

## **Maize diet in the management of type 2 Diabetes Mellitus**

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### **ABSTRACT**

**Objective:** The objective of this study is to assess the glycemicrosponses of maize meals. And, this review aims to discuss the major phytochemical compounds in maize and their health promoting effects, in order to better understand the nutritional and health potential of maize and consequently improve its consumption.

**Conclusion:** Due to increasing population there is more food demand, therefore maize can satisfy the food requirements as well as provide human nutrition along with number of health benefits. Thus, the aim of the present review was to provide necessary information regarding the nutritive and health benefits of maize, specially in the management of diabetes mellitus because of its low glycemic load, high fiber and high phytochemical content, so that people start taking more interest to it and its consumption as a good food source will increase. Maize flour is a energy rich flour loaded with fiber. Cornmeal prevents blood glucose level from shooting up and loaded with Zink which is necessary for formation of insulin. Maize flour or maize whole grain is good for diabetics, heart patients, weight loss and healthy lifestyle but the key is the portion control.

**Key Words :** Maize/ Corn, Glycemic index, Glycemic load, Phytochemicals, Nutraceuticals, zein, Phenolic compounds, Carotenoids, GNA- Maize

### **INTRODUCTION**

Maize or corn (*Zea mays* L.) is an important annual cereal crop of the world belonging to family Poaceae. Zea is an ancient Greek word which means “sustaining life” and Mays is a word from Taino language meaning “life giver”. The word “Maize” is from spanish connotation “Mais” which is the best way of describing the plant. Various Other synonyms like Zea, silk maize, makka, barajovar, etc. are used to recognise the plant. It is considered as a staple food in many parts of the world. It is a third leading crop of the world after Rice and wheat. The world production of maize was 967metric tons and in India its production was 23 MMT in 2013 – 14 (India Maize Summit, 2014). Due to its highest yield potential among

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the cereals it is known as queen of cereals. In india maize is widely processed into various types of products such as cornmeal, grits, starch, flour, tortillas, snacks, and breakfast cereals. Maize flour is used to make chapatis or flat breads which are eaten mainly in a few northern states of india. Due to increasing attention becoming drawn towards the development of nutraceuticals, the phytochemical compounds derived from Maize and their health properties have recently become the major focus of studies.

Maize is a source of energy, Vitamins, minerals, and fiber. It is also low in sodium and fat. You can eat maize if you have diabetes. That said, follow the advice of American Diabetes association. Set a daily limit for the amount of carbohydrates you plan to eat, and keep track of the carbohydrates you consume. Dietary modification in association with life style changes is important in the management of the diabetes mellitus. Cereals accounts for as much as 60 to 70 percent in most indian diets.

Corn is considered both a vegetable and a cereal grain. Sweet corn that you eat off the cob is usually considered a vegetable in the culinary world, whereas the dry seeds that are used for flour and popcorn are classified as whole grains. Corn originated in Mexico over 9000 years ago and is known by its original name “Maize” in many parts of the world. Native Americans grew and harvested this crop as a main source of food. Today , it is one of the most widely consumed cereal grains worldwide.

**Objective:**

The objective of this study is to assess the glycemic responses of maize meals. And, this review aims to discuss the major phytochemical compounds in Maize and their health promoting effects, in order to better understand the nutritional and health potential of maize

and consequently improve its consumption.

Also known as maize (*Zea Mays*) corn is one of the world's most popular cereal grains. It's the seed of a plant in the grass family, native to central America but grown in countless varieties worldwide. Whole grain maize is as healthy as any cereal grain, as it's rich in fiber and many vitamins, minerals and antioxidants. Maize contains a fair amount of fiber. While the fiber content of different types of maize varies, it's generally around 9 to 15 percent of the dry weight (6). Depending on the variety, the protein content ranges from 10 to 15%. The most abundant proteins in corn are known as zeins, accounting for 44 – 79% of the total protein content. Overall, the protein quality of zein is poor because they lack some essential amino acids.



Maize meal is hugely popular across much of southern and East Africa – research shows that Sub-saharan Africa consumes 21% of Maize produced in the world. The maize meal is boiled with water, and a bit of salt is added. It is then folded into the desired texture, making it a quick, cheap and easy dish. It can also be fermented and served at breakfast as porridge, or cooked in a more dense form for lunch and dinner, when it is often served with meat, vegetable stews and sour milk. When eaten in its original form, maize contains such as Vitamin A, C, iron and fiber, but all the goodness is lost if it is over-processed. Unfortunately the maize sold in supermarkets is highly processed and therefore lacks nutrients, vital for the health of our skin, hair and brain. Unlike in many other countries, processed maize meal in South Africa is fortified with vitamin A and B complex to boost its health benefits. The more modern grain is steel ground. It doesn't contain the germ of the kernel and that is where the nutrients are. If we were to stone mill the whole kernel we would get more energy producing

carbohydrates, protein and fiber, which isn't found even in fortified variants of the maize meal. Yellow maize is also packed with more nutrients than White maize but sadly we have been conditioned to believe that the yellow coarse kind is for the less affluent (16).

### Nutritional Value:

The Fat Content of maize ranges from 5 to 6 percent making it a low fat food (6). However, maize germ, an abundant side product of corn milling, is rich in fat and used to make corn oil, which is a common cooking product. Refined maize oil is mainly composed of linoleic acid, a polyunsaturated fatty acid, while monounsaturated and saturated fats make up the rest (7). It also contains significant amount of vitamin E, Ubiquinone (Q10), and phytosterols, increasing its shelf life and making it potentially effective at lowering cholesterol levels (8). Thus whole maize is relatively low in fat, though corn oil – a highly refined cooking oil is sometimes processed from corn germ, a side product of corn milling. Parched maize / Popcorn boasts several minerals including Manganese, phosphorus, magnesium, Zinc and copper. Whereas Sweet corn boasts a number of vitamins, including, Pantothenic acid, folate, vitamin B1, Niacin, & potassium. Maize contains a number of bioactive plant compounds, some of which may boost your health. In fact maize boasts higher amounts of antioxidants than many other common cereal grains (9). These antioxidants are : Ferulic acid, Anthocyanins, zeaxanthin, Lutein, and Phytic acid. (Though phytic acid may reduce mineral absorption). Maize is especially rich in eye healthy carotenoid.

Carbohydrate	71.88 g
Protein	8.84 g
Fat	4.57 g
Fiber	2.15 g
Ash	2.33 g
Moisture	10.23 g
Phosphorus	348 mg
Sodium	15.9 mg
Sulfur	114 mg
Riboflavin	0.10 mg
Amino acids	1.78 mg
Minerals	1.5 g
Calcium	10 mg
Iron	2.3 mg
Potassium	286 mg
Thiamine	0.42 mg
Vitamin C	0.12 mg
Magnesium	139 mg
Copper	0.14 mg

Source: Shah, Prasad and Kumar (2015); Gopalan, Rama Sastri, and Balasubramanian (2007)

High – grain foods may have several health benefits, including reduced risk of disease and type 2 diabetes (10, 11).

Table 2 : Concentration of major phytochemical compounds of maize per 200 gm		
Compounds	Concentration (mg/100 gm)	References
<b>(1) Carotenoids</b>		
(a) Caratene	2.20	Waston and Ramstad (1987)
(b) Xanthophylls	2.07	Maros, Darnoko, Cheryan, Perkins, and Jerrell (2002)
(i) Lutein	1. 50	
(ii) Zeaxanthin	0.57	
<b>(2) Phenolic compounds</b>		
(a) Ferulic acid (FA)	174	Zhao et al. (2005)
(b) Anthocyanins	141.7	Salinas-Moreno, Soto-Hernandez, Martinez-Bustos, Ganzalez-Hernan-dez, and Ortega-Paczka (1999)
<b>(3) Phytosterols</b>		
(a) Sitosterol	14.83	Locatelli and berado (2014)
(b) Stigmasterol	9.91	
(c) Campesterol	1.52	
	3.40	

Source: Rouf Shah et al. Cogent Food and Agriculture, 2015

### Glycemic Index of Maize:

How food affects blood glucose level is indicated by the glycemic index (GI). Foods with GI from 56 to 69 are medium glycemic foods. Low glycemic foods score less than 55. Foods with a high glycemic index (70 or above) can increase your blood sugar level. The glycemic index of maize is 52. If we make chapati it is beneficial for diabetics. Other related GI's include :

Corn tortilla	:	46
Cornflakes	:	81
Popcorn	:	65

Low GI foods are beneficial for diabetic patients. Because foods with high GI release glucose quickly. Low glycemic foods tend to release glucose slowly and steadily, which maintain blood glucose within normal limits. The GI is based on a scale of 0 to 100, with 100 being pure glucose.

### Glycemic load of corn:

Portion size and digestible carbohydrates are included in glycemic load(GL), along with glycemic index. The GL of a medium ear of corn is 15.

### Maize flour flatbread or Chapati:

Maize flour is energy rich, fibre rich and loaded with Zink which prevents hyperglycemia because Zink is necessary for insulin formation. Maize flour is a good source of magnisiuim which is necessary for maintaining steady heart beat and normal blood pressure. The fiber binds with the bike salts and throws it out of the body, which helps in reducing the cholesterol from the body and good for heart.

### **Mieliepap ( Maize meal porridge) and the glycemic index:**

Does mieliepap have a high or low glycemic index? The answer is not really straightforward because mieliepap can have either a high GI, an intermediate or a lower GI depending on the temperature at which it is eaten. Now this is quite a difficult concept for most people to understand, but there are a number of starches which have a lower GI when they are eaten cold, rather than hot. So type 2 diabetics can still eat their mieliepap or maize meal porridge three times a day, but they will achieve much better control of their blood glucose levels, insulin levels, weight and health, if they cook their pap, cool it down and then eat it together with low - GI foods (19).

### **Low-Carbohydrate, high -fat diet Vs High – carbohydrate, low – fat diet:**

A 52 week study of patients with type 2 diabetes compared the effects of a low carbohydrate, high fat diets versus a high carbohydrates, low fat diet. Although both diet improved average blood sugar levels, weight, and fasting glucose, the low carbohydrate diet performed much better for overall glucose control (1).

According to a recent study, high consumption of flavonoids, like those found in maize( it's largest group of phenolic compounds), reduces the risk of chronic diseases, including diabetes. The study also indicated: 1. A moderate intake of resistant starch (about 10 gm per day) from corn can reduce glucose and insulin response.

2. Regular whole grain maize consumption improves digestive health and can lower the risk of developing chronic diseases, such as type 2 diabetes and obesity (2).

The study suggested that further studies are needed on the bioactive compounds of maize as related to health.

High fructose corn syrup is a sweetener made from maize. It is commonly found in processed foods. Although, high fructose corn syrup may not raise blood sugar levels as much as regular sugar does, it doesn't stimulate the release of insulin, leaving people with diabetes in need of insulin to regulate blood sugar (3).

High fructose corn syrup can also lead to leptin resistance. According to the journal of Endocrinology, the hormone leptin triggers satiety, letting your brain know that the body doesn't need to eat and burn calories at a normal rate (4).

Eating maize has some benefits, but it's important to understand how it's high level of carbohydrates can raise blood glucose and impact how you manage your diabetes. Although not everyone with diabetes reacts the same way to certain foods, following dietary guidelines and tracking what you eat can help (5).

There is a growing interest in glycemic index of carbohydrate rich foods to help consumers make healthy food choices within specific food groups. Glycemic index is defined as the incremental addition under the blood glucose response curve of a 50 gm carbohydrate portion of a test food expressed as a percent of the response to the same amount of carbohydrate from a standard food taken by the same subject (12). It is used to classify carbohydrate foods based on their blood glucose raising potential. Low GI foods are that are digested and absorbed slowly, resulting in low fluctuations in blood sugar levels (13). Good example of such foods are whole grain cereals, whole kernel bread, beans and fruits. High- GI foods, by virtue of their rapid digestion and absorption, produce marked fluctuations in blood sugar

levels and they include white bread and highly processed grains, cereals and potatoes (14). At present, there is global research based evidence that reductions in daily glycemic load may lead to a reduced risk for developing non communicable diseases (NCDs), such as type 2 diabetes, cancer, and coronary disease. In 1998, Food and agriculture organization and World health Organization recommended low GI diets(GI of 0 – 55) as a viable way to prevent and address the burden of NCDs. In several countries(Australia, France, Sweden, Canada, and south Africa), the use of the GI concept has been integrated in dietary guidelines given by health professionals, and an increasing number of food companies market low – GI products (15). In line with these developments, a large number of academic and commercial laboratories have undertaken measurements of glycemic indices of food for both research and commercial application purposes (15).

Tender corn has about 1/3<sup>rd</sup> of the calories of dry corn. At 125 calories per 100 gm, it contains about 5 gm of protein and negligible amount of fat. Tender Maize is extremely rich in thiamin, Vitamin B5 and Vitamin C, which helps in fighting diseases and generating new cells. High in fiber, maize also helps in lowering cholesterol levels in the body by reducing the levels of blood sugar in diabetics too. A whole grain product, it can be easily included in a healthy diet. Maize is not all unhealthy. Since it is rich in carbohydrates, it is a great source of energy , vitamins and minerals (17).

#### **Role of Maize in health and disease:**

Maize is an important cereal crop of the world. It is a source of nutrition as well as phytochemicals compounds. Phytochemicals play an important role in preventing chronic diseases. It contains various major phytochemicals such as carotenoids, phenolic compounds and phytosterols. It is believe to have anti HIV activity due to presence of Galanthus nivalis agglutinin (GNA) lectin or GNA – maize. A tablespoon of maize oil satisfies the requirements for essential fatty acids for a healthy child or adult. Decoction of maize silk, roots, leaves, and con are used for bladder problems, nausea, vomiting, and stomach complaints. Zein an alcohol soluble prolamine found in maize endosperm has unique novel application in pharmaceutical and nutraceutical areas. Resistant starch(RS) from maize reduces the risk of Caecal cancer (Carcinoma of caecum), atherosclerosis, and obesity- related complications (18). This review present a detailed view on the nutritional and potential health benefits of maize.

#### **Conclusion:**

Due to increasing population there is more food demand, therefore maize can satisfy the food requirements as well as provide human nutrition along with number of health benefits. Thus, the aim of the present review was to provide necessary information regarding the nutritive and health benefits of maize , specially in management of type 2 diabetes mellitus because of its low glycemic load , high fiber and high phytochemical content, so that people start taking more interest to it and it's consumption as a good food source will increase. Maize flour is a carbohydrate rich and energy rich flour loaded with fibre. Cornmeal prevents blood glucose level from shooting up and loaded with Zink which is necessary for formation of insulin. Maize flour is good for Diabetics, heart patients, weight loss and healthy lifestyle

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