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Investigation of phytochemical profiling and therapeutic effects of corn silk against diabetes in human male subjects

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Abstract: The metabolic illness known as diabetes mellitus (DM) is brought on by a problem with insulin secretion, action, or both. Chronic hyperglycemia brought on by insulin insufficiency also causes abnormalities in the metabolism of proteins, fats, and carbohydrates. Corn silk (*Stigma maydis*) has been used from centuries for treatment of many diseases like diabetes, hyper-uricemia, obesity, kidney stones, edema and many others. The female flower of *Zea mays* has an extended stigma that has historically been used to treat diabetes mellitus (DM). The objective of the current study was to evaluate how well corn silk lowers blood glucose levels. For this purpose, proximate, mineral and phytochemical profile of corn silk powder was analyzed. Afterwards human male subjects were divided into two groups G0 was a control group and G1 and G2 was an experimental group along with the dosage of 1 and 2g respectively. The effect of corn silk powder on blood sugar levels of male diabetic patients was checked every 7th day for 2 months and HbA1c test was done before and then after 60 days of clinical trial. The ANOVA results showed that random blood sugar level and HbA1c were highly significant.

Keywords: Corn silk, flavonoids, anti-diabetic, HbA1C.

INTRODUCTION

Diabetes mellitus (DM), a metabolic disease, is brought on by an issue with insulin secretion, action, or both. Protein, lipid, and carbohydrate metabolism issues are also brought on by chronic hyperglycemia brought on by insulin deficiency (Bastaki, 2005). The presence of natural antioxidants, particularly phenolic compounds, is what gives many traditional plants their therapeutic properties. Medicinal herbs and the phytocompounds they derive from are increasingly acknowledged as effective alternative therapies for several types of metabolic disorders (Yin *et al*., 2013). Traditional views of corn silk as a waste product have changed recently, in part because of the numerous health benefits it has on Asian and African nations. Because of its bioactive components, which have been shown to have effects against diabetes, hyperlipidemia, obesity, cancer, hepatotoxicity, nephrotoxicity and microbes (Fatima *et al*., 2012). Antioxidant qualities of the phytochemicals found in maize silk suggest that they may benefit humans. As a result, it can be utilised as food additives and dietary fibre to prevent a number of chronic diseases (Hasanudin *et al*., 2012).

Scientific research has shown that maize silk can improve insulin secretion, which in turn improves glycemic metabolism. Increasing insulin levels and restoring -cell function are two potential processes by which corn silk might reduce blood sugar levels (Chen *et al*., 2013; Zhang, Hulver, McMillan, Cline, & Gilbert, 2014).

Determining the proximate, mineral and phytochemical composition of maize silk was the aim of the current work. The purpose of the study was to determine how type 2 diabetic individuals would respond to corn silk powder.

MATERIALS AND METHODS

Procurement of raw material

Corn silk to be used in research purpose was collected from local fields in village located in Okara (Punjab) Pakistan. Mature and healthy corn silk was dried in sunlight only for one day and then packed in air tight bags in measured quantity and was stored at the room temperature.

Proximate Analysis

Corn silk powder was assessed for moisture, ash, crude, fat, protein and crude fiber and nitrogen extract as done by according to their standard procedures described by Association of official analytical chemists (Eisele & Drake, 2005).

Minerals Analysis

The suitable minerals analysis of corn silk such Na, Mg, K and Ca,, iron and zinc were analyzed by using this method (Zilic *et al*., 2016).

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Antioxidant features

Total phenolic content was analyzed by the activity of folin ciocalteu and total flavonoid content was determined by spectrophoto metrically through the colorimeter activity of alumin chloride (Žilić *et al*., 2016).

Experimental Study design for determination of hypoglycemic effects of corn silk on human male subjects

This study's three primary groups, each with ten people, served as its foundation. A placebo group received nothing, while the other two groups of patients received daily administration of 1 and 2 gram of corn silk ib form of capsules, respectively, for male diabetic patients.

Inclusion criteria

The human male subjects who were included in this study met the following criteria.

- Type II male diabetic subjects on hypoglycemic drug were selected from different area from the age group 35 to 60 year, of male gender.

Exclusion criteria

- Patients on insulin and had any other metabolic disorder were be excluded from this study.

Ethical approval

The present research work entitled "Investigation of phytochemical profiling and therapeutic effects of corn silk against diabetes in human male subjects" was performed by taking into consideration all ethical concerns and permission was guaranteed by the Institutional Biosafety Committee IBC.

STATISTICAL ANALYSIS

Using SAS version 6.12, the ANOVA along with Duncan Multiple Range Test were used to determine the significance of the data (SAS 1989).

RESULTS

Proximate analysis

A crucial element that is connected to the food's shelf stability is moisture. Therefore, assessing moisture content is essential for the creation of products with value added using food ingredients. Its shelf-life management was made easier by the prepared corn silk powder's moisture content of 7.54 0.28g/100g fw (table 1). The high carbohydrate content of maize silk, 54.21 0.45g/, is revealed by the chemical makeup of corn silk powders. The corn silk powder samples had a total fibre content of 12.59 0.74g/100g. Corn silk is one of the best sources of both protein and ash, with an average protein and ash levels of 14.78% and 4.38%, respectively. The mentioned variety's fat content was approximately 0.54%, NFE was measured at 65.94% and crude fibre was measured at 14.82%.

Minerals analysis

Everybody needs minerals to remain healthy. Body utilizes minerals for a variety of purposes, including maintaining healthy bones, muscles, a strong heart, and a sharp mind. The synthesis of hormones and enzymes depends on minerals. Micro minerals and trace minerals are the two different categories of minerals. A few factors that affect the mineral content of corn silk include the environment, soil type, irrigation, and nutrients from fertigation that contact nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, zinc, manganese, copper, boron, molybdenum and chlorine obtained from soil minerals and organic matter as well as from organic and inorganic fertilisers. This form of corn silk is a good source of sodium, magnesium, potassium, calcium, iron, and zinc, as demonstrated in table 2.

Table 1: Mean±Std deviation of proximate analysis of corn silk powder

PARAMETER	Mean ±Std
Moisture (%)	7.54 ± 0.28
Carbohydrate (%)	54.21 ± 0.45 g
Total fiber (%)	12.59 ± 0.74
Protein (%)	14.78 ± 0.27
Ash (%)	4.38 ± 0.28
NFE (%)	65.94 ± 1.08
Crude fiber (%)	14.82 ± 0.11

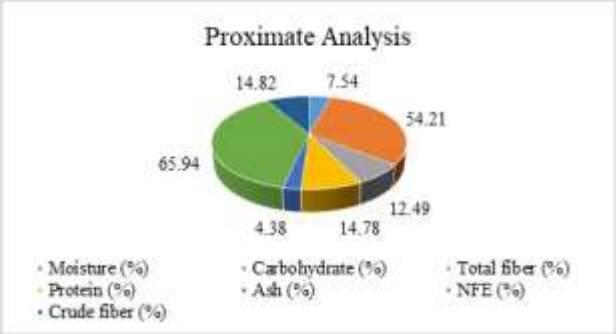

Fig. 1: Proximate composition of Corn silk powder

Table 2: Mean±Std Mineral analysis of corn silk powder

PARAMETER	Mean (ug/g) ±Std
Sodium	3221.18 ± 1.28
Magnesium	1145.14 ± 10.45
Calcium	1308.12 ± 101.45
potassium	1128.48 ± 4.8
Iron	38.24 ± 1.45
zinc	87.45 ± 0.89

Antioxidant measurements (TFC, TPC)

Corn silk is frequently regarded as a good source of antioxidants. These antioxidants include acrobats, flavonoids and polyphenolic chemicals. Quality and nutritional value are provided by these ingredients, in addition to anti-inflammatory, anti-diabetic, antiviral and antioxidant qualities that are crucial for maintaining good health. Although the methods of action of secondary

metabolites from medicinal plants differ depending on the structure and environment, they function as tiny molecular weight antioxidants. The total phenolic content of corn silk powder was 94.10 0.26 mg GAE/g, as shown in table 3. The amount of flavonoids in corn silk varies depending on the variety and ranges from less than 0.1% to 3%. According to recent findings, corn silk has a high flavonoid concentration of 163.93 0.83 mg QE/100g.

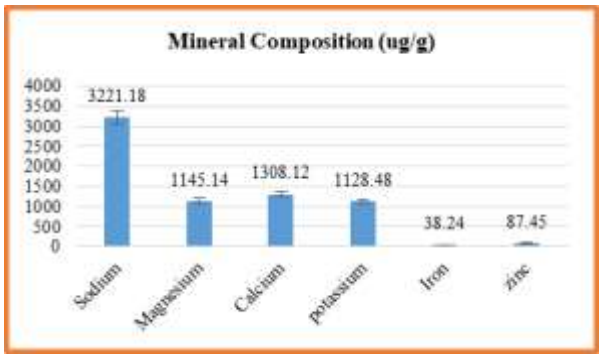

Fig. 2: Minerals analysis of corn silk powder

Table 3: The antioxidant-profile of corn silk powder

PARAMETER	Mean ±Std
Total-phenolic content (mg-GAE/g)	89.15±0.49
Total-flavonoid content (mg-QE/100 g)	157.43±0.58

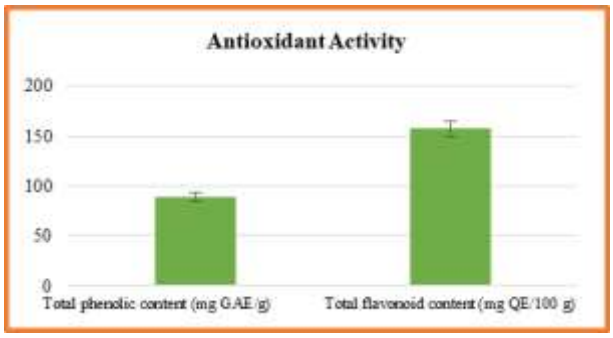

Fig. 3: Antioxidant features (tpc, tfc) of *Corn* silk powder

Bio evolution of corn silk in the management of blood sugar level in male subjects

Initial stage of treatment there was not any significant result but according to control the results were significant. However after 60 days, the random blood sugar level was checked to all patients; the results were highly significant. The control patients showed 227.30mg/dL but the group 1 which contained 1g corn silk powder showed 202.7mg/dL and group 3 that contained 2g corn silk powder showed 192.56mg/dL random blood sugar level. So, these results showed that 2g corn silk powder was more significant as compared to all other treatments. A significant difference was obtained in fasting level of blood sugar and postprandial level of blood sugar according to statistical results. Hence, the statistic results show that the powder of corn silk has highly significant effect on the diabetic patients and this powder has not any harmful effect on human health to reduce the level of blood sugar level.

Table 4: Mean ±Std of random blood sugar level corn silk powder

Groups	Day 0	Day 60	Mean
G0	225.15 + 1.45	229.45 + 0.45	227.30
G1	210 + 1.12	195.45 + 1.78	202.72
G2	198.12 + 1	187 + 1.95	192.56
Mean	227.30	227.30	227.30

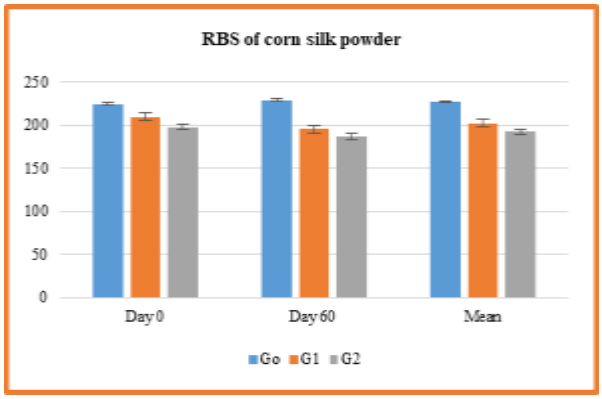

Fig. 4: RBS of corn silk powder

Folic acid, vitamin B12 and iron are abundant in corn and help the body produce more red blood cells. It aids in lowering the risk of anemia by giving the body the nutrition it needs to build new red blood cells.

Table 5: Mean±Std deviation of HbA1c of corn silk powder

Groups	Day 0	Day 60	Mean
G0	10.1 ± 0.5	10.65 ± 0.3	10.375
G1	12.12± 0.8	12.5 ± 0.5	12.31
G2	12.65 ± 0.5	12.0 ± 0.6	12.325

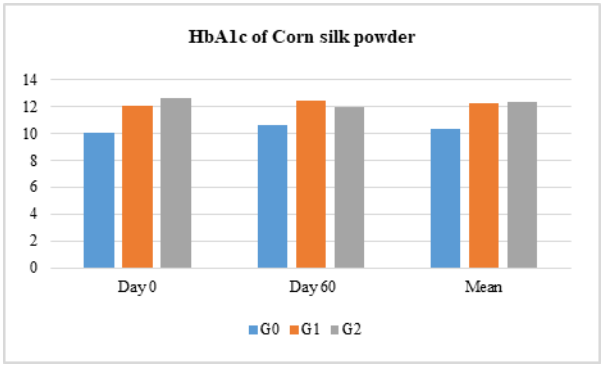

Fig. 5: HbA1c of *Corn silk powder*

DISCUSSION

Diabetes mellitus is polygenic metabolic disorder which generally requires lifelong pharmacological management. Glycemic level in diabetes mellitus is maintained

appropriately in the modern pharmacotherapy either with insulin supplements or with oral anti-diabetic medications like biguanides, sulphonylureas, thiazolidinediones, DPP4 inhibitors, α-amylase, α-glucosidase inhibitors etc (Marín *et al*., 2016). Uncontrolled hyperglycemia is associated with various micro-vascular (retinopathy, neuropathy and nephropathy), macro-vascular (stroke, coronary heart disease) and both micro-macro complications (diabetic foot) (Dwivedi and Rasal, 2020). Although, these agents are extensively used in the allopathic medicine system, there are some major drawbacks such as high cost and adverse events that alarm the investigation of new molecule for proper management of diabetes and its complications (Bacanli *et al*., 2019). Folk medicine or traditional plants are the best option to investigate for the new molecule which could be safe and cost effective as advised by the WHO (Pan *et al*., 2017). The current pharmacology employs the use of bioinformatic tools for the screening the bio-actives from the traditional plants.

The metabolic illness known as diabetes mellitus (DM) is brought on by a problem with insulin secretion, action, or both. Chronic hyperglycemia brought on by insulin insufficiency also causes abnormalities in the metabolism of proteins, fats, and carbohydrates. Corn silk (Stigma maydis) has been used from centuries for treatment of many diseases like diabetes, hyper-uricemia, obesity, kidney stones, edema and many others. The female flower of Zea mays has an extended stigma that has historically been used to treat diabetes mellitus (DM). The objective of the current study was to evaluate how well corn silk lowers blood glucose levels. For this purpose, proximate, mineral and phytochemical profile of corn silk powder was analyzed. Afterwards Human male Subjects were divided into two groups G0 was a control group and G1 and G2 was an experimental group along with the dosage of 1 and 2 g respectively. The effect of corn silk powder on blood sugar levels of male diabetic patients was checked every 7th day for 2 months and HbA1c test was done before and then after 60 days of clinical trial. The ANOVA results showed that random blood sugar level and HbA1c were highly significant.

Corn silk is rich in the flavonoid content and flavonoids are known to own antioxidant potential which can counter- act the oxidative stress which is one of the leading causes of diabetes (Marín *et al*., 2016). The improper balance between the antioxidant system and formation of oxygen derived free radicals leads to oxidative stress. Phytoconstituents known to possess antioxidant property that may be useful to target multiple pathways in order to manage diabetes and its complications (Nawaz *et al*., 2018). Thus, phyto chemicals from corn silk can modulate several pathways involved in pathogenesis of diabetes and manage blood glucose level synergistically *i.e.* "*single master key unlocks multiple locks*".

Many studies have been conducted in the past to establish the anti-diabetic potential of corn silk. One study was carried out to investigate the anti-diabetic potential of methanol extract of cooked corn silk on alloxan-induced diabetes in albino mice in which they found that blood glucose level decreased significantly ($p<0.05$) after 72 hours at dose 500mg/kg and 96 hour at dose 750 mg/kg of body weight (Zhang *et al*., 2016). Similarly, another study was conducted to investigate anti-diabetic, antioxidant and anti-hyperlipidemic activity of flavonoids from corn silk in which mice were given streptozotocin to induce diabetes where they found that flavonoids from corn silk have positive results for all three categories of investigations (Nawaz *et al*., 2018). A study conducted in the alloxan induced diabetic mice in which aqueous extract of corn silk is found to show anti-diabetic effect by improving the insulin production and healing up the beta cell of pancreas (Sani, 2016). Another study gave insight to the anti-diabetic effects of polysaccharides from corn silk in streptozotocin induced diabetic mice where they found that polysaccharides whose molecular weight is between 30-80 kDa have more potential than that of those having molecular weight <30 kDa and >80 kDa (Gaikwad *et al*., 2014).

CONCLUSION

Current research suggests that the corn silk variety G5417 has a high nutritional bioactive potential due to its high polyphenol, flavonoid, and ascorbate content as well as its significant antioxidant activity (Oyabambi *et al*., 2020). Due to its great value as a natural source of polyphenols, this plant material could be used to create value-added, functional, and nutraceutical goods (Abudayeh *et al*., 2022). The produced powder was found to be extremely heat-stable, as shown by DSC experiments. The components of corn silk powder are confirmed by FTIR analysis, the amorphous nature of the powder is demonstrated by XRD analysis, and the powder has acceptable colour values, making it a strong candidate for usage as a food additive (Xiao *et al*., 2022).

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