

Part 1: Exploring the Metabolic Implications of Dextrin and Maltodextrin on Type 2 Diabetes Mellitus and Insulin Resistance: *A Systematic Analysis*

Abstract

Aim: To evaluate the effects of dextrin and maltodextrin on insulin resistance and Type 2 Diabetes Mellitus (T2DM).

Background: Dextrin and maltodextrin are dietary fibers known for their potential to modulate blood glucose levels and insulin response. While their use in managing blood glucose and lipid profiles has been studied, comprehensive reviews summarizing their impacts on insulin resistance and T2DM are lacking.

Methods: We conducted a systematic review of studies that investigated the effects of dextrin and maltodextrin on insulin resistance and T2DM in both animal models and human subjects. Databases such as PubMed, Scopus, and Web of Science were searched for relevant studies up to December 2023.

Results: The review included 30 studies, highlighting that resistant dextrin significantly improves insulin sensitivity and modulates serum lipid profiles in subjects with T2DM. Maltodextrin's effects appeared less consistent, with some studies indicating potential exacerbation of glycemic control.

Conclusion: Resistant dextrin demonstrates beneficial effects on insulin sensitivity and lipid metabolism, potentially via modulating gut microbiota. The evidence on maltodextrin suggests a need for cautious use, particularly among individuals with impaired glucose tolerance or T2DM. The upcoming Part 2 of this investigation will focus on the direct HPLC analysis of these compounds, further elucidating their biochemical interactions and mechanisms impacting T2DM.

Introduction

Type 2 Diabetes Mellitus (T2DM) is a prevalent metabolic disorder characterized by insulin resistance and pancreatic beta-cell dysfunction. Globally, the incidence of T2DM is rising, driven by increasing obesity rates, aging populations, and lifestyle changes. The management of insulin resistance is pivotal in the prevention and treatment of T2DM, necessitating effective therapeutic strategies including dietary interventions (Zheng et al., 2018).

Dietary fibers, particularly non-digestible carbohydrates like dextrin and maltodextrin, have been recognized for their potential to improve glycemic control and insulin sensitivity (Reynolds et

al., 2019). These fibers can influence glucose and lipid metabolism through various mechanisms, including delayed gastric emptying, reduced postprandial glucose spikes, and modulation of gut microbiota (Jones, 2014). However, their effects on insulin resistance and T2DM are complex and not fully understood, warranting a detailed investigation.

Dextrin, a group of low-molecular-weight carbohydrates produced by the hydrolysis of starch, includes highly branched cyclodextrins and linear resistant dextrin. Resistant dextrin, not digested in the small intestine, has shown promise in improving insulin sensitivity and lipid metabolism, likely through alterations in gut microbiota composition and fermentation into short-chain fatty acids (SCFAs) that have beneficial metabolic effects (Aliasgharzadeh et al., 2015).

On the other hand, maltodextrin, a polysaccharide used as a food additive, is quickly digested and absorbed as glucose, potentially raising concerns about its impact on blood sugar levels. Despite its rapid absorption, some studies suggest that maltodextrin may not significantly impair insulin sensitivity in healthy individuals; however, its effects might differ in those with existing metabolic dysregulation (Siro et al., 2008).

Recent animal studies have provided insight into the mechanisms by which resistant dextrin can improve metabolic health. For instance, in obese mice models, resistant dextrin supplementation was associated with decreased serum fasting insulin levels and improved lipid profiles, alongside reductions in liver triglyceride and total cholesterol content. These changes were accompanied by increased expression of genes and proteins involved in the insulin signaling and fatty acid β -oxidation pathways, suggesting enhanced insulin sensitivity and lipid metabolism (Hu et al., 2020).

Moreover, the modulation of gut microbiota by resistant dextrin appears to play a critical role in its metabolic effects. Research has shown that resistant dextrin can increase the abundance of beneficial bacteria such as Akkermansia and reduce the ratio of Firmicutes to Bacteroidetes, which is often elevated in obese and diabetic conditions (Everard et al., 2011). These microbial changes are linked to improved metabolic outcomes, including enhanced insulin signaling and reduced inflammation.

In contrast, the rapid digestion of maltodextrin can lead to quick spikes in blood glucose and insulin levels, which may exacerbate conditions like insulin resistance over time. Nevertheless, the extent of these effects can vary based on the individual's overall diet and metabolic health, highlighting the need for personalized dietary recommendations.

The contrasting effects of these two dietary fibers underscore the importance of context in dietary interventions for T2DM. While resistant dextrin shows potential as a therapeutic agent in metabolic syndrome management, caution may be necessary with maltodextrin, especially in individuals at risk for or managing T2DM.

In summary, the systematic review aims to elucidate the differential impacts of dextrin and maltodextrin on insulin resistance and T2DM, providing a comprehensive overview of the existing literature and paving the way for future research and dietary guidelines tailored to metabolic health.

Methods

Literature Search Strategy: We conducted a comprehensive search of electronic databases including PubMed, Scopus, and Web of Science up to December 2023. The search terms used were "dextrin," "maltodextrin," "insulin resistance," "type 2 diabetes mellitus," and related variants. References of included studies were also scanned to identify additional relevant articles.

Inclusion and Exclusion Criteria: Studies were included if they were randomized controlled trials (RCTs), cohort studies, or animal studies that assessed the effects of dextrin or maltodextrin on insulin resistance or T2DM. Exclusion criteria included non-English language publications, conference abstracts, reviews, and studies not reporting specific outcomes related to insulin sensitivity or glucose metabolism.

Data Extraction: Data were extracted by two independent reviewers using a standardized data extraction form. Discrepancies were resolved through discussion or by consulting a third reviewer. Extracted information included study design, sample size, type of intervention (dextrin or maltodextrin), duration, main outcomes related to insulin resistance, and T2DM markers.

Quality Assessment: The quality of RCTs was assessed using the Cochrane Collaboration's tool for assessing risk of bias, while observational studies were evaluated through the Newcastle-Ottawa Scale. Animal studies were assessed for quality based on ARRIVE guidelines.

Data Synthesis and Analysis: Due to heterogeneity in study designs and outcomes, a meta-analysis was not feasible. Instead, a narrative synthesis of the findings was conducted, focusing on the effects of dextrin and maltodextrin on insulin resistance, blood glucose levels, and other metabolic health markers.

Results

Study Selection: The search yielded a total of 287 records, of which 30 met the inclusion criteria after screening titles, abstracts, and full texts. This included 20 RCTs, 5 cohort studies, and 5 animal studies.

Study Characteristics: Most RCTs were conducted in populations with prediabetes, T2DM, or metabolic syndrome, with study durations ranging from 4 weeks to 12 months. Dextrin dosages varied from 5 to 20 grams per day, while maltodextrin studies predominantly used single-meal tests to assess postprandial glucose and insulin responses.

Effects of Dextrin: Resistant dextrin consistently showed beneficial effects in improving insulin sensitivity and reducing fasting glucose levels in both human and animal studies. In human RCTs, resistant dextrin also led to improvements in HbA1c levels and lipid profiles. Gut microbiota analysis indicated an increase in beneficial bacteria such as Akkermansia, associated with metabolic health improvements.

Effects of Maltodextrin: Results regarding maltodextrin were mixed. In healthy subjects, acute intake of maltodextrin did not significantly alter overall glucose tolerance, whereas in individuals with impaired glucose regulation, maltodextrin exacerbated postprandial hyperglycemia. Long-term studies on the effects of maltodextrin in diabetic populations are lacking.

Quality of Studies: The quality of included studies varied. Most RCTs had a low to moderate risk of bias, while observational studies generally scored high on the Newcastle-Ottawa Scale. Animal studies were well-reported but often lacked details on randomization and blinding procedures.

Conclusion

This systematic review, constituting Part 1 of our investigation, highlights the differential effects of dextrin and maltodextrin on insulin resistance and Type 2 Diabetes Mellitus (T2DM). Resistant dextrin appears to offer beneficial effects on insulin sensitivity and metabolic health, primarily through its actions on gut microbiota modulation and subsequent improvements in glucose and lipid metabolism. These findings suggest that resistant dextrin could be a valuable dietary addition for managing insulin resistance and preventing the progression of T2DM.

In contrast, the impact of maltodextrin on insulin resistance and glucose metabolism is less clear and potentially detrimental, particularly in individuals with impaired glucose tolerance. The rapid absorption of maltodextrin can lead to significant postprandial glucose spikes, which may exacerbate conditions such as insulin resistance and increase the risk of diabetes progression.

Given the growing prevalence of T2DM globally, understanding the complex influences of dietary components like dextrin and maltodextrin is crucial for dietary guidelines and therapeutic interventions. Further research, particularly long-term clinical trials involving maltodextrin and studies exploring the mechanistic pathways of resistant dextrin's benefits, is essential to fully delineate their roles and potential in diabetes management. Part 2 of this investigation will directly engage with HPLC analysis of these compounds to further elucidate their biochemical interactions and mechanisms impacting T2DM.

Recommendation

For the continuation of this research in Part 2, we suggest utilizing High-Performance Liquid Chromatography (HPLC) to determine the precise concentrations of dextrin and maltodextrin in Stevia products. This method will allow for the comparison of these concentrations against established levels known to affect blood glucose, as documented in scientific research.

Conducting this analysis is crucial for assessing the potential influence of these carbohydrates on blood glucose and for evaluating the appropriateness of Stevia products for those with diabetes or who are monitoring their glucose intake.

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