Chapter 3
Medical Herbs and the Treatment of Diabetes Mellitus: Mechanisms of Action

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ABSTRACT

Diabetes mellitus is a chronic metabolic disorder that affects millions of persons worldwide, and if uncontrolled may cause cardiovascular disease, retinopathy, or chronic kidney disease. Effective therapeutic management of diabetes mellitus involves the use of mainly oral hypoglycemic drugs whose mechanism of action includes improved insulin secretion, reduced insulin resistance, or increased glucose uptake. There is growing exploration of medicinal herbs as potential therapeutic sources for the management of type 2 diabetes mellitus and compared with conventional oral hypoglycemic drugs they have little

DOI: 10.4018/978-1-7998-4808-0.ch003

or no side effects. The aim of this review is to provide up-to-date information on potential medicinal herbs that have demonstrated anti-hyperglycemic activity through either increased secretion of insulin from pancreatic β-cells, reduction of insulin resistance with subsequent increase in insulin sensitivity, or inhibition of intestinal glucose absorption via decreased α-glucosidase activity.

INTRODUCTION

Diabetes mellitus

Diabetes mellitus is a chronic endocrine metabolic syndrome described by hyperglycemia (higher levels of blood glucose) and glucose intolerance due to deficiencies in insulin secretion or impairment in insulin's action (American Diabetes Association, 2009). It is classified into two main types, type 1 diabetes mellitus and type 2 diabetes mellitus.

Type 1 diabetes is caused by the destruction of insulin producing pancreatic islet β-cells with resultant insulin deficiency and increased tendency for ketoacidosis. Pancreatic islet β-cell destruction is largely attributable to an autoimmune process, but other unknown mechanisms have been described (Punthakee et al., 2018). Type 2 diabetes mellitus is defined by peripheral insulin resistance with relative insulin deficiency or impaired insulin secretion (Punthakee et al., 2018). Type 2 diabetes mellitus presents with increased demand for insulin. There is an inability of insulin target tissues to respond or progressive failure of pancreatic islet β-cells (Halban et al., 2014).

The chronic hyperglycemic milieu associated with diabetes mellitus can affect many vital organs in the body and cause considerable complications such as blindness, stroke, lower extremity amputations, kidney disease, heart failure and may lead to death (World Health Organization, 2018). Epidemiological data indicate that over 700 million people will be affected by diabetes mellitus in 2045, (International Diabetes Foundation, 2019). Global estimates suggest that the mortality burden of diabetes mellitus is over one million deaths annually (Khan et al., 2020). Diabetes mellitus was also ranked the seventh leading cause of death for the year 2016 (World Health Organization, 2018). As such, it is imperative to conduct more extensive research on the prevention and management of diabetes mellitus for improved patient outcomes.

In recent years, the pharmacologic armamentarium for the treatment of diabetes mellitus has considerably advanced but maintaining well controlled glucose levels is an ongoing challenge. The management of diabetes mellitus is largely dependent on the type of diabetes mellitus present. There are a number of oral antidiabetic conventional drugs that are employed in the control and management of diabetes mellitus. These include (i) Drugs that promote the release of insulin from pancreatic islet β-cells such as sulfonylurea-type (e.g. glibenclamide, glipizide, tolazamide and glimepiride), (ii) Drugs which improve insulin sensitivity by lowering resistance such as thiazolidinediones (e.g. pioglitazone and rosiglitazone), (iii) Drugs that reduce the production and release of glucose from the liver, and increase the sensitivity of peripheral tissues to insulin such as biguanides (e.g. metformin), (iv) Drugs that decrease glucose reabsorption via the intestine by inhibition of α-glucosidase (e. g. acarbose and miglitol) and (v) Drugs known as glucagon-like peptide 1 receptor agonists whose mechanism of action include the lowering