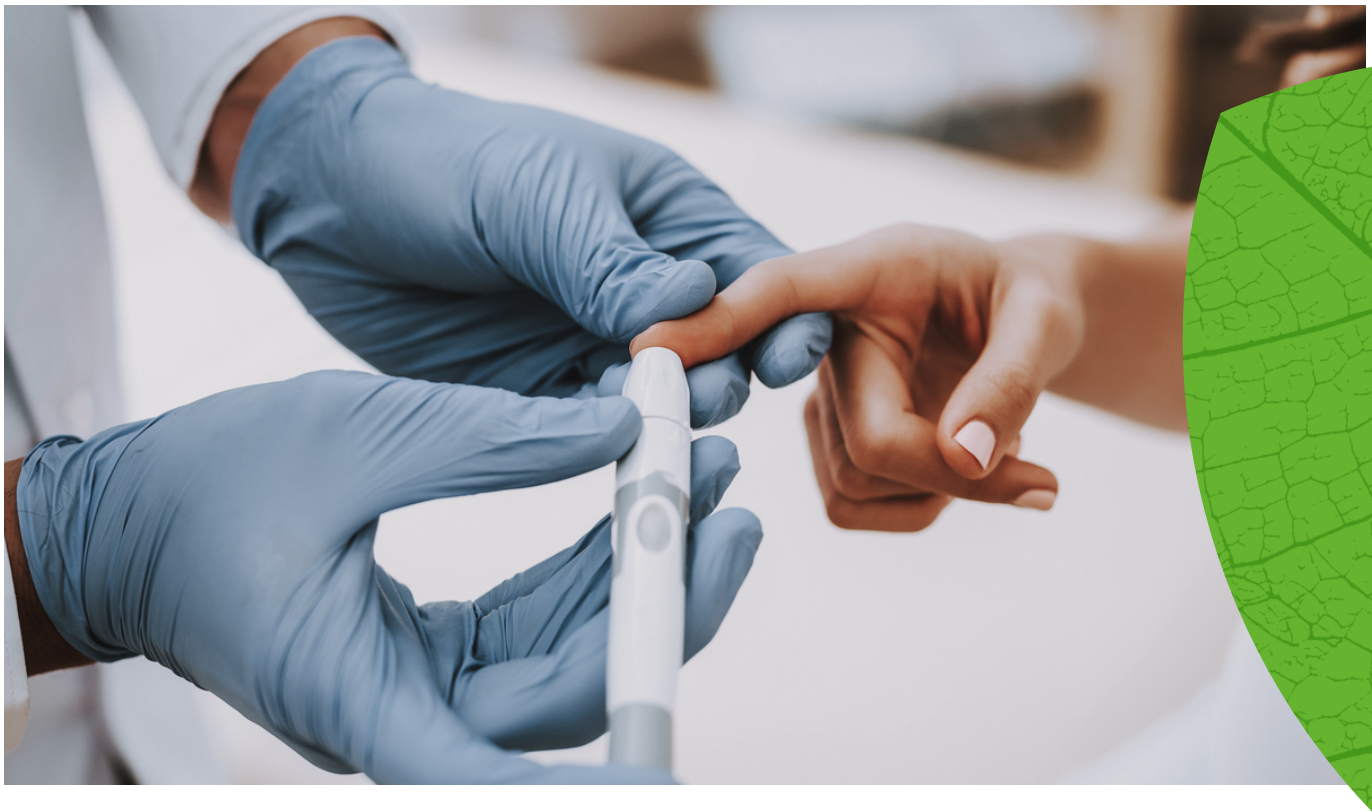
Key messages

- Plant-based foods, including whole grains, vegetables, fruits, legumes, nuts, seeds and plant oils rich in unsaturated fatty acids, are recommended for the dietary management of (pre-) diabetes. Additionally, the consumption of red and processed meat, salt, sugar-sweetened beverages and refined grains should be limited.
- Dietary fibre, found in a wide range of plant-based foods, plays a key role in improving glycaemic control, supporting healthy body weight, and promoting gut health.
- Replacing animal- with plant-based proteins may help reduce the risk of developing type 2 diabetes.
- Vegetarian diets may offer health benefits through lower energy intake, due to increased dietary fibre and reduced saturated fat intake.



In 2021, over half a billion people, approximately 10% of the world's adult population, were estimated to have diabetes mellitus (diabetes), most of whom have type 2 diabetes (DM2). The prevalence of DM2 continues to rise, impacting both quality of life and healthcare systems[1]. Overweight, obesity and low physical activity are key risk factors for (pre-)diabetes. A healthy diet is crucial in diabetes management[2]. Healthy plant-based dietary patterns are gaining attention, not only for their environmental benefits but also for their potential to support overall health and manage diabetes.

(Pre-)diabetes

Diabetes is a metabolic disorder characterised by chronically elevated blood glucose levels (hyperglycaemia). Prediabetes occurs when the body's ability to regulate blood glucose is impaired. Blood glucose levels are higher than normal, but not yet high enough to be classified as diabetes. This increases the risk of developing diabetes. Prediabetes occurs gradually and often remains unnoticed for a long time[3]. In type 1 diabetes (DM1), the body produces little or no insulin, while in DM2, the body does not respond properly to insulin. The rise in DM2 is linked to lifestyle factors, including reduced physical activity and energy overconsumption leading to overweight and insulin resistance. People with diabetes are at higher risk for cardiovascular diseases and damage to the kidneys, eyes, and nerves. For DM1, treatment focuses on lowering blood glucose using insulin. For DM2, it includes other medications and lifestyle recommendations, such as physical activity and a healthy diet, to achieve and maintain a healthy body weight in order to reduce insulin resistance[2].

More information is provided in the Factsheet Diabetes Mellitus.

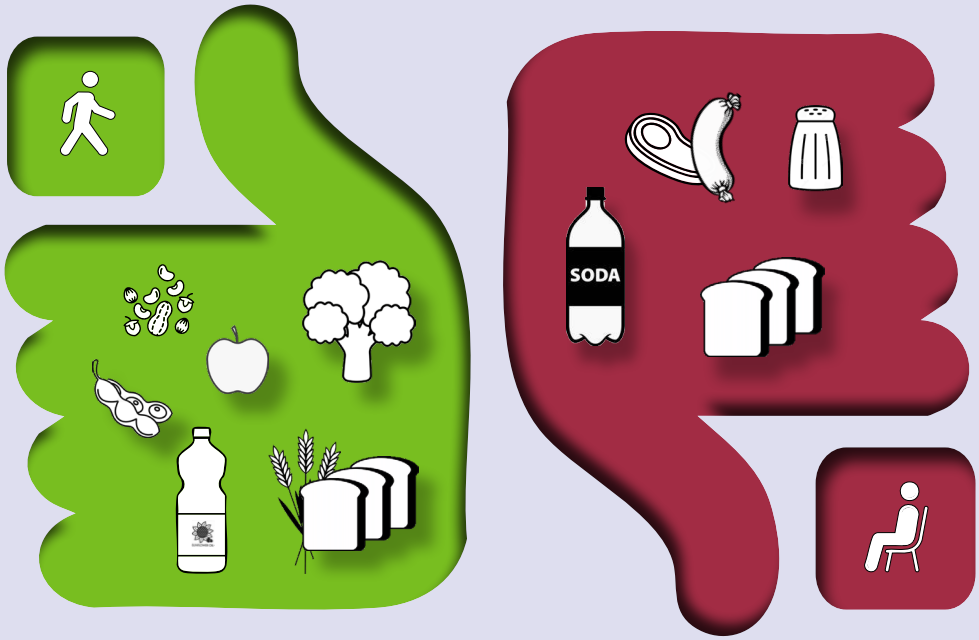


Figure 1. Recommended and limited foods for individuals with (pre-)diabetes, including the advice to maintain an active lifestyle.

Dietary recommendations in guidelines for diabetes management

The Diabetes & Nutrition Study Group (DNSG) of the European Association for the Study of Diabetes (EASD), has published evidence-based European recommendations for the management of DM2[4]. These recommendations are currently the most complete, unbiased and up-to-date guidelines for the dietary management of diabetes. Dutch dietary guidelines for diabetes management are provided by the Netherlands Diabetes Federation (NDF)[5]. The recommendations of the EASD and NDF are briefly explained below with a focus on their suggestions regarding plant-based nutrition. More details are available in the full recommendations by the EASD and NDF[4, 5].

Overall, the EASD and NDF dietary recommendations for diabetes management promote a dietary pattern rich in plant-based foods, such as whole grains, vegetables, fruits, legumes, nuts, seeds and plant oils rich in unsaturated fatty acids. Intake of red and processed meat, salt, sugar-sweetened beverages and refined grains should be minimised[4, 5].

Energy balance and weight management

Sustained weight loss can lead to remission of DM2. Therefore, people with DM2 that are overweight or obese should be supported in achieving and maintaining weight loss. Weight loss can be achieved by a negative energy balance, which can be obtained by combining increased physical activity and reduced energy intake. Several diets, such as high-protein, Mediterranean, or vegetarian diets, can support weight management in people with DM2. Extreme high-carbohydrate or high-fat diets are not recommended for weight loss in individuals with DM2[4].

Carbohydrate intake

For people with diabetes, a wide range of carbohydrate intakes is acceptable, as long as it aligns with recommendations for free or added sugars, saturated fats, and protein intake. Diets with a low glycaemic index (GI) or low glycaemic load are encouraged. Additionally, it is recommended to limit free or added sugars to below 10% of total energy intake[4].

Dietary fibre intake

Dietary fibre is beneficial for overall health, supporting digestive function and contributing to a balanced diet. A dietary fibre intake of at least 35 grams per day is recommended. Fibre is found in a wide variety of plant-based foods, including vegetables, fruits, potatoes, whole grain bread, cereals, legumes, seeds, and nuts. If dietary fibre intake from the diet is insufficient, fibre-enriched foods or supplements should be considered[4].

Protein intake

For people under the age of 65 with DM2 and a normal, stable weight, a 10-20% energy intake from protein is recommended. For older people, a higher protein intake (15-20% of total energy) is recommended. For individuals with moderate diabetic nephropathy, protein intake should be limited to 10-15% of total energy intake[4]. Low caloric diets relatively high in protein can be of benefit to lose weight. No specific recommendation is made regarding the preference for ratio of plant-based and animal-based protein sources. However, the EASD highlights that animal-based protein diets may often exceed recommended saturated fat intake levels. In contrast, plant-based proteins are generally associated with lower serum cholesterol concentrations and better blood glucose control[4].

Dietary fat intake

The primary sources of fat in the diet should be plant-based foods rich in mono- and polyunsaturated fats containing both n-3 and n-6 fatty acids. These include nuts, seeds, and plant oils rich in unsaturated fatty acids (e.g. olive, rapeseed and sunflower). Saturated fats should provide less than 10% of total energy intake, and trans-fats less than 1%[4].

Glycaemic index

The glycaemic index (GI) provides an estimate of the rate at which the glucose concentration in the blood increases over two hours following the intake of 50 grams of carbohydrates. This is then expressed as a percentage compared to 50 grams of a reference (white bread or glucose). A food with a high GI (>70) produces a faster increase in the blood glucose concentration than a food with a low GI (<55). The GI depends not only on the type of carbohydrate, but also, for example, the preparation method, processing of the product and individual factors (gastrointestinal motility, insulin sensitivity, physical activity). In addition, people usually eat a meal that contains not only carbohydrates, but also proteins and fats. This also affects the GI. The glycaemic load adjusts for portion size to predict the blood glucose response[6].

The blood glucose-increasing effect of sucrose (table sugar) is relatively low (glycaemic index = 65 compared to, for example, white rice = 89) because 50 percent of this disaccharide is fructose. With a GI of 15, fructose causes a low increase in the blood glucose concentration[6].

Dietary pattern

Dietary patterns that emphasize the consumption of whole grains, whole vegetables and fruits, legumes, nuts, seeds and plant oils rich in unsaturated fatty acids, while minimising consumption of meat, sugar-sweetened beverages, sweets and refined grains are recommended. These include Mediterranean, Nordic and vegetarian dietary patterns[4].

Scientific background on plant-based diets in (pre-)diabetes

A healthy plant-based diet may offer valuable health benefits and can be a positive choice for individuals with, or at high risk of, DM2. In a plant-based diet, animal-based foods are replaced either fully or partially with plant-based alternatives. Systematic reviews and meta-analyses of observational studies show that plant-based diets, especially when enriched with healthy plant-based foods, are beneficial for lowering the risk of DM2[7,8]. Several systematic reviews and meta-analyses of randomised controlled trials show significantly lowered HbA1c, fasting glucose, low-density lipoprotein cholesterol (LDL-C), body weight, BMI and waist circumference (**Table 1**). These improvements were observed in middle-aged, overweight and obese people with DM2, controlled by medications, who adhere to a vegetarian dietary pattern[9]. No significant effects were observed for fasting insulin, HDL-C, triglycerides and blood pressure[9]. Another systematic review and meta-analysis of observational studies indicated an inverse association of the consumption of a vegetarian diet with DM2 risk[10]. Potential mechanisms which may explain the observed benefits of vegetarian diets may be their lower overall energy content. This is mainly attributed to lower saturated fat and higher fibre content, which promotes weight loss, and in turn, improvements in glycaemic control[9]. Evidence from clinical trials and observational studies also suggests that a higher intake of plant-based diets can lead to short-term weight l oss or help prevent long-term weight gain[8].

More research is needed on the effects of vegetarian diets in individuals with DM1. No definitive recommendations can be made due to the limited available evidence[5].

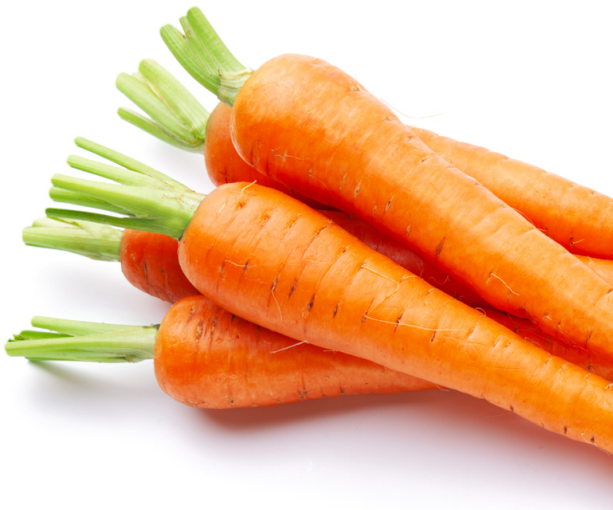


Table 1. Clinical and biochemical markers used in studies to investigate effects of nutrition on diabetes[11].

Type of marker	Marker
Glycaemic control markers	Haemoglobin A1c (HbA1c)
	Fasting blood glucose
Insulin sensitivity and secretion	Fasting insulin
	Homeostasis Model Assessment of Insulin Resistance (HOMA-IR)
	Oral Glucose Tolerance Test (OGTT)
Lipid profile markers	Total cholesterol
	Low-density lipoprotein cholesterol (LDL-C)
	High-density lipoprotein cholesterol (HDL-C)
	Triglycerides
	Apolipoprotein
Inflammation markers	C-reactive protein (CRP)
	Interleukin-6 (IL-6)
	Tumour necrosis factor alfa (TNFa)
Anthropometric markers	Body Mass Index (BMI)
	Waist circumference

Dietary fibre exerts its beneficial effects mainly following their fermentation in the large intestine, and through their effects on water retention, consistency and transit time of the stool. Additionally, its presence may slow down absorption of glucose from the gut, reducing postprandial glycaemic peaks[5]. Several meta-analyses of observational studies show an association of high fibre intake with a lowered risk for DM2[5]. A systematic review and meta-analysis of randomised controlled trials and observational studies indicates that diets high in fibre are important in diabetes management, as these diets improve measures of glycaemic control, blood lipids, body weight, and inflammation in prediabetes, DM1 and DM2[12]. Especially a change from low fibre intake to moderate or high fibre intake showed improvements in glycaemic control[12]. Dietary fibre also contributes to satiety, good digestion and a lowered risk for cardiovascular diseases[5]. Additionally, a fibre-rich diet stimulates the presence of healthy gut microbiota that ferment dietary fibre[5]. Some evidence suggests a possible link between gut microbiota composition and DM2, however further research is needed to better understand this relationship[13]. Most randomised controlled trials investigating the effects of fibre intake in diabetes are performed with fibre supplements containing a single type of fibre. More randomised controlled trials are needed to investigate the effects of fibre-rich foods[5].

Inulin

Inulin-type fructans (ITF) such as inulin and oligofructose occur naturally in foods like chicory root, leeks, onions, wheat, bananas, and garlic. Inulin and oligofructose extracted from chicory roots can also be added to foods as functional ingredients to enhance fibre content, replace digestible sugars or starches and fat, and support digestive health.

Inulin is a non-digestible soluble dietary fibre. Along with fructo-oligosaccharides (FOS) and galacto-oligosaccharides (GOS), inulin belongs to the only prebiotic fibres recognized by the International Scientific Association for Probiotics and Prebiotics (ISAPP)[14]. Inulin passes through the small intestine intact and is fermented as an energy source by the gut microbiota in the large intestine, producing short-chain fatty acids (SCFAs). The non-digestible nature of chicory ITF leads to a low glycaemic response. Thus, rather than causing a rapid increase in blood glucose, inulin can help moderate postprandial blood glucose levels when used as a substitute for high GI carbohydrates[15, 16]. This effect is supported by an EU-authorised health claim, recognizing the benefit of inulin for blood glucose control[17]. Additionally, chicory inulin supports digestive health by improving stool frequency, a claim that is also authorized by the EU[18].

Systematic reviews and meta-analyses of randomised controlled trials have shown that ITF significantly reduce blood glucose for people with prediabetes and diabetes[16, 19]. ITF may also contribute to supporting weight reduction or maintenance, which is a risk factor for DM2. ITF are low in calories and can replace digestible carbohydrates and fat in foods. There is also evidence that inulin reduces body fat by impacting various physiologic processes that influence body weight, notably by modifying the gut microbiota and its metabolism, and thereby may influence hunger and satiety[20, 21].

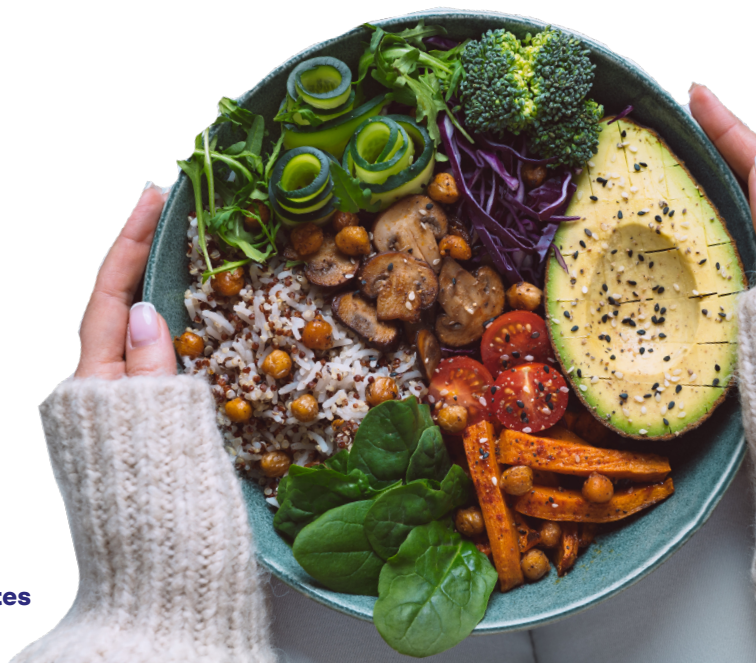
Dietary fibre

There are several types of dietary fibres, each with different functions. Fibres can be classified as either fermentable or non-fermentable. Fermentable fibres are broken down by bacteria in the colon, producing short-chain fatty acids (SCFAs) such as butyrate, which provides energy to the colon cells. Some fermentable fibres, like beta-glucans and pectin, can also help lower LDL-C, supporting cardiovascular health. On the other hand, non-fermentable fibres pass through the digestive system unchanged. These fibres increase stool volume, promoting regular bowel movements, without supplying energy. Fibres can also be classified based on their ability to dissolve in water. Soluble fibres dissolve in water and play a role in regulating digestion. Insoluble fibres act like a sponge by absorbing water, thereby increasing stool volume and promoting regular bowel movements. It is important to note that fibres can have multiple characteristics.
For example, some fibres are both soluble and fermentable (e.g., inulin), while others are insoluble and non-fermentable (e.g., lignin). Both fermentable and non-fermentable fibres are important for health[22].

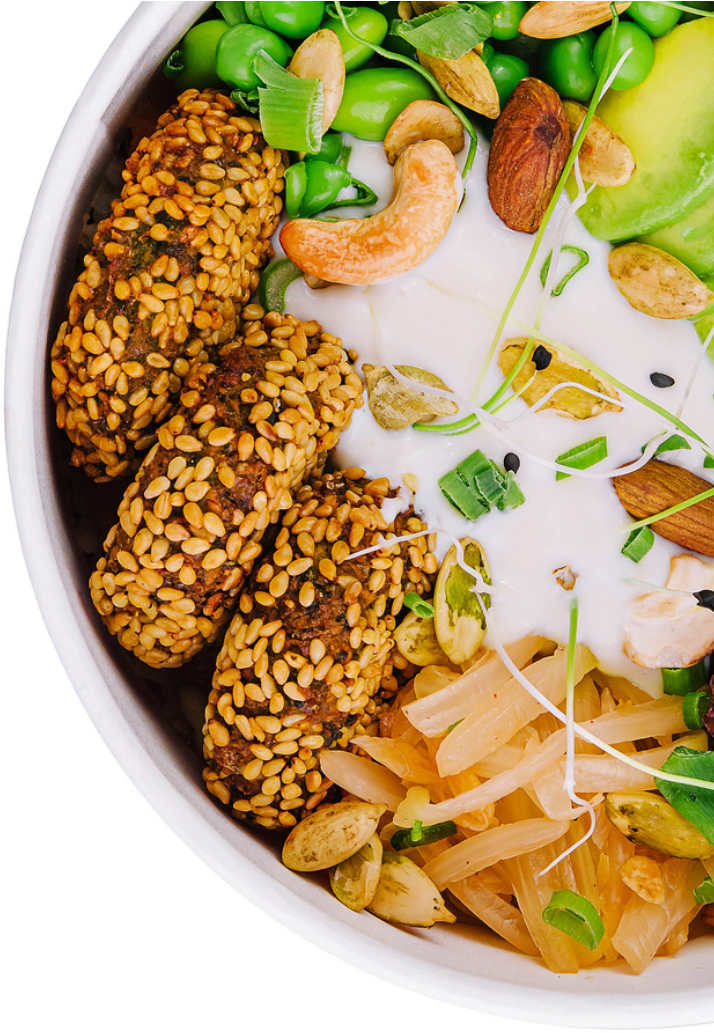
In a plant-based dietary pattern, animal-based protein is fully or partly substituted by plant-based protein. Replacing animal-based protein for plant-based protein sources in the diet usually leads to a higher fibre intake and lower saturated fat intake. A systematic review and meta-analysis of randomised controlled trials showed that HbA1c, fasting blood glucose and fasting insulin were significantly lowered in individuals with DM1 or DM2 that replaced animal with plant-based protein in their diets[23]. Several systematic reviews and meta-analyses of observational studies have found an association between a diet high in plant-based protein and a lower risk of DM2. In contrast, high total protein intake and high animal-based protein intake were associated with a higher risk of DM2[5]. Further research is needed to examine the effects of high plant-based protein intake or replacing animal-based protein with plant-based protein in the context of diabetes[5].

Just like for the general healthy population, a vegetarian diet is considered safe for individuals with diabetes. However, extra attention should be given to ensuring adequate intake of iron, vitamins B1, B2, B12, and calcium. This is especially important for diabetics who are taking metformin, as they have a higher risk for vitamin B12 deficiency[5]. This deficiency can result from altered gut motility, bacterial overgrowth in the small intestine and impaired vitamin B12 absorption. The Netherlands Diabetes Federation does, due to limited evidence, not recommended a vegan diet for people with DM1 or DM2[5].

The results of current randomised controlled trials and observational studies support the need for further research into the inclusion of plant-based diets in diabetes management. Evidence should be strengthened with more high-quality, long-term randomised controlled trials in individuals with or at risk for diabetes.



Conclusions



The intake of healthy plant-based foods is recommended for diabetes management, in particular DM2. Increased fibre intake, whether through whole foods or fibre-enriched foods, is encouraged to support better glycaemic control and overall health. Replacing animal-based with plant-based proteins may help lower the risk of developing DM2. Additionally, plant-based and vegetarian diets may lower the risk of DM2 and improve key clinical and biochemical health markers in individuals with DM2.

While current research shows promising results regarding the benefits of healthy plant-based dietary patterns in diabetes management, more, larger, long-term randomised controlled trials are needed to further clarify the long-term effects and to better understand the mechanisms involved.

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Cosun Nutrition Center, November 2024

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