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Hypoglycemic Effect of Selected Plant Species in Diabetic Patients

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Abstract

In the present project it was attempted to see the hypoglycemic effect of certain plant species in diabetic subjects. The subjects were fed with Neelkanthi (*Ajuga bracteosa*) and Plakhar (*Ficus lacor*) leaves alone and in combination with oats, soybean flour, amla powder and tomato juice for a span of 3 weeks. The sugar level was investigated and it was observed when Neelkanthi fed alone there was a 22.70 and 31.14 percent decrease in fasting and postprandial blood sugar. Plakhar was also noticed for its hypoglycemic effect but was found less effective in comparison of Neelkanthi as the per cent decrease was found as 3.41 and 19.47 in both the cases whereas, all the combinations were found most satisfactory. The neelkanthi and plakhar with oats were more hypoglycemic. The finding of this investigation indicates that the usage of these plant leaves resulted in a better decreased blood sugar level in both the cases.

Keywords: Neelkanthi; Plakhar; Hypoglycemic; Diabetes

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Introduction

The prevalence of diabetes has been steadily on the escalating for the past 3 decades, mirroring an increase in the prevalence of obesity and overweight people. In particular, the occurrence of diabetes is growing most rapidly in low and middle income countries. In 2015, worldwide there were 415 million people with diabetes by 2040 are estimated to increase 642 million. There were million cases of diabetes in India in 2015. Even 36.1 percent cases of diabetes in Indian adults who are undiagnosed. Globally in 2015, there were 5.0 million deaths occur due to diabetes means every 6 seconds one person dies from diabetes. There are several medicines available in the market to treat diabetes mellitus but no drug is found to be fully effective and safe. However, plants and plant-derived products have proven to be effective and safe in the treatment of various types of diabetes mellitus. In Indian system of medicine, several medicinal plants have found potential use as blood sugar lowering agents. Many of them have been scientifically explored for their usefulness in managing diabetes, the reports of which have been acknowledged and published in a number of scientific journals. These plants have no side effects and many existing medicines are derived from the plants.

Himachal Pradesh is well known for its richness in biodiversity and there are so many known and unknown plant species, which could prove to be quite effective against common ailments including diabetes. Keeping in view the increasing incidents of diabetes, there is an urgent need to explore some of the widely grown plant species for the hypoglycemic effect. In the present work it was attempted to see the hypoglycemic effect of certain plant species viz. Neelkanthi (*Ajuga bracteosa*) and Plakhar (*Ficus lacor*) leaves in diabetic subjects. The subjects were fed with Neelkanthi (*Ajuga bracteosa*) and Plakhar (*Ficus lacor*) leaves alone and in combination with oats, soybean flour, amla powder and tomato juice for a span of 3 weeks and tested hypoglycemic effect.

Materials and Methods

Raw material was collected from nearby villages, washed thoroughly to remove dust and debris and dried in a dehydrator at ± 50°C till completely dried. Cooled at room temperature and stored in air tight containers till further use.

Experiment with diabetic subjects

Thirty non-insulin dependent volunteers' diabetic subjects were selected from total 150 respondents. The selected patients were randomly divided into 12 groups and kept on suitable therapy for three weeks. The various interactions are given in **Table 1**. They were kept on controlled diet calculated on the basis of their age and weight along with the test materials for a period of 3 weeks.

Before the start of experiment, the blood samples of 30 volunteers NIDDM subjects was analyzed for fasting and post prandial blood glucose for a period of 3 weeks. No treatment was given during this period except the prescribed medicine, which they were already taking and the period was treated as self-control. After 3 weeks fasting and post- prandial blood sugar level samples were again collected.

Under controlled conditions, fasting blood sugar level and postprandial sugar level were estimated before and after the experimental period. The standards for blood sugar have been given in **Table 2**.

Collection of blood sample

Five ml of fasting and postprandial (2 hour after meal) blood samples of thirty selected NIDDM patients were collected before and after starting the supplementary experiment of three weeks. Blood samples were collected from a vein at anticubical arm area into centrifuge tube by a technician using 5 ml disposable syringe (dispovan). The plasma and serum were separated and transferred into sterilized and labelled screw capped glass vials and stored in deep freezer until used.

Analysis of blood samples

Serum glucose was analysed by Bayer diagnostics Auto Blood Analyzer based upon glucoseoxidase (GOD)/ peroxidase (POP) method (Bayer Diagnostics India Ltd.) by Trinder [1].

Results and Discussion

Blood sugar level

To see the effect of two medicinal species i.e., Neelkanthi (*Ajuga bracteosa*) and Plakhar (*Ficus lacor*) on fasting blood glucose level, an experiment was conducted on selected diabetic volunteers who were fed with Neelkanthi and Plakhar alone and along with oat, soybean, amla powder and tomato juice. One group was also fed with roasted wheat chapatis, whereas, control group was advised to take normal diet.

Table 1 Experiment with diabetic subjects (interactions).

T_0S_0	Control
T_1S_0	Roasted wheat chapati
T_2S_0	Neelkanthi (*Ajuga bracteosa*)
T_2S_1	Neelkanthi (*Ajuga bracteosa*) + Oat flour
T_2S_2	Neelkanthi (*Ajuga bracteosa*) + Soybean flour
T_3S_0	Plakhar (*Ficus lacor*)
T_3S_1	Plakhar (*Ficus lacor*) + Oat flour
T_3S_2	Plakhar (*Ficus lacor*) + Soybean flour
T_4S_1	Neelkanthi (*Ajuga bracteosa*)+ Amla powder
T_4S_2	Plakhar (*Ficus lacor*) + Amla powder
T_5S_1	Neelkanthi (*Ajuga bracteosa*)+ Tomato
T_5S_2	Plakhar (*Ficus lacor*) + Tomato

Table 2 Biochemical indices of metabolic control.

	Desirable	Acceptable	Poor
Fasting plasma glucose (mg/dl)	80-115	<140	>140
2 h post prandial plasma glucose (mg/dl)	120-160	<200	>200

Fasting blood sugar level

Fasting blood glucose levels of subjects of control and experimental groups are presented in **Table 3**. It is evident from the **Table 3** that fasting blood glucose of the subjects put on controlled diet was initially observed to be 137.53 ± 82.33 mg/dl which was increased to 156.33 ± 71.7 mg/dl after a span of 3 weeks. But when the subjects fed with roasted wheat chapatis the fasting blood glucose level was found to be decreased from 145.80 ± 64.01 to 135.06 ± 62.53 mg/dl. Similarly, in case of treatments T_2S_0, T_2S_1 and T_2S_2 the values for fasting blood glucose level were decreased to 136.30 ± 22.72, 124.50 ± 29.92 and 111.76 ± 19.9 mg/dl after three weeks from initial values 167.46 ± 43.16, 180.30 ± 55.87 and 115.86 ± 21.25, respectively. Similarly, the initial values recorded for the same constituents in case of treatments T_3S_0, T_3S_1 and T_3S_2 were 158.03 ± 77.86, 110.43 ± 16.55 and 201.35 ± 84.07 which were further decreased to 152.63 ± 74.75, 101.20 ± 21.62 and 169.90 ± 73.85 mg/dl, respectively. Whereas, in case of experimental groups with treatments T_4S_1 and T_4S_2, the values were decreased to 101.26 ± 10.02 and 81.73 ± 12.76 from 123.03 ± 1.09 and 85.77 ± 10.21 mg/dl, respectively. The initial values for the subjects with treatments T_5S_1 and T_5S_2 were 176.40 ± 11.45 and 138.03 ± 46.25 mg/dl which were decreased to 163.66 ± 12.0 and 135.76 ± 45.07 at the end of experiment. This decrease was observed to be statistically significant in case of treatments T_2S_0 and T_2S_1 at 10.0 per cent level and in case of T_4S_1 at 5.00 percent level whereas, in case remaining treatments the decrease was non-significant.

However, decrease in fasting blood sugar level (before and after the completion of trial) as compared to the control group was observed in the entire experimental group.

From the **Table 3**, it is apparent that all the experimental groups showed decrease in fasting blood sugar level in contrast to the control group, which showed an increase of +13.4 percent within a span of three weeks. This means that all the treatments and sub-treatments had positive correlation to decrease the blood sugar level. Neelkanthi showed more hypoglycemic effect in

Table 3 Fasting blood glucose level (mg/dl) of control and experimental groups.

S.No.	Groups	Initial level	Final level	% decrease	t' value
1	T_0S_0	137.53 ± 82.33	156.33 ± 71.7	13.4	0.29
2	T_1S_0	145.80 ± 64.01	135.06 ± 62.53	7.3	0.2
3	T_2S_0	176.46 ± 43.16	136.30 ± 22.72	22.7	1.42*
4	T_2S_1	180.30 ± 55.37	124.50 ± 29.92	30.9	1.53*
5	T_2S_2	115.86 ± 21.25	111.76 ± 19.9	3.5	0.24
6	T_3S_0	158.03 ± 77.86	152.63 ± 74.75	3.41	0.08
7	T_3S_1	110.73 ± 16.55	101.20 ± 21.62	8.6	0.6
8	T_3S_2	201.33 ± 84.07	169.90 ± 73.85	15.6	0.48
9	T_4S_1	123.03 ± 1.09	101.26 ± 1.02	17.6	15.03**
10	T_4S_2	85.77 ± 10.21	81.73 ± 12.76	4.6	0.42
11	T_5S_1	176.40 ± 11.45	163.66 ± 12.0	7.2	0.18
12	T_5S_2	138.03 ± 46.25	135.76 ± 45.07	1.6	0.06
CD (P<0.05)		102.63	74.95		

Values are the mean ± S.E
* Significant at 10 per cent level. ** Significant at 5 per cent level

comparison to Plakhar. Hypoglycemic action of Neelkanthi may be due to the relatively higher amount of fibre (NDF/ADF), alkaloid, tannin, palmitic acid β-sitosterol, and γ-sitosterol. Chopra et al. [2] reported presence of ceryl alcohol, β-sitosterol γ-sitosterol, cerotic and palmitic acid and a glucosidic constituent. Even in ayurveda, it is mentioned that Neelkanthi is a Tikta (bitter) and Kashaya (astringent) in taste and his Katu Vipaka and hence is helpful to relieves signs and symptoms of Madhumeha [3].

Among all treatments, subjects fed with oats chapatis along with Neelkanthi and Plakhar showed decrease in fasting blood level. However, the decrease was more in combination with Neelkanthi. This hypoglycemic effect is due to the nature of fibre and its viscosity which perhaps causes delayed gastric emptying, decreased intestinal transit time and impaired or delayed nutritional absorption. Also presence of fibre in the intestine activates the gastric inhibitory polypeptide which decreases the uptake of glucose from the small intestine. A study was also conducted on Oat given by Anderson et al. [4] in diabetic models. It was mentioned that the mode of action of fibre β-glucan is by decreasing rate of gastric emptying and reducing glucose absorption from gut. Water soluble dietary fibre form viscous solution, increases viscosity in the intestine, slow intestinal transit and delay gastric emptying [4] and slow glucose absorption by the intestine. The link between oat meal and diabetes was made by Kahlon et al. [5] who explained the mode of action of oat bran in reducing postprandial glycemia.

Combination of Neelkanthi with Amla powder had showed significant decrease in fasting blood sugar level at 5.0 percent level. This is due to the presence of antioxidants (Vitamin-C) in Amla, which is used in the treatment of liver and pancreatic disorder and also has neutralising effect on cell damaging free radical compounds, which were harmful to our body. Amla and tomato are rich in Vitamin-C and with antioxidant properties. This property reduces the extent of tissue changes in pancreas. This was also reported by Kalara and Anon [6,7].

The subjects fed with roasted wheat chapaties also showed 7.30 percent decrease in fasting blood sugar level; this may be due to the formation of pyruvates during roasting of wheat flour which does not raise the blood sugar level through reduction in body weight which prevents the occurrence of diabetes and its complications. Soybean showed hypoglycemic effect due to the presence of antioxidants like isoflavons which acts as hypoglycemic agent and also due to the low glycemic index of Soybean. Moreover, soybean fibre is extremely fermentable in humans and has more physiological benefits [8,9].

Postprandial blood glucose level of control and experimental subjects

Post prandial blood glucose levels in case of control and experiment group are presented in **Table 4**. From the **Table 4** it is clear that initial level of post prandial blood glucose level recorded for the control diet was 156.26 ± 75.03 which was increased to 171.50 ± 69.70 after 21 days. However, the values recorded in case of subjects put on experimental diet Roasted wheat (T_1S_0) was 222.63 ± 88.89 and was decreased marginally 218.10 ± 88.04 with 2.03 per cent decrease. The initial values observed in treatments T_2S_0, T_2S1 and T_2S_1 were 269.40 ± 38.82, 281.13 ± 25.92 and 246.56 ± 61.04 mg/dl, respectively which was decreased to 185.50 ± 31.62, 224.66 ± 27.10 and 246.56 ± 61.04 mg/dl, respectively and per cent decrease recorded as 31.14, 20.0 and 12.2, respectively. The values for postprandial blood glucose recorded for subjects with treatments T_3S_0, T_3S_1 and T_3S_2 were 288.03 ± 96.26, 277.43 ± 52.86 and 367.43 ± 140.26 at the initial level. But after 21 days a decrease was noted with the values of 231.93 ± 109.71, 239.03 ± 46.59 and 326.16 ± 123.11 mg/dl correspondingly. The percent decrease turned out to be 19.47, 13.84 and 11.23 percent, respectively. The initial and final post prandial blood glucose level in case of treatments T_4S_1 and T_4S_2 were 299.06 ± 20.75 and 140.96 ± 32.02 mg/dl. Whereas, the values were decreased to 210.63 ± 18.88 and 129.50 ± 27.27, respectively. Moreover, a decrease was also noted for treatments T_5S_1 and T_5S_2 with the initial values of 292.20 ± 50.96 and 192.43 ± 61.48 which were decreased to 222.03 ± 16.59 and 173.40 ± 53.49, respectively. That mean the values were decreased to 24.01 and 9.88 percent, respectively. The treatment T_2S_0, T_2S_1 and T_5S_1 showed significant decrease at 5.0 percent level, while in case of rest of the treatments the decrease was statistically non-significant.

However, decrease in post prandial blood sugar level were observed in all the experimental group (before and after the completion of trial) as compared to control group, who were kept on normal diet.

From the same table, it is apparent that all the experimental groups showed decrease in blood glucose level in contrast to control group, which showed an increase of +7.6 percent within the span of 3 weeks. This means that all the treatments and sub-treatments had positive correlation to decrease the blood sugar level. Neelkanthi showed more hypoglycemic effect than Plakhar. This hypoglycemic effect of Neelkanthi may be due to the relatively higher amount of fibre (NDF/ADF), alkaloid, tannin, protein and palmitic acid along with a glucosidic constituent. Chopra et al. [2] have already mentioned the presence of ceryl alcohol, β-sitosterol, γ–sitosterol cerotic and palmitic acid along with glucosidic constituents in Neelkanthi. This was further supported by Karnick and Pathak [10] who found that Neelkanthi contain glucoside and tannins.

Also combination of Neelkanthi and Plakhar with oat flour showed decrease in postprandial blood glucose level. However, the significant decreases were found in combination with Neelkanthi. This may be due to the presence of soluble fibre especially β-glucane in oat which have antidiabetic activity. This soluble fire slows the absorption of food by creating gel like substance in the stomach. Even the presence of anti-nutrients like phytic acid and phenol may act as hypoglycemic agent which inhibits amylase and thereby decreases the glycemic response. This explanation was also given by Thompson in 1984 to discuss the relationship of phytic acid and polyphenol with hypoglycemia. The link between Oat meal and diabetes was made by Anderson et al. [3] who explained the mode of action of Oat bran in reducing postprandial glycemia. The difference in molecular

Table 4 Postprandial blood glucose level (mg/dl) of control and experimental groups.

S.No.	Groups	Initial level	Final level	% decrease	't' value
1	T_0S_0	159.26 ± 75.03	171.50 ± 69.70	7.6	0.2
2	T_1S_0	222.63 ± 88.89	218.10 ± 88.04	2.03	0.06
3	T_2S_0	269.40 ± 38.82	185.50 ± 37.62	31.14	2.68**
4	T_2S_1	281.13 ± 25.92	224.66 ± 27.10	20	2.60**
5	T_2S_2	246.56 ± 61.04	216.43 ± 54.86	12.2	0.63
6	T_3S_0	288.03 ± 96.26	231.93 ± 109.71	19.47	0.66
7	T_3S_1	277.43 ± 52.86	239.03 ± 46.59	13.84	0.94
8	T_3S_2	367.43 ± 140.26	326.16 ± 123.11	11.23	0.38
9	T_4S_1	299.06 ± 20.75	210.63 ± 18.88	29.56	5.45**
10	T_4S_2	140.96 ± 32.02	129.50 ± 27.25	8.12	0.47
11	T_5S_1	292.20 ± 50.96	222.03 ± 16.59	24.01	0.72
12	T_5S_2	192.43 ± 61.68	173.40 ± 53.49	9.88	0.4
CD (P<0.05)		136.73	110.49		

Values are the mean ± S.E
** Significant at 5 per cent level

weight, processing methodology indicates that possible activity of other components in bran may affect results.

Combination of Neelkanthi with Amla powder showed significant decrease in blood sugar level. This is due to the presence of antioxidants (vitamin-C) in amla which used in the treatment of liver and pancreatic disorders and also has neutralising effects on cell damaging free radical compounds, which are harmful to the body Kalra [6].

The subject fed with roasted wheat chapatis also showed 2.03 percent decrease in fasting and postprandial blood sugar level. This may be due to the formation of pyruvate during roasting of wheat flour, which does not raise the blood sugar level through reduction in body weight and prevents the occurrence of diabetes or its complications. Soybean showed hypoglycemic effect due to the presence phytate. Phytate brings the hypoglycemic activity through the inhibition of amalyase the calcium dependent enzyme because the activity of this enzyme can be reduced by the binding of phytate to calcium or by the binding to the calcium, it can also bind to the protein and starch, thereby reducing the ability of starch to reach the active site of amylase causing delay in the absorption of glucose.

Conclusion

Through the trial, it can be concluded that though both the species showed a decrease in blood sugar level Neelkanthi proved to be more effective than Plakhar. These species then combined with Oat flour and Amla powder lowered the blood sugar level in the human diabetic subjects. Plants are natural antioxidants and effective herbal medicines, in part due to their anti-diabetic compounds, such as flavonoids, tannins, phenolic, and alkaloids that improve the performance of pancreatic tissues by increasing the insulin secretion or decreasing the intestinal absorption of glucose. More researches are needed in order to separate the active components of plants and molecular interactions of their compounds for analysis of their curative properties.

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