The Role of Resistant Starch in Management of Diabetes

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***Abstract*— Resistant starch is defined as a portion of starch that cannot be digested in the small intestine and passes to the colon to be fermented by gut microbiota. The presence of a starch fraction resistant to enzymatic hydrolysis was first recognized by Englyst et al. in 1982. It is similar to dietary fibre in a way that it escapes digestion. Dietary intake of resistant starch has been found to havea variety of therapeutic roles in the human body contributing to the overall health. Also, it is recognized to be a prominent factor in controlling and managing diabetes. This review aims to provide an insight into the chronic problem of diabetes mellitus and the positive role of resistant starch in diabetes management.**

Index Terms: **Diabetes, dietary fiber, insulin sensitivity, resistant starch (RS).**

DIABETES MELLITUS

The term diabetes mellitus(commonly known as diabetes) refers to a group of chronic metabolic disorders characterized and identified by the presence of untreated hyperglycemia[1]. Defects in insulin secretion, insulin action, or both, as well as changes in carbohydrate, lipid, and protein metabolism, are among the several etiopathologies[2],[3]. Retinopathy[4], nephropathy[5], and neuropathy[6] are only a few of the long-term consequences associated with diabetes. Diabetes puts people at risk for heart disease, peripheral arterial disease, and cerebrovascular disease, as well as obesity, cataracts, erectile dysfunction, and non-alcoholic fatty liver disease. They are also at increased risk of some infectious diseases, such as tuberculosis [7].

PREVALENCE

With the advent of industrialisation worldwide and the staggering rise in obesity, diabetes has manifested as a global epidemic. The global prevalence of diabetes in adults has been increasing over the recent decades. In 2010, the global prevalence of diabetes among adults (aged 20–79 years) was 6.4 percent, impacting 285 million people, it is expected to rise to 7.7 percent, affecting 439 million people by 2030 and predicted to rise to 10.4% in 2040. Between 2010 and 2030, the number of adults with diabetes in developing nations would rise by 69 percent, while it will rise by 20 percent in industrialised countries[8],[9].Diabetes claimed the lives of nearly 5 million people aged 20 to 99 years old worldwide in 2017. In 2017, the global healthcare spend for diabetics was expected to reach USD 850 billion. The revised estimates of diabetes prevalence, diabetes-related fatalities, and diabetes-related healthcare expenditures pose a significant social, financial, and health-system burden around the world[10].

CARBOHYDRATES

The identification of modifiable risk factors for type 2 diabetes, such as dietary factors, is crucial to the disease's prevention [11]. Diet has long been recognised as a modifiable risk factor for type 2 diabetes due to its ability to impact body weight[12]. Clinical work on the glycemic index and the glycemic load supports the notion that the form and content of carbohydrate and fat in foods may be important determinants of the short-term glycemic response[13].

Breads, cereals, fruits, vegetables, and dairy products all contain carbohydrates. They’re an essential part of a healthy diet. When you eat any type of carbohydrates, your digestive system breaks it down into simple sugars that enter the bloodstream[14]. Not all carbohydrates are the same, mono-, di-, oligo, and polysaccharides make up food carbohydrates,

with starch and non-starch polysaccharides (NSP) making up the latter. The glycaemic response to sugars and starches is dependent upon the types of sugars present and the form of the starches, and 'complex carbs' do not always induce slower or lower glycaemic responses than sugars. Carbohydrates that are not absorbed in the small intestine are fermented by the big intestinal microbiota to a greater or lesser extent. There is a significant nutritional difference between digestible and non-digestible (unavailable) carbohydrates. Undigestible carbohydrates are mostly NSP, resistant starch (RS), and oligosaccharides. Dietary fibre is often confused with 'unavailable' carbohydrates [15].

RESISTANT STARCH AND DIABETES MANAGEMENT

Starches relatively high in amylose content tend to be more resistant to digestion than starches with higher amylopectin content. Considering this, starch can be divided into rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS)[16],[17].The total amount of starch, and the products of starch degradation that resists digestion in the small intestine of healthy people is termed as resistant starch[18].Resistant starch has been classified into four general subtypes called RS1, RS2, RS3 and RS4[19].

Hyperglycemia is a feature of both type 1 and type 2 diabetes, and it leads to systemic tissue damage. Increased fasting and postprandial glucose responses, as well as impaired insulin sensitivity and obesity, are all risk factors that can be reversed with lifestyle changes, which have been demonstrated to be more successful than pharmacological therapies in postponing the onset of type 2 diabetes [20]. Because resistant starch has a low glycemic index, it can be substituted for conventional starch in foods. In human investigations, it was shown that eating foods high in resistant starch, such as corn porridges, resulted in lower postprandial glucose concentrations and a corresponding insulin response than eating foods high in regular starch [21].

Consuming less digestible starches may also reduce the glycemic response to a forthcoming meal, a phenomenon known as the "second meal effect." When ten healthy people ate high-amylose starch for breakfast, their blood glucose response to a highly digestible carbohydrate lunch was lower than when they ate high-amylopectin starch for breakfast [22]. Diabetes can be managed by replacing regular dietary starch with resistant starch. Increasing consumption of resistant starch can also improve weight control and management, beneficially influence body composition, or both in part because food with resistant starch has lower energy concentration and has been shown in mice to reduce body fat, an important predictor of disease[23].A positive effect of dietary resistant starch was demonstrated in animal models of diabetes, such as an improvement in glycemic control in the Goto-Kakizaki rat, a nonobese model of type 2 diabetes.[24]

Consumption of 15–30 g/d of (High Amylose Maize-resistant starch 2) HAM-RS2 enhanced Insulin Sensitivity (SI) in overweight and obese males. Data from previous HAM-RS2 investigations conducted in men and women in short-term and longer-term feeding trials support the improvement in insulin sensitivity compared to control. However, to our knowledge, this is the first trial to show such benefits in SI at a dose as low as 15 g/d HAM-RS2[25].Due to a mechanism that appears to entail increased muscle absorption of FAs and higher S-IMCL, HAM-RS2 ingestion improved meal glucose tolerance in subjects with existing good diabetic control[26].

The incorporation of high-RS food into the diet is a feasible strategy to improve both fasting and postprandial insulin response, as well as insulin sensitivity, and therefore, to reduce the risk of developing Type-2Diabetes[27].RS could be an effective dietary element for improving insulin sensitivity in women, especially those who are at a higher risk of type 2 diabetes, such as African-American and postmenopausal women. Consumption of 30 g/d of RS in the form of a snack food item (HAM-RS2) was linked to enhanced insulin sensitivity in insulin resistant women[28].

CONCLUSION

It is evident from the range of studies that consumption of resistant starch has aninverse effect on postprandial glucose concentrations and also enhances insulin sensitivity in subjects. Consumption of a diet rich in resistant starch in place of traditional starch can thus play an important role in the

management of diabetes. Further it is recommended that more such studies may be conducted on resistant starch content of different cereals grains so that cereal varieties with high resistant starch could be promoted for incorporation in the diets of diabetic patients.

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