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Anti-diabetic Effects of *Cucumis sativus* (Cucumber) on Type 2 Diabetes mellitus

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Abstract

Type 2 diabetes mellitus (T2DM) is a widespread metabolic disorder characterized by chronic hyperglycemia, insulin resistance, and associated oxidative stress. Patients increasingly seek dietary supplements and herbal therapies to aid glycemic control. *Cucumis sativus* (cucumber) is a common Cucurbitaceae vegetable traditionally used for its cooling, diuretic and folk medicinal properties. Although other cucurbit-family plants (e.g. bitter melon) show anti-diabetic activity, the clinical evidence for cucumber in T2DM remains scant. This narrative review summarizes human-based studies (≤2020) of cucumber's glycemic effects, and explores putative mechanisms via cucumber phytochemicals. No dedicated clinical trial of cucumber supplementation in T2DM has been reported up to 2020, and indirect human data are limited. In vitro and animal studies suggest cucumber extracts mitigate oxidative stress and glycation, and identified flavonoids (kaempferol, quercetin, apigenin) that modulate glucose metabolism. Kaempferol, isolated from cucumber, improves insulin signaling and inhibits hepatic gluconeogenesis. Quercetin, another cucumber flavonoid, inhibits DPP-IV (prolonging incretin action) and suppresses pro-inflammatory cytokines. These mechanisms could in principle blunt postprandial hyperglycemia. However, the therapeutic potential of cucumbers in T2DM is limited by the absence of clinical trial evidence, low bioactive content in the edible fruit, and the modest scale of any effects. More rigorous studies in diabetic patients are needed to confirm whether regular cucumber consumption or extracts can meaningfully improve glycemic control.

Key Words: Anti-diabetic, *Cucumis sativus*, Diabetes mellitus

Introduction

Type 2 diabetes mellitus is a major and growing public health problem worldwide. Its prevalence was estimated at 285 million adults in 2010, projected to rise to 439 million by 2030. Chronic hyperglycemia in T2DM leads to microvascular (retinopathy, nephropathy, neuropathy) and macrovascular (heart disease) complications, driven in part by oxidative and carbonyl stress. Conventional antidiabetic drugs (e.g. insulin, metformin, sulfonylureas) are effective but have side effects and cost issues, prompting interest in adjunct dietary or herbal interventions. *Cucumis sativus* L. (cucumber) is a member of the Cucurbitaceae family, cultivated globally for its elongated green fruit (botanically a pepo). In traditional medicine, cucumber fruits and seeds have been used as diuretics and cooling agents, and sometimes recommended for diabetes, high blood pressure and other conditions. Laboratory studies (mainly in animals or cell models) have reported anti-hyperglycemic effects of various cucurbit species; cucumber fruit extracts have shown some ability to lower blood sugar in diabetic rodents. However, the specific anti-diabetic efficacy of cucumber in humans with T2DM is unclear.

This review aims to examine the literature up to the end of 2020 for evidence of anti-diabetic effects of *C. sativus* in humans with type 2 diabetes. We focus on clinical or observational studies involving diabetic patients, and on possible mechanisms mediated by cucumber's nutrients or phytochemicals. We also discuss therapeutic potential and limitations of cucumber use in diabetes management.

Methods

A narrative literature search was conducted in PubMed, Google Scholar, and Web of Science for articles on "*Cucumis sativus*" or "cucumber" and "type 2 diabetes", "hypoglycemic", or "glycemic control", up to December 2020. Only human studies (clinical trials, cohort studies, case reports) were included. Preclinical (animal or in vitro) studies were reviewed for mechanistic insights (e.g. identification of active constituents or biochemical pathways) but were not counted as clinical evidence. We also examined reviews and ethnobotanical reports on cucumber's metabolic effects. Relevant findings were extracted and organized into an Introduction, Methods, Results (clinical evidence), Discussion (mechanisms and implications), and Conclusion.

Results

Clinical Evidence in Type 2 Diabetes

Surprisingly, no randomized controlled trials (RCTs) have been published (≤2020) that test cucumber consumption or supplementation for glycemic outcomes in T2DM patients. In fact, systematic searches and hand-review of journals up to 2020 reveal an absence of dedicated human trials where diabetic subjects were administered cucumber juice, extract, or preparations with primary endpoints of blood glucose or HbA1c.

One small clinical study in healthy volunteers (not diabetic) showed that consuming large volumes of cucumber juice alongside a carbohydrate meal attenuated the postprandial glucose rise, suggesting an "anti-hyperglycemic" effect in non-diabetics. However, this result was in normoglycemic individuals and thus may not directly extrapolate to T2DM. Similarly, a 2017 RCT in mildly hyperlipidemic but non-diabetic adults found that daily cucumber seed extract (from *C. sativus* seeds) for 6 weeks significantly lowered total and LDL cholesterol compared to placebo. This trial did not report changes in blood glucose, but it demonstrates that cucumber-derived preparations can improve metabolic risk markers in humans. Outside of these, most "clinical" data on cucumber and glycemia comes from dietary advice (recommending cucumber as a low-calorie vegetable for diabetics) or isolated case reports, none of which provide strong evidence. In summary, clinical evidence for cucumber's glucose-lowering effect in T2DM is essentially lacking. There is a report of combined resistance training and cucumber juice improving glucose and lipids in women with T2DM, but this was published in 2023 (beyond our cutoff) and included exercise as a co-intervention.

Thus, based on human studies alone, we cannot conclude that cucumber has any proven anti-diabetic effect. At best, cucumber may form part of a healthy diet (being low in carbohydrates and high in water), but no human trial has isolated its specific impact on glycemic control in diabetes.

Discussion

Nutritional Profile and Phytochemicals

Although clinical trials are lacking, cucumber's biochemical composition suggests several mechanisms by which it could influence glucose metabolism. Cucumber fruits are ~95% water with very low calories (≈16 kcal/100g) and modest macronutrients: about 3.6 g carbohydrates (≈1.7 g sugars, 0.5 g fiber) and negligible fat per 100 g. They provide micro-nutrients including potassium, magnesium, vitamin C, and vitamin K. Dietary potassium may improve blood pressure (often elevated in T2DM), and magnesium is a cofactor for insulin signaling, but these effects are general nutritional benefits rather than unique properties of cucumber.

More relevantly, cucumbers contain polyphenolic antioxidants. Phytochemical analyses have identified several flavonoids in cucumber fruit extracts, notably kaempferol, quercetin, and apigenin. These compounds have documented anti-diabetic activities in various models. For example, kaempferol (a flavonol) was isolated from cucumber and shown to account for its enzyme-inhibitory and glucose-lowering effects in diabetic rats. In humans and animal models, kaempferol has been demonstrated to suppress hepatic gluconeogenesis: it directly inhibits pyruvate carboxylase (a key gluconeogenic enzyme) and downregulates glucose-6-phosphatase, leading to reduced hepatic glucose output. Kaempferol also enhanced Akt-mediated insulin signaling and hexokinase activity in liver, improving systemic insulin sensitivity. In other words, kaempferol promotes glucose utilization and lowers basal glucose production.

Quercetin (another abundant flavonol) has multiple anti-diabetic actions. It improves glucose tolerance and β-cell insulin secretion, and inhibits carbohydrate-digesting enzymes α-glucosidase and dipeptidyl-peptidase-IV (DPP-IV). In particular, quercetin's DPP-IV inhibition prolongs incretin hormones (GLP-1, GIP), enhancing insulin release. A recent mechanistic study confirmed that quercetin strongly inhibits DPP-IV (even more effectively than standard drugs like sitagliptin) and reduces oxidative stress markers. Quercetin also downregulates inflammatory cytokines (IL-1β, IL-6, TNF-α), which is relevant because T2DM is a state of chronic inflammation.

Apigenin, a flavone found in cucumber, has modest glucose-lowering effects as well, primarily via anti-inflammatory and antioxidant pathways. While apigenin's role in diabetes is less studied than kaempferol/quercetin, it is known to protect pancreatic β-cells and improve insulin sensitivity in some models.

Beyond flavonoids, other cucumber constituents may help. The antioxidative vitamins (e.g. vitamin C) and phenolic content can scavenge reactive oxygen species and decrease protein glycation that is accelerated in hyperglycemia. In vitro, cucumber fruit extract prevented hepatocyte injury induced by glyoxal or cumenehydroperoxide (models of carbonyl and oxidative stress), normalizing glutathione levels and reducing lipid peroxidation. This suggests cucumber compounds protect cells from diabetes-related oxidative damage, potentially slowing complications. Moreover, some cucurbitane-type triterpenoids (cucurbitacins) are present in Cucurbitaceae plants; although common cucumbers are bred to lack bitter cucurbitacins, residual levels may confer anti-inflammatory effects.

Putative Mechanisms of Action

- Enzyme inhibition: cucumber flavonoids (especially kaempferol) inhibit α-amylase and α-glucosidase.
- Improved insulin signaling via Akt/PI3K pathways.
- Reduced hepatic glucose output via inhibition of gluconeogenic enzymes.
- DPP-IV inhibition (quercetin) extends incretin action.
- Antioxidant activity (quenching ROS) and anti-inflammatory effects.

Therapeutic Potential and Limitations

Cucumber is non-toxic, low-calorie, and nutrient-dense. While animal and biochemical studies support its potential benefits in glucose metabolism, there is no direct human trial confirming its anti-diabetic effect as of 2020. Bioavailability, required dosage, and cultivar variability remain issues. More clinical research is essential before any therapeutic claims can be justified.

Conclusion

Human data on *Cucumis sativus* as an antidiabetic intervention are virtually nonexistent through 2020. While cucumber contains bioactive flavonoids (kaempferol, quercetin, etc.) that have demonstrated glucose-lowering and insulin-sensitizing actions in preclinical models, these findings remain to be confirmed in diabetic patients. Only indirect clinical evidence is available. Consequently, the therapeutic potential of cucumber in T2DM is largely speculative at present. Well-designed clinical trials are needed to determine whether regular cucumber intake or concentrated cucumber extracts can meaningfully improve glycemic control in type 2 diabetes.

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