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# Hypoglycemic Activity of Okra (*Abelmoschus esculentus*) in Participants with Impaired Fasting Glucose

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## ABSTRACT

Impaired fasting glucose (IFG) is characterized by a blood glucose level higher than normal but lower than that of diabetes level. Abelmoschus esculentus (okra) is an alternative hypoglycemic and antidiabetic plant due to its phytochemical constituents that regulate intestinal glucose absorption and prevents insulin resistance. This study determined the hypoglycemic activity of okra among IFG participants. Subjects were random subjects with impaired fasting glucose results upon screening. Quasi-experimental pre-test post-test was used where a standard glucose load was consumed in the control phase and powdered okra seed-peel mixed with the glucose load was consumed during the experimental phase. The blood sugar concentration was measured again every hour until three hours after consumption of the standard glucose load. In the experimental phase, the same group of participants was asked to consume 75 grams of glucose load with powdered okra peel that depends on their body weight (200 mg/kg of body mass). Fasting, 1 -hour, 2-hour and 3-hour glucose concentration were measured the same way it was done during the control phase. Statistical analysis revealed that Abelmoschus esculentus has its hypoglycemic effect only during the first hour while data results for the 2nd and 3 rd hour are considered insignificant. The results proved that okra's mechanism in lowering glucose levels is immediate yet of short duration. Based on the data gathered, the researchers conclude that the powdered peel of Abelmoschus esculentus (okra) is effective in lowering the blood glucose levels of IFG individuals only during the first hour after the administration of oral glucose load. Abelmoschus esculentus may not be effective in lowering the blood glucose after the next hours due to the fact that its mechanism of action is immediate but of short duration. The researchers recommend future researches on the study of Abelmoschus esculentus using increased dosage of each participant and that the experiment should be performed at the same month.

**Keywords**: Abelmoschus Esculentus, Okra, Impaired Fasting Glucose, Diabetes, Ypoglycaemia, Insulin Resistance

## INTRODUCTION

Abelmoschus esculentus, locally known as okra, is a common dietary plant with a wide range of medicinal value and has been used to manage several disorders. Okra contains fibers that reduce blood sugar levels by regulating the sugar absorption rate in the intestinal tract.

Impaired fasting glucose (IFG) or prediabetes is an asymptomatic condition with fasting blood glucose levels higher than the reference range (70-99 mg/dl) but lower than the provisional diagnostic range of diabetes mellitus (126 mg/dL). People with IFG have a higher risk of developing diabetes and its associated complications like nephropathies. According to study, metformin is not recommended for IFG patients since they have not yet reached the boundary of diabetes level 1 (Prabune, Sharma, & Ojha, 2017).

This study intended to determine the ability of Abelmoschus esculentus in lowering glucose levels among IFG participants. Abelmoschus esculentus peel was separated from its seeds, dried and powdered and weighed according to the body weight of each participant, then mixed with a standard glucose load. The results of this study provided an alternative option for the management of IFG. This study also generated useful information for future researchers on Abelmoschus esculentus.

## LITERATURE REVIEW

People with Impaired Fasting Glucose (IFG) are potentially at risk for Diabetes Mellitus (DM) type II. DM type II is a prevalent chronic disease associated to risk factors namely physical inactivity, poor diet, genetic predisposition and aging review (Sabitha et al., 2011). DM type II is currently managed with pharmacologic drugs and physical interventions like diet and exercise but pharmacologic agents carry along with them side effects and fail to modify the rate of DM progression in the end that is why the scientific community is on quest to find the traditional medicines, which might be less toxic (Firdous, 2014; Neetu, Dileep, & Rizvi, 2016; Sabitha et al., 2011).

Organic phytochemicals such as flavonoids, steroids, terpenoids, carbohydrates, polyphenols, alkaloids, and tannins are sourced mainly from medicinal plants. These phytochemicals isolated from plants such as Abelmoschus esculentus exhibit lowering activity against glucose levels (Bauman,2015). Certain phytochemical studies confirmed the presence of triterpenes, tannins, sterols, and flavonoids (Panche, Diwan, &Chandra, 2016). Flavonoids contain phenolic structures. It is found in almost every part of certain plants with hypoglycemic potentials. The flavonoid phytochemical can be categorized into various classes like flavanones, flavanols, catechins, anthocyanins, flavones, etc. In relation to diabetes mellitus, beneficial effects of flavonoids have been studied, either through their capacity to avoid glucose absorption or to increase glucose tolerance (Saritha, 2017).

Flavonoids and its subclasses demonstrate antidiabetic characteristics either through increasing the uptake of insulin mediated glucose by target cells, increasing the secretion of insulin through the production of pancreatic B-cells, inhibition of aldose reductase, and promoting calcium uptake (Chung, 1998).

Tannins have the protective mechanism against bacterial infections, being a potential antimicrobial agent. Physiological effects of tannins were also determined such as to modulate immune responses, decrease the serum lipid level, reduce blood pressure, and accelerate blood clotting. The kind and dosage of tannins are important to these effects. Triterpenes are phytochemical agents known to have activity against diabetic complications, rendering them effective for antidiabetic mechanisms (Nazaruk & Borzym-Kluczyk, 2015).

Triterpenes can hinder enzymes involved in metabolic activity of glucose, they can control insulin levels, plasma glucose and as well as the prevention of insulin resistance development. They are considered potent antioxidant organic compounds due to inhibition of the development of the end products of advanced glycation (Ramachandran et al., 2010). Triterpenes work by inhibiting a-glucosidase and alpha-amylase which delays the absorbance of carbohydrates in the intestine, hence decreasing the postprandial insulin level (Fan et al., 2011).

Abelmoschus esculentus, possesses oleanolic acid, beta sistostenol, myricetin, kaempferol, as its antidiabetic compounds (Sabitha et al., 2011). Powdered okra seeds and peel (mesocarp) has been proven to lower glucose levels in streptozotocin and alloxan-induced rats (Nazaruk & Borzym-Kluczyk, 2015; Neetu, Dileep, & Rizvi, 2016). The water-soluble portion of okra was used to check the oral glucose absorption of Long Evans rats and it did give a significant reduction after 24 hours (Neetu, Dileep, & Rizvi, 2016). Ethanol extract reduced blood glucose, serum insulin levels and improved glucose tolerance in obese mice (Fan et al., 2011). Animals trials are adequate to support the effectivity, safety and toxicity of Abelmoschus esculentus but it needs human trials to confirm its therapeutic effect (Sabitha et al., 2011).

The method that was used in this study was based on a research design for diabetes mellitus type II where the participants were given plain tea which served as the control while the experimental group was given mulberry tea. Whereas in this study, the control group were given the glucose load only while the experimental group were given the glucose load with powdered okra seed which is dependent on the body mass of the participant, 200mg/kg (Banu et. al., 2015; Nazaruk & Borzym-Kluczyk, 2014; Worede et. al, 2017).

## METHODS

Sampling

This study used purposive sampling. The subjects included in this study had an initial FBS of 100-125 mg/dl, and with ages thirty-five years old and above. To avoid possible interferences, the researchers excluded those who were taking medications or any other dietary supplements.

Research Design

Quasi-Experimental Pre-test Post-test Design was used in the study because it aims to assess interventions but will not utilize randomization of subjects. The design was used to determine the effectiveness of the plant by comparing the result of the two phases of the study. In here, the selected participants served as both the control and the experimental group. During the control phase, the seventeen participants consumed the glucose load. During the experimental phase, the same group of participants consumed powdered Abelmoschus esculentus seed and peel, which was processed in Adventist University of the Philippines' facility. Independent t-test statistical tool was used in order to determine if a significant difference existed between the means of the two groups. An Advan glucometer was used to measure the Fasting Blood Sugar (FBS), 1st hour, 2nd hour, and 3rd hour for both the control and experimental groups. 6

Preparations of Powdered Okra Peel

The researchers used dried and powdered peel of the okra bought from the Biñan public market. The preparations for the powdered okra peel are as follows: The first one is the separation of okra peel from the fruit that was done manually in a clean yet convenient area. Second, drying of the okra was processed at the Adventist University of the Philippines for 8 hours using the Multi-Commodity Heat Pump Dryer. Third, the dried okra peels were pulverized using a heavy-duty grinding machine from the University Research Center. Fourth, the powdered okra peels were weighed according to the body weight of the participants (200mg/kg). Lastly, the powdered okra peels were packed together with the corresponding name of the subjects with a certain printed checklist.

Procedures for Administration

The researchers gave consent forms to the participants who passed the screening criteria. In the control phase of the study, the seventeen participants were asked to consume 75 grams of glucose load after observing 8-10 hours of fasting. The fasting blood glucose levels were measured using an Advan glucometer. The blood sugar concentration was measured again every hour until three hours after consumption of the standard glucose load. In the experimental phase, the same group of participants was asked to consume 75 grams of glucose load with powdered okra peel that depends on their body weight (200 mg/kg of body mass). Fasting, 1 - hour, 2-hour and 3-hour glucose concentration were measured the same way it was done during the control phase.

Analysis of Data

Independent t-test was used to compare the mean FBS of the experimental and control phase. To compare the effects between the groups (1 st hour, 2nd hour, 3 rd hour), paired t-test was used. Table 1 contains the reference values of Fasting Blood Sugar levels.

Table 1. **Reference Values for Fasting Blood Sugar Levels**

| Values | Interpretation |
|---|---|
| **70-99 mg/dl** | Normal |
| **100-125 mg/dl** | Impaired |
| **>125 mg/dl** | Diabetic |

## RESULTS

Fasting Blood Sugar and 1 st hour Glucose of Participants

Table 2 presents the fasting blood sugar (FBS) and 1st hour glucose result of both the control and experimental phases. The control phase has a mean difference of 48 while the experimental phase has a mean difference of 34.94. When these means are compared, their p-value is 0.039, indicating a significant difference in the glucose levels rise during the 1st hour.

Table 2. **Mean Difference between FBS and 1st Hour.**

| Difference | Group | M(mg/dL) | SD | t | p-value | Interpretation |
|---|---|---|---|---|---|---|
| **Between FBS and 1st hour** | Control | 48 | 20.67 | 2. 155 | 0.039 | Significant |
| | Experimental | 39.4 | 14.03 | | | |

Table 3. **Presents the Results Between the Experimental Hourly Intervals and Control. Difference of 1st and 2nd Hour, 2nd and 3rd Hour**

| Difference | Group | M(mg/dL) | SD | t | p-value | Interpretation |
|---|---|---|---|---|---|---|
| **Between 1st and 2nd hour** | Control | -25.65 | 29.74 | -1.91 | 0.065 | Not Significant |
| | Experimental | -9.06 | 19.97 | | | |
| **Between 2nd and 3rd hour** | Control | -16.24 | 16.74 | -0.859 | 0.397 | Not Significant |
| | Experimental | -11.18 | 17.00 | | | |

The values of the mean difference are negative due to the fact that glucose levels lower after the first hour. Decreased mean difference value between 1 st and 2nd hour and between 2nd and 3rd hour of the control and experimental phases are in favor of the control phrase, yet their p values are not significant. Though the mean of each phase have big differences, they are still insignificant.

Figure 1 shows the glucose level of the respondents across time intervals. As can be seen in the figure, after one hour, the glucose level of the control group increased faster than the experimental group. Then during the second and third hour, the glucose level of the control group decreased faster than the experimental group.


Figure 1. **Blood Sugar of the Respondents Across Time Intervals.**

## DISCUSSION

Impaired Fasting Glucose (IFG) or pre-diabetes is a condition wherein the blood glucose level of a person is above the reference range but below 126 mg/dl. It is a great public health challenge specifically to third world countries because most of the cases are undiagnosed and later on progresses to diabetes. About 12% of the world population has IFG and is considered to be very significant (Nazaruk & Borzym-Kluczyk, 2014). However, impaired fasting glucose (IFG) is a well manageable disease if detected in early stages. Table 4 enumerates the actual phytochemical contents of the local Abelmoschus esculentus that was used in this study as analyzed by Industrial Technology Development Institute (ITDI), Standards and Testing Division (STD) of the Department of Science and Technology (DOST) held last August 24-25, 2018:

Table 4. **Phytochemical Test Results of Abelmoschus Esculentus Powdered Peel**

| Sterols | (+) |
|---|---|
| Triterpenes | (+++) |
| Flavonoids | (+++) |
| Alkaloids | (++) |
| Saponins | (++) |
| Glycosides | (+) |
| Tannins | (+++) |

Legend: (+) Traces, (++) moderate, (+++) abundant, (-) Absence of constituents

Abelmoschus esculentus is a plant with known hypoglycemic activity due to its main components namely triterpenes, flavonoids and saponins. Triterpenes work by inhibiting the α-glucosidase and α-amylase activity (Lee & Phuong, 2010). When these two enzymes are inhibited, there will be a delay in the absorbance of carbohydrates in the intestine which Sterols (+) Triterpenes (+++) Flavonoids (+++) Alkaloids (++) Saponins (++) Glycosides (+) Tannins (+++) also leads to decrease in insulin postprandial levels. Plant-derived triterpenes are known to exert their hypoglycemic activity through various mechanisms which include stimulation of cellular glucose uptake and insulin secretion (Nazira, Qamar, &Ahmed, 2017). Flavonoids are potent antioxidants, it increases antioxidant defense mechanism to prevent cellular damage since both hyperglycemia and insulin resistance are associated to the production of oxidative stress, which can also result to impaired insulin action. On top of its action, it also inhibits α-glucosidase activity (Nazira, Qamar, &Ahmed, 2017). Myricetin is also a natural flavanol found in okra. Myricetin may modulate glucose and fructose transport by inhibiting the expression of the glucose transporter 2 (GLUT2), a major pathway of sugar absorption as a result, myricetin may inhibit or delay glucose absorption (Kwon et al.,2007). Saponins on the other hand may also inhibit the same enzyme.

As reflected from the results, the hypoglycemic effect of Abelmoschus esculentus was only found to be significant during the first hour. This only proves that certain phytochemicals mentioned above and are found in Abelmoschus esculentus delay the absorption of glucose in the intestine. The high viscosity of soluble okra fibers may also contribute to the inhibition the diffusion of glucose or any chemical taken together with it (Hajera et al., 2011). The phytochemical screening of Abelmoschus esculentus reveals that okra is abundant in triterpenes, flavonoids and tannins. In addition, moderate amount of alkaloids and saponins were detected while only trace amount for sterols and glycosides.

The results of the study showed a significant difference between the FBS and the first hour of the control and the experimental groups. However, the results were insignificant when the 2nd hour and 3rd hour were compared. Some of the participants during the experimental phase were not able to consume the exact amount of okra which is patterned to their body weights. The 200 milligrams in every one kilogram of body weight was based according to the study conducted to lowering the glucose levels in streptozotocin and alloxan-induced rats. The significant effect was only on the first hour, thus, the amount of 200 mg/kg of body weight may not be enough to lower the blood sugar levels until the 3rd hour.

**Conclusion**

Based on the data gathered, the researchers conclude that the powdered peel of Abelmoschus esculentus (okra) is effective in lowering the blood glucose levels of IFG individuals only during the first hour after the administration of oral glucose load. Abelmoschus esculentus may not be effective in lowering the blood glucose after the next hours due to the fact that its mechanism of action is immediate but of short duration.

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