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Mini Review

The Relationship Between Wheat Flour and Diabetes: Role of Adiponectin

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Abstract

Type 2 diabetes mellitus (T2DM) is a major global health concern where dietary strategies play a important role in its prevention and management. Whole wheat flour, a staple food in majority of the cultures, is rich in dietary fibre, micronutrients, and bioactive compounds that enhance glycemic control and metabolic regulation. This mini-review examines the link between whole wheat flour consumption and diabetes, focusing on adiponectin-a hormone with insulin-sensitizing, anti-inflammatory, and anti-atherogenic effects. Several studies show that whole grain improves insulin sensitivity and better metabolic health. Several studies have reported association of higher adiponectin levels and improved metabolic advantages. These findings suggest that incorporating whole wheat flour into the diet may help mitigate type 2 diabetes risk, warranting further investigation into its underlying mechanisms.

Keywords: *Whole Wheat Flour; Diabetes; Insulin Sensitivity; Adiponectin*

Introduction

T2DM, represents a significant global health challenge, with lifestyle and dietary factors playing crucial roles in its development and management. Among dietary interventions, the consumption of whole grains such as whole wheat flour has gained attention for its potential benefits in glycemic control and metabolic regulation [1]. A growing body of evidence suggests that whole wheat flour, rich in dietary fibre, vitamins, minerals, and bioactive compounds, may modulate key metabolic pathways [2]. One such pathway involves adiponectin, an adipokine known for its insulin-sensitizing, anti-inflammatory, and anti-atherogenic properties [3]. This mini review examines the current understanding of whole wheat flour composition in the context of diabetes and explores how its consumption might influence adiponectin levels, thereby contributing to improved metabolic outcomes.

Whole wheat flour composition and diabetes

Wheat, is a staple food in majority of the cultures. The form in which wheat is consumed-whether as whole wheat flour or refined wheat flour-can significantly impact metabolic health. Whole grains are defined as the intact kernel, whether ground, cracked, flaked, or otherwise processed, after removing inedible parts like the hull and husk. All three anatomical components-the endosperm, germ, and bran-must be present in their original proportions as found in the whole, unprocessed kernel [4]. Whole wheat flour is produced by milling the entire wheat kernel-preserving the bran, germ, and endosperm-and thus maintains a richer nutritional profile compared to refined wheat flour. The whole wheat flour is composed of dietary fibre, micronutrients, phytochemicals, essential vitamins (such as B vitamins), and minerals including iron, magnesium, and zinc [5,6].

In an animal study, diabetic rats supplemented with whole wheat demonstrated enhanced glycemic control and improved insulin action [7]. Similarly, human randomized trials have shown that diets rich in whole grains lead to improved postprandial glycemic responses and insulin sensitivity [8]. The high fibre content in whole wheat flour helps slow down glucose absorption in the digestive system, leading to reduced postprandial glucose spikes [9]. This slower absorption not only helps in stabilizing blood sugar levels but also contributes to better insulin sensitivity. Regular consumption of whole wheat flour is associated with a lower risk of developing metabolic disorders, such as type 2 diabetes, due to its positive impact on blood sugar regulation and overall metabolic health [10].

Additionally whole wheat flour is rich in vitamins (e.g. B vitamins and vitamin E), minerals (e.g. magnesium and zinc), and antioxidants (e.g. phenolic acids and flavonoids) that play critical roles in modulating oxidative stress and inflammatory processes, both of which are key contributors to insulin resistance. For instance, B vitamins serve as coenzymes in numerous metabolic pathways, including carbohydrate metabolism, thereby enhancing energy utilization and reducing metabolic inefficiencies associated with diabetes. Vitamin E, a potent fat-soluble antioxidant, protects cell membranes from lipid peroxidation and oxidative damage, helping to maintain cellular integrity under hyperglycemic conditions [11]. Minerals such as magnesium and zinc are also crucial; magnesium is involved in insulin receptor function and post-receptor signaling, while zinc is integral to insulin synthesis, storage, and secretion. Their presence in whole wheat flour helps ensure proper metabolic regulation and cellular responsiveness to insulin [12]. Additionally, the phenolic acids and flavonoids present in whole wheat flour exhibit significant antioxidant and anti-inflammatory properties. These compounds act by scavenging reactive oxygen species (ROS), improved antioxidant enzyme activities (e.g. increased superoxide dismutase and catalase levels) and modulating signaling pathways involved in inflammation, such as the NF-κB pathway, thereby reducing the expression of pro-inflammatory cytokines (TNF-α and IL-6) [13].

Most cereal products that are currently available are refined. Refined grain products are products that lack one or more parts of the integral kernel [4]. In the classical refining process for wheat e.g. the bran and the germ are separated from the starchy endosperm. The starchy endosperm is then grinded to a fine white flour. Although during this process from a nutritional point of view, the refining process removes vital nutrients, dietary fibre and other phytochemicals therefore they have lower nutritional quality than the original whole grain products [4]. Lack of fiber causes rapid glucose absorption, leading to sharp increases in blood sugar levels after consumption which may contribute to the development of insulin resistance and other metabolic disorders [8,9]. Therefore, frequent intake of refined wheat products can be associated with weight gain, insulin resistance, and an increased risk of developing type 2 diabetes.

Adiponectin

Adiponectin is a key adipocytokine secreted by adipose tissue that plays a crucial role in regulating various metabolic processes. Structurally, adiponectin is a peptide hormone composed of a 244-amino-acid polypeptide chain that circulates in the blood in different molecular forms, including trimers, hexamers, and the most biologically active form, the high-molecular-weight (HMW) complex. Adiponectin has gained attention due to its anti-inflammatory, antiatherogenic, and insulin-sensitizing properties [14]. Its importance in metabolic regulation is underscored by its role in enhancing insulin sensitivity, promoting fatty acid oxidation, and regulating glucose metabolism [15]. Additionally, low levels of adiponectin have been linked to an increased risk of developing metabolic disorders such as obesity, type 2 diabetes, and cardiovascular diseases, making it a critical biomarker for metabolic health [14,15].

Influence of whole wheat flour on adiponectin

Diet plays a significant role in modulating adiponectin levels. The components present in food influence adiponectin secretion. The influence of wheat flour on adiponectin levels can be attributed to the mechanisms through which dietary fibre and whole grains interact with metabolic processes. High-fibre diets, such as those rich in whole wheat flour, are known to enhance adiponectin secretion by improving gut microbiota composition. A balanced gut microbiome promotes the production of short-chain fatty acids (SCFAs), which help reduce systemic inflammation-one of the key factors that can lower adiponectin levels [16,17]. Additionally, fibre slows the digestion

and absorption of carbohydrates, leading to more stable blood sugar levels [6], which may further contributes to the optimal secretion of adiponectin. As fibre-rich whole grains help reduce inflammatory markers, they also foster a more favorable environment for adiponectin production, which plays a critical role in maintaining metabolic balance and supporting insulin sensitivity [18,19]. In a recent study diets rich in phytate (present in whole wheat) promoted increased secretion of adiponectin, while diets high in processed foods, refined sugars, and unhealthy fats tend to lower adiponectin levels [20].

On the contrary, refined wheat flour, which is stripped of its fibre and essential nutrients, can promote hyperglycemia and insulin resistance. The rapid absorption of glucose from refined flour products leads to sharp spikes in blood sugar, followed by increased insulin secretion. Over time, this can result in insulin resistance, a condition where the body's cells no longer respond effectively to insulin. This dysfunction hampers the secretion of adiponectin, as insulin resistance is often associated with lower adiponectin levels [18]. The consumption of refined wheat flour, therefore, not only promotes unhealthy metabolic responses but also contributes to a cycle of decreased adiponectin production, further exacerbating insulin resistance and increasing the risk of developing metabolic diseases such as type 2 diabetes.

Conclusion

To summarize, we can say that the synergistic actions of fibre, micronutrients and phytochemicals in whole wheat flour may contribute to its protective effects against insulin resistance and metabolic dysregulation, underscoring its potential role in dietary strategies aimed at diabetes management. These compounds also help to increase adiponectin levels, combat oxidative stress and inflammation, which are implicated in insulin resistance. While both animal and human studies offer supportive evidence, further research is needed to fully elucidate the molecular pathways involved.

Conflict of Interest

Declare if any financial interest or any conflict of interest exists.

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