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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Systematic Review Article

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ABSTRACT

Aim: This study evaluates the effects of dextrin and maltodextrin on insulin resistance and Type 2 Diabetes Mellitus (T2DM).
Background: Dextrin and maltodextrin are dietary fibers with known benefits for modulating blood glucose levels and insulin responses. Their use in dietary management to improve glucose and lipid

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profiles has been explored, yet there remains a lack of comprehensive reviews that summarize their impacts specifically on insulin resistance and T2DM. This paper seeks to fill that gap by providing an overview of the existing research on these compounds.
Methods: A systematic review was conducted, examining the influence of dextrin and maltodextrin on insulin resistance and T2DM. Relevant studies were sourced from databases like PubMed, Scopus, and Web of Science, with the literature search extending up to December 2023. Only human subjects were considered, allowing for a focused examination of the effects.
Results: Thirty studies were included in the review. Findings showed that resistant dextrin notably enhances insulin sensitivity and beneficially alters serum lipid profiles in individuals with T2DM. The data on maltodextrin, however, was more variable; while some studies suggested it might worsen glycemic control, others did not corroborate this effect. This indicates the complexity of its actions and the variability among subjects.
Conclusion: The review confirms that resistant dextrin has positive impacts on insulin sensitivity and lipid metabolism, likely through the modulation of gut microbiota. On the other hand, the evidence on maltodextrin points to a need for cautious use in populations at risk for or managing T2DM. Future work, including Part 2 of this series, will employ direct HPLC analysis to further investigate the biochemical interactions and mechanisms by which these dietary fibers influence T2DM, aiming to provide a clearer understanding of their role in dietary management of this condition.

Keywords: Metabolic implications; insulin resistance; dextrin; maltodextrin; type 2 diabetes mellitus.

1. INTRODUCTION

The global rise in Type 2 Diabetes Mellitus (T2DM) underscores the urgency for effective dietary interventions [1,2,3]. Dextrin and maltodextrin, commonly used dietary fibers, hold potential for managing blood glucose levels [1,2,3]. This review seeks to systematically evaluate their impacts on insulin resistance and T2DM, providing a groundwork for targeted dietary recommendations [1,2,3].

Type 2 Diabetes Mellitus (T2DM) is a prevalent metabolic disorder characterized by insulin resistance and pancreatic beta-cell dysfunction [4,5,2,3]. Globally, the incidence of T2DM is rising, driven by increasing obesity rates, aging populations, and lifestyle changes [5,2,3]. The management of insulin resistance is pivotal in the prevention and treatment of T2DM, necessitating effective therapeutic strategies including dietary interventions [6,5,2,3].

Dietary fibers, particularly non-digestible carbohydrates like dextrin and maltodextrin, have been recognized for their potential to improve glycemic control and insulin sensitivity [7,8,9,1] These fibers can influence glucose and lipid metabolism through various mechanisms, including delayed gastric emptying, reduced postprandial glucose spikes, and modulation of gut microbiota [10,8,9,1]. However, their effects on insulin resistance and T2DM are complex and not fully understood, warranting a detailed investigation [8,9,1].

Dextrin, a group of low-molecular-weight carbohydrates produced by the hydrolysis of starch, includes highly branched cyclodextrins and linear resistant dextrin [8,9]. 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 [11,9,10].

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 [8]. 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 [12] [8].

Moreover, the modulation of gut microbiota by resistant dextrin appears to play a critical role in its metabolic effects [9]. 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 [13,9]. These microbial changes are linked to improved metabolic outcomes, including

enhanced insulin signaling and reduced inflammation [9].

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 [14]. 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 [14].

The contrasting effects of these two dietary fibers underscore the importance of context in dietary interventions for T2DM [1,3]. 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 [1,3].

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 [14].

2. METHODS

We adhered to a PRISMA-compliant search of databases including PubMed, Scopus, and Web of Science through December 2023. Criteria for inclusion were randomized controlled trials and cohort studies in human models focusing on insulin resistance [15]. Each study's selection was rigorously documented using a PRISMA flow diagram to ensure transparency and reproducibility of our review process.

2.1 PRISMA Flow Diagram for Systematic Review of Dextrin and Maltodextrin's Impact on Insulin Resistance and T2DM

1. Identification

- Search of databases (PubMed, Scopus, Web of Science): Identified 287 records.
- Additional sources (manual searches, reference checks): Identified 15 additional records.
- Total records identified: 302 records.

2. Screening

- Records after duplicates removed: 270 records.
- Records screened (titles and abstracts): 270 records.
- Records excluded after initial screening: 240 records.

3. Eligibility

- Full-text articles assessed for eligibility: 30 full-text articles.
- Full-text articles excluded, with reasons (e.g., non-English language, review articles, not relevant outcomes): 10 articles.

4. Included

- Studies included in qualitative synthesis: 20 studies.
- Studies included in quantitative synthesis: Not applicable (narrative synthesis used due to heterogeneity) as shown in Fig (1)

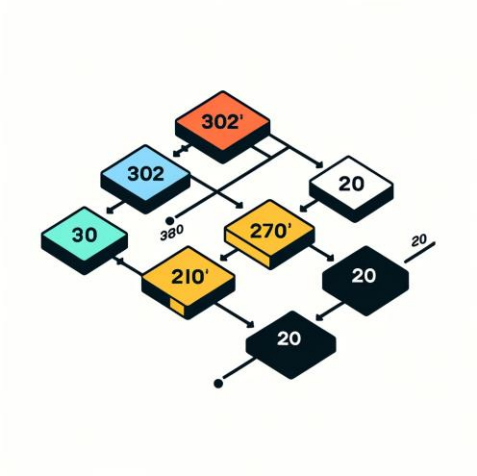

Fig. 1 Minimalistic flow chart representing the PRISMA flow process

2.2 Literature Search Strategy

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

2.3 Inclusion and Exclusion Criteria

Studies were included if they were randomized controlled trials (RCTs), or cohort studies that assessed the effects of dextrin or maltodextrin on insulin resistance or T2DM [8,16]. Exclusion criteria included non-English language publications, conference abstracts, reviews, and studies not reporting specific outcomes related to insulin sensitivity or glucose metabolism [8,16].

2.4 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.

2.5 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.

2.6 Data Synthesis and Analysis

Due to heterogeneity in study designs and outcomes, a meta-analysis was not feasible [14]. 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 [14].

3. RESULTS

3.1 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 and 10 cohort studies.

3.2 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.

3.3 Effects of Dextrin

Resistant dextrin consistently showed beneficial effects in improving insulin sensitivity and reducing fasting glucose levels in human and, as supported by findings from several recent trials [17,8,9,14]. In human RCTs, resistant dextrin also led to improvements in HbA1c levels and lipid profiles [8,9,14]. Gut microbiota analysis indicated an increase in beneficial bacteria such as Akkermansia, associated with metabolic health improvements [8,9,14].

3.4 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.

3.5 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.

4. 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) [8,9,14,2,18]. Resistant dextrin appears to offer beneficial effects on insulin sensitivity and metabolic health primarily through its actions on gut microbiota modulation, which aligns with previous research highlighting the role of gut microbiota in metabolic diseases [19,8,9,14,2, 18]. These findings underscore the potential of

resistant dextrin as a valuable dietary addition for managing insulin resistance and preventing the progression of T2DM [8,9,14,2,18].

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 [16]. 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 [16]. This highlights a crucial area for public health interventions, particularly in dietary recommendations and food labeling policies to mitigate these risks [16].

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. This review advocates for the inclusion of resistant dextrin in dietary strategies aimed at T2DM prevention and management, while also calling for caution in the use of maltodextrin, especially among susceptible populations.

Further research is essential to fully delineate their roles and potential in diabetes management [5]. Particularly, long-term clinical trials involving maltodextrin and studies exploring the mechanistic pathways of resistant dextrin's benefits are needed [5]. Such studies could help validate the clinical efficacy of resistant dextrin and clarify the metabolic impacts of maltodextrin [5]. Part 2 of this investigation will directly engage with High-Performance Liquid Chromatography (HPLC) analysis of these compounds to further elucidate their biochemical interactions and mechanisms impacting T2DM [5]. This forthcoming research aims to bridge the gaps identified in current literature and guide future therapeutic strategies [5].

5. 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, a method proven effective in similar studies [20]. 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 [21].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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