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Review

The hypoglycaemic effect of pumpkins as anti-diabetic and functional medicines

Gary G. Adams [a,d,*], Shahwar Imran [a,d], Sheng Wang [a,d], Abubaker Mohammad [a], Samil Kok [b], David A. Gray [c], Guy A. Channell [c], Gordon A. Morris [d], Stephen E. Harding [d]

[a] Insulin and Diabetes Experimental Research (IDER) Group, University of Nottingham, Faculty of Medicine and Health Science, Clifton Boulevard, Nottingham, NG7 2RD UK
[b] Department of Food Engineering, Abant Izzet Baysal University, Bolu, Turkey
[c] University of Nottingham, School of Biosciences, Food Sciences, Sutton Bonington, LE12 5RD UK
[d] University of Nottingham, School of Biosciences, National Centre Macromolecular Hydrodynamics, Sutton Bonington, LE12 5RD UK

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ABSTRACT

Diabetes mellitus is considered as a common, growing, serious, costly, and potentially preventable public health problem. In 2030, the number of people with diabetes is estimated to increase from 117 million in 2000 to 366 million. The prevalence of diabetes has and will continue to have burden on the health and finances of economic climates, which in turn, will impact on individuals, families and nations. There are many different types of insulins available to treat diabetes, but there are still physiological consequences for such use. Alternatives are, therefore, required and this includes herbal preparations as well as dietary plants in the form of *curcubitaceae* (pumpkin).

Pumpkin is widely considered to have active hypoglycaemic properties. Pumpkin is a plant, which has been used frequently as functional food or medicine and belongs to the family Cucubitaceae, and consists of succulent stem with numerous seeds. Based on previous evidence of its fruit pulp, it is reported to have anti-diabetic effects.

This review has focused on the main medicinal properties of pumpkin and how this has been used in animal models, and point out areas for future research to further elucidate mechanisms whereby this compound may reduce disease risk.

Contents

1. Introduction

Cucurbitaceae is a plant family generally considered to consist of melons, cucurbits and pumpkins. Polysaccharides, proteins and peptides, para-aminobenzoic acid, and sterols are biologically active components, which are contained within pumpkins (Appendino, Jakupovic, Belloro, & Marchesini, 1999; Kuhlmann, Koetter, & Theurer, 1999). The leaves of pumpkins contain phytochemicals such as phenolic glycosides, 13-hydroxy-9Z, 11E-octadecatrienoic acid, in addition to proteins from germinated seeds (Bang et al., 2002; Koike, Li, Liu, Hata, & Nikaido, 2005). Much research has been written on the medicinal activities of these polysaccharides and proteins such as: 1) antibacterial (Hammer, Carson, & Riley, 1999); 2) hypocholesterolaemic and anti-oxidant (Kong, 2000); 3) immunomodulatory (Xu, 2000); 4) antimutagenic (Ito, Maeda, & Sugiyama, 1986); 5) anthelmintic (Diaz Obregon, Lloja, Lozano, & Carbajal Zuniga, 2004) and 6) anticancer properties (Xie, 2004). Despite the volume of research published, however, this

* Corresponding author at: Insulin and Diabetes Experimental Research (IDER) Group, University of Nottingham, Faculty of Medicine and Health Science, Clifton Boulevard, Nottingham, NG7 2RD UK. Tel.: +44 115 8230901; fax: +44 115 8230999.
E-mail address: Gary.adams@nottingham.ac.uk (G.G. Adams).

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review will only focus on the use of the hypoglycaemic properties of pumpkins for patients, who present with diabetes mellitus.

1.1. The prevalence of DM

In 2004, Wild presented the global prevalence of DM in 2000 and provided estimated projections for 2030 and stated that the number of diabetes patients would increase during the next 30 years (Wild, Roglic, Green, Sicree, & King, 2004). The most dramatic increases would happen in the Middle Eastern Crescent, sub-Saharan Africa, and India. In developed countries such as most areas in Europe, the majority of people with diabetes are older than 65; but in developing countries, most people with diabetes are aged between 45 and 64 years (Cockram, 2000). Wild et al. (2004) estimated that the number of people, who are older than 64 years of age with diabetes, will account for more than 82 million in developing countries by 2030; in developed countries this will be more than 48 million.

As is shown in Table 1, the 10 countries estimated to have the highest numbers of people with diabetes in 2000 and 2030 are listed. In both 2000 and 2030, the top three countries remain the same: India, China and U.S.A., Bangladesh, Brazil, Indonesia, Japan and Pakistan still appear in the top 10 lists from 2000 to 2030. The Russian Federation and Italy are in the list of 2000 but in 2030, it is envisaged that these will be replaced by Philippines and Egypt.

1.2. The burden of DM on health and economy

DM is a metabolic disorder caused by multifarious aetiologies (Alberti, Zimmet, & Shaw, 2006), including disturbances of carbohydrate, fat and protein metabolism (Fowler, 2010). The root cause is the defect in insulin secretion, insulin action, or both. Dysfunction, long-term damage and failure of various organs, especially the eyes, nerves, kidneys, heart, and blood vessels, can be affected by DM (ADA, 2010). People with diabetes are at increased risk of cardiovascular and cerebrovascular disease (CVS/CVD), new cases of end-stage renal disease (ESRD), lower-limb amputations, blindness and even death (ADA, 2007).

Gregg et al. (2000) and associates analyzed data on 6588 individuals (3475 women and 3113 men) with a history of diabetes, and U.S. civilians older than 60 years old (Gregg et al., 2000). The data was concerned with their health status and physical disability, and was carried out by five consecutive cross-sectional national surveys: National Health Examination Survey I (1960–1962), National Health and Nutrition Examination Survey (NHANES) I (1971–1974), NHANES II (1976–1980), NHANES III (1988–1994), and NHANES 1999–2000.

It is apparent that people with diabetes are more likely to have fair or poor health, cardiovascular diseases, and visual impairment compared to patients without diabetes. Diabetes mellitus also places a financial burden on the family as well as the nation. For people with diabetes, it influences the quality of life (QoL) and forces lifestyle changes such as the monitoring of blood glucose on a daily basis (Smyth & Heron, 2005). The total estimated cost of diabetes in the U.S. in 2007 was $ 174 billion, including $ 116 billion in excess medical expenditure and $58 billion in reduced national productivity (ADA, 2008). For a low-income country, for example Mexico, in 2005 the cost for diabetes was $ 317 million and the direct and indirect costs were approximately $140 and $177 million, respectively (Arredondo & Zuniga, 2004).

Table 1
List of countries with the highest numbers of estimated cases of diabetes for 2000 and 2030 (Wild et al., 2004).

Ranking	2000		2030	
	Country	People with diabetes (millions)	Country	People with diabetes (millions)
1	India	31.7	India	79.4
2	China	20.8	China	42.3
3	U.S.	17.7	U.S.	30.3
4	Indonesia	8.4	Indonesia	21.3
5	Japan	6.8	Pakistan	13.9
6	Pakistan	5.2	Brazil	11.3
7	Russian Federation	4.6	Bangladesh	11.1
8	Brazil	4.6	Japan	8.9
9	Italy	4.3	Philippines	7.8
10	Bangladesh	3.2	Egypt	6.7

Table 2
Diagnostic thresholds for diabetes and lesser degrees of impaired glucose regulation (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2003).

Category	Test	
	FPG	2-h PG
Normal	<100 mg/dl (<5.6 mmol/l)	<140 mg/dl (<7.8 mmol/l)
IFG	100–125 mg/dl (5.6–6.9 mmol/l)	–
IGT	–	140–199 mg/dl (7.8–11.0 mmol/l)
Diabetes	≥126 mg/dl (≥7.0 mmol/l)	≥200 mg/dl (≥11.1 mmol/l)

1.3. Diagnosis and classification of diabetes

After a series of deliberations, the new diagnostic criteria for diabetes including impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) are recommended by the Expert Committee (Gavin et al., 1997). The range of fasting plasma glucose FPG levels between normal and diabetes was called "IFG", and that range for 2-h PG was named "IGF". IGF is between 100 and 125 mg/dl of FPG, and IGF is 140–199 mg/dl of 2-h PG (Table 2). As is shown in Table 2, normal fasting plasma glucose (FPG) is less than 110 mg/dl (5.6 mmol/L), and the cut-off point to separate diabetes and non-diabetes is an FPG ≥ 126 mg/dl (7.0 mmol/L) or a 2-hour post-load plasma glucose (2-h PG) ≥ 200 mg/dl (11.1 mmol/L). During the diagnosis of a patient with diabetes, it is important to distinguish a person presenting with gross hyperglycaemia and severe symptoms (Table 3) from an asymptomatic person more than one result is required to confirm the lower diabetic range (ADA, 2010).

1.4. Classification

1.4.1. Type 1 diabetes mellitus (T1DM)

T1DM is caused by β-cell destruction, and leads to absolute insulin deficiency (Cryer, Davis, & Shamoon, 2003), and this type of diabetes only accounts for 5–10% of those with diabetes (ADA, 2010). Because T1DM patients develop an absolute deficiency, they must depend on exogenous insulin (Atkinson & Eisenbarth, 2001). T1DM can be classified as immune-mediated diabetes (type 1A) and idiopathic diabetes (type 1B), and only a minority of patients with T1DM belong

Table 3
Criteria for the diagnosis of the diagnosis of diabetes (American Diabetes ADA, 2010).

1. A1C ≥ 6.5%. The test should be performed in a laboratory using a method that is certified by the National Glycohaemoglobin Standardization Program (NGSP) and standardized to the DCCT assay.

OR

2. FPG ≥ 126 mg/dl (7.0 mmol/l). Fasting is defined as on caloric intake for least 8 h.

OR

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

OR

4. In a patient with classic symptoms of hyperglycaemia or hyperglycaemic crisis, a random plasma glucose ≥ 200 mg/dl (11.1 mmol/l).