Effect of cinnamon on blood glucose and lipids in patients with type 2 diabetes

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List of abbreviations

ACE	Angiotensin converting enzyme
ADA	American Diabetes Association
BMI	Body mass index
CAD	Coronary artery disease
CAM	Complementary and alternative medicine
CHD	Coronary heart disease
COX	Cyclooxygenase
ESRD	End stage renal disease
GFR	Glomerular filtration rate
GLA	Gamma linolenic acid
GDM	Gestational diabetes mellitus
GSK-3	Glycogen synthase kinase-3
GTF	Glucose tolerance factor
GTT	Glucose tolerance test
HbA_{1C}	Hemoglobin A_{1C}
HDL	High-density lipoprotein
IDDM	Insulin-dependent diabetes mellitus
IDL	Intermediate-density lipoprotein
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
IU	International unit
LDL	Low-density lipoprotein
MHCP	Methylhydroxychalcone polymer
MODY	Maturity-onset diabetes of the young
n	number
NO	Nitric oxide
RCT	Randomized controlled trial
STZ	Streptozotocin
TxA2	Thromboxane-A2
TZDs	Thiazolidinediones
VLDL	Very low density lipoprotein
WHO	World Health Organization

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Abstract

Spices such as cinnamon display insulin-enhancing activity in vitro and its aqueous extracts have been shown to increase in vitro glucose uptake and glycogen synthesis. Recent clinical studies reported decrease in blood glucose and lipids in patients with type 2 diabetes with the intake of cinnamon daily (i.e. cinnamon may be beneficial for type 2 diabetic patients due to its hypoglycemic and hypolipidemic effects).

Key words:

Type 2 diabetes
Cinnamon
Blood glucose
Blood lipids

INTRODUCTION

Type 2 diabetes has reached epidemic proportions in the United States and worldwide (>18 million and 160 million individuals, respectively), and is projected to increase dramatically **(Zimmet et al, 2001)**.

Furthermore, the prevalence of insulin resistance, a major causative factor in the early development of type 2 diabetes and an independent risk factor for cardiovascular disease and the metabolic syndrome X, is even more widespread **(Reaven , 2000; Reaven 1988; DeFronzo , 1997)**.

This situation is further exacerbated by obesity, a major risk for developing type 2 diabetes. The number of adults overweight or obese in the US is 125 million (65% of population) and 1.3 billion worldwide **(Hill et al, 2003)**.

Since dietary modification and increased physical activity provide insufficient glucose control over the long-term course of the disease, the vast majority of patients require some type of pharmacological intervention **(Turner et al, 1999).**

Although pharmacological options for the management of type 2 diabetes have been increasing, and will continue to do so **(DeFronzo, 1999)**, not all patients benefit from them. In addition, the

cost of prescription medications may exceed the financial capacity of an increasing number of older citizens, those without adequate health insurance, and those living in poverty **(Fuhr et al, 2005 and Altman et al, 2002).**

Furthermore, certain ethnic groups who are at increased risk for developing diabetes (e.g. Asians, Hispanics, and Native Americans), come from cultures with a long history of use of traditional medicines, and are likely to employ one or more folk (botanical) treatments rather than prescription medications **(Dham et al, 2006).**

Plant derivatives with purported hypoglycemic properties have been used in folk medicine and traditional healing systems around the world (e.g., Native American Indian, Jewish **(Yaniv et al, 1987)**, Chinese **(Covington, 2001)**, East Indian, Mexican). Many modern pharmaceuticals used in conventional medicine today also have natural plant origins. Among them, metformin was derived from the flowering plant, *Galega officinalis* (Goat's Rue or French Lilac), which was a common traditional remedy for diabetes **(Pandey et al, 1995 and Oubre et al, 1997)**. Similarly, the use of vitamin and mineral supplements for primary or secondary disease prevention is of increasing interest **(O'Connell, 2001).**

To date, the anti-diabetic activities of well over 1200 traditional plants has been reported, although scant few have been subjected to rigorous scientific evaluation for safety and efficacy in humans **(Oubre et al, 1997)**.

The incidence of cardiovascular diseases is increased two- to fourfold in people with type 2 diabetes **(Raza and Movahed, 2003).** Although the causes of type 2 diabetes and cardiovascular diseases are multifactorial, diet definitely plays a role in the incidence and severity of these diseases. The dietary components beneficial in the prevention and treatment of these diseases have not been clearly defined, but it is postulated that spices may play a role. Spices such as cinnamon, cloves, bay leaves, and turmeric display insulin-enhancing activity in vitro **(Khan et al, 1990 and Brodhurst et al, 2000).**

Botanical products can improve glucose metabolism and the overall condition of individuals with diabetes not only by hypoglycemic effects but also by improving lipid metabolism, antioxidant status, and capillary function **(Bailey and Day, 1989).**

Aqueous extracts from cinnamon have been shown to increase in vitro glucose uptake and glycogen synthesis and to increase phosphorylation of the insulin receptor; in addition, these cinnamon extracts are likely to aid in triggering the insulin cascade system **(Imparl-Radosevich, 1998 and Jarvil-Taylor et al, 2001).**

Aim of work

The aim of this work is to study the effect of cinnamon on blood glucose and lipids of patients with type 2 diabetes.

Review of literature

Definition of diabetes

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage, dysfunction, and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels **(American Diabetes Association, 2006a).**

Criteria for the diagnosis of diabetes mellitus

1. Symptoms of diabetes plus casual plasma glucose concentration ≥ 200 mg/dl (11.1 mmol/l). Casual is defined as any time of day without regard to time since last meal. The classic symptoms of diabetes include polyuria, polydipsia, and unexplained weight loss.

OR

2. FPG ≥126 mg/dl (7.0 mmol/l). Fasting is defined as no caloric intake for at least 8 h.

OR

3. 2-h postload glucose ≥200 mg/dl (11.1 mmol/l) during an OGTT. The test should be performed as described by WHO, using a glucose load containing the equivalent of 75 g anhydrous glucose dissolved in water.

In the absence of unequivocal hyperglycemia, these criteria should be confirmed by repeat testing on a different day. The third measure (OGTT) is not recommended for routine clinical use **(American Diabetes Association, 2006a).**

Etiological classification of diabetes mellitus

I. Type 1 diabetes

(ß-cell destruction, usually leading to absolute insulin deficiency)

A. Immune mediated

B. Idiopathic

II. Type 2 diabetes (may range from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with insulin resistance)

III. Other specific types

A. Genetic defects of ß-cell function

1. Chromosome 12, HNF-1$_\alpha$ (MODY3)
2. Chromosome 7, glucokinase (MODY2)
3. Chromosome 20, HNF-4$_\alpha$ (MODY1)
4. Chromosome 13, insulin promoter factor-1 (IPF-1; MODY4)
5. Chromosome 17, HNF-1ß (MODY5)
6. Chromosome 2, *NeuroD1* (MODY6)
7. Mitochondrial DNA 8. Others

B. Genetic defects in insulin action

Type A insulin resistance, Leperchaunism, Rabson-Mendenhall syndrome and lipoatrophic diabetes.

C. Diseases of the exocrine pancreas

Pancreatitis, trauma, pancreatectomy, neoplasia, cystic fibrosis, hemochromatosis, fibrocalculous pancreatopathy and others.

D. Endocrinopathies

Acromegaly, Cushing's syndrome, glucagonoma, pheochromocytoma, hyperthyroidism, somatostatinoma, aldosteronoma and others.

E. Drug- or chemical-induced

Vacor, pentamidine, nicotinic acid, glucocorticoids, thyroid hormone, diazoxide, β-adrenergic agonists, thiazides, dilantin, interferon and others.

F. Infections

Congenital rubella, cytomegalovirus and others.

G. Uncommon forms of immune-mediated diabetes

1. "Stiff-man" syndrome
2. Anti–insulin receptor antibodies 3. Others

H. Other genetic syndromes sometimes associated with diabetes

Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Wolfram's syndrome, Friedreich's ataxia, Huntington's chorea, Laurence-Moon-Biedl syndrome, myotonic dystrophy, porphyria, Prader-Willi syndrome and others.

IV. Gestational diabetes mellitus (GDM)

GDM is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. The definition applies regardless of whether insulin or only diet modification is used for treatment or whether the condition persists after pregnancy. It does not exclude the possibility that unrecognized glucose intolerance may have antedated or begun concomitantly with the pregnancy. GDM complicates ~4% of all pregnancies in the U.S., resulting in ~135,000 cases annually. The prevalence may range from 1 to 14% of pregnancies, depending on the population studied. GDM represents nearly 90% of all pregnancies complicated by diabetes. Deterioration of glucose tolerance occurs normally during pregnancy, particularly in the 3rd trimester **(American Diabetes Association, 2006a).**