Article

Effect of Peanut (Arachis Hypogaea L.) On Fasting Blood Glucose And Hba_{1c} in Alloxan Induced Diabetic Male Rats

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Abstract

Background: Diabetes mellitus (DM) is a heterogeneous group of metabolic disorders with micro and macrovascular complications which are the major causes of morbidity and mortality in diabetic patients. Peanut due to its anti-oxidant property can reduce blood glucose level and may reduce the risk of diabetes. **Objective:** To observe the anti-diabetic effects of peanut (Arachis hypogaea L.) in alloxan-induced diabetic male rats. **Method:** This experimental study was carried out in the Department of Physiology, Sir Salimullah Medical College (SSMC), Dhaka in 2013. For this purpose, 15 wistar albino male rats, aged 90-120 days, weighing 160-200 g (initial body weight) were included in the experimental group (DG-A-P). Age and weight matched 20 wistar albino rats without peanut supplementation was taken as control and divided into (BC and DC-A) . All groups of animals received basal diet for 21 consecutive days. In addition to basal diet, animals of DC-A received alloxan intraperitoneally only on the first day of the study. Moreover, animals of DG-A-P also received peanut extract for 21 consecutive days. After 16 hours of fasting blood samples were collected from tail vein of all rats on day-1 and day-3. After taking final body weight all the rats were sacrificed on 22nd day. Their pancreas was removed and weighed. To observe glycemic control serum blood glucose and blood HbA_{1c} levels were measured by usual laboratory technique. ANOVA, independent t-test and paired t-test were used for statistical analysis. **Result:** The % change of body weight was significantly ($p<0.001$) lower in DC-A in comparison to that of BC. The weight of pancreas was significantly lower in DC-A ($p<0.001$) and DG-A-P ($p<0.05$) when compared to that BC, whereas this level was significantly higher ($p<0.001$) in DG-A-P than that of DC-A. The mean fasting blood glucose level on day-3 was significantly ($p<0.001$) higher in DC-A and DG-A-P in comparison to that of BC. Then this level was significantly ($p<0.001$) lower in DG-A-P in comparison to that of DC-A on day-22. Moreover, significantly higher levels of HbA_{1c} were observed in DC-A ($p<0.001$) and DG-A-P ($p<0.05$) in comparison to those of BC. Again, significantly ($p<0.001$) lower level of blood HbA_{1c} were observed in DG-A-P than those of DC-A. **Conclusion:** From this study, it can be concluded that peanut (Arachis hypogaea L.) has anti-diabetic effect by reducing fasting blood glucose, HbA_{1c} levels. This anti-diabetic effect may be due to its high MUFA content and anti-oxidant property.

Key word: Anti-diabetic, Peanut, Alloxan.

Bangladesh Soc Physiol. 2014, December; 9(2): 48-53
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http://www.banglajol.info/index.php/JBSP

Introduction

Diabetes mellitus is a syndrome of impaired carbohydrate, fat and protein metabolism caused by either lack of insulin secretion or decreased sensitivity of the tissues to insulin[1].Two types of diabetes mellitus exist and are caused by a complex interaction of genetics and environmental factor [2]. It is a chronic debilitating disease associated with severe

Received March 2014; Accepted October 2014

complication like cardiovascular disease, nephropathy, neuropathy, retinopathy[3].

Alloxan is a cytotoxic glucose analogues and the most prominent diabetogenic agent. Some researchers reported that alloxan could induce diabetes due to necrosis of the pancreatic â-cells[4]. It also generates free radicals which inhibits glucokinase thereby decreases glucose induced insulin secretion and causes hyperglycaemia[5] .

Peanuts are nutrient dense foods that are particularly rich in protein and fat, mostly unsaturated fatty acids[6]. These unsaturated fatty acids improves insulin sensitivity and reduce the risk of type 2 diabetes [7].Peanuts are also a rich source of vitamin- B_6, vitamin- E, niacin, folic acid, copper, magnesium, potassium and zinc[6]. Again, peanuts are also a source of plant protein, arginine, dietary fiber and numerous bioactive substances like flavonoids, resveratrol and plant sterols[8-9]. Flavonoid is a specific inhibitor of glucose-6-phosphate translocase and reduce hepatic glucose production thus decrese blood glucose level and HbA_{1c} [10].

It has been observed that consuming two ounces of nuts daily as a replacement for carbohydrates can reduce blood glucose level in people with diabetes mellitus[11]. Again, other researchers observed that consumption of peanut; 5 times per week (about 140 g of peanuts per week) reduce the risk of type 2 diabetes by 21% [9].

Diabetes mellitus (DM) is not a curable disease and treatment is must for the survival of the patients, therefore in diabetic patients dieting and exercise are usually recommended[1]. For the treatment of diabetes mellitus some anti-diabetic drugs are available, but these drugs may produce some side effects[3]. Traditional and herbal medicines may play important role in prevention and management of diabetes mellitus due to their anti-oxidant nature[12]. Therefore, the present study has been designed to observe the anti-diabetic effect of peanut in alloxan induced diabetic rats. It is also expected that the result of this study would make peanut acceptable among the people as a rich source of nutrients with medicinal value for the prevention of diabetes mellitus.

Methods

This experimental study was conducted in the Department of Physiology, Sir Salimullah Medical College (SSMC), Mitford, Dhaka from July 2012 to June 2013. The protocol of this study was approved by Institutional Ethics Committee (IEC) of SSMC. Total 35 Wistar albino male rats, age 90-120 days, weighing 160-200 grams were included in this study. After acclimatization for 14 days, the animals were divided into control group (without peanut) and experimental group (with peanut). Control group was divided into BC (Baseline control, n=10) and DC-A (Diabetic control with alloxan, n=10). Experimental group was DG-A-P (Diabetic group with alloxan after peanut treatment, n=15). All groups of animals received basal diet for 21 consecutive days. In addition to basal diet, animals of DC-A received alloxan intraperitoneally (170mg/kg body weight) only on the first day of the study. Moreover, animals of DG-A-P in addition to alloxan intraperitoneally (170mg/kg body weight) only on the first day of the study, also received peanut extract (2 ml/day; orally) for 21 consecutive days (started from day-1 of study period). After 16 hours of fasting blood samples were collected from tail vein of all rats on day-1 and day-3. After acclimatization and before giving any supplementation, body weights of all the rats were measured (initial bw). After giving alloxan and peanut extract all the animals including the baseline control were anaesthetized with the help of chloroform (30%) and sacrificed on 22nd day. Before anaesthetized the rats, their body weight (final bw) were recorded. The blood and pancreas samples were collected after sacrificing the rats. The pancreas was washed in ice cold saline and weighed by electric balance analyzer. For the assessment of glycemic control fasting blood glucose and blood HbA_1c were measured in the

laboratory of Department of Physiology, SSMC and in the Department of Biochemistry, BSMMU respectively. The statistical analysis was done by one way ANOVA, Bonferroni and Paired t-test as applicable.

Results

The % change of body weight was significantly ($p<0.001$) lower in DC-A in comparison to that of BC. The weight of pancreas was significantly lower in DC-A ($p<0.001$) and DG-A-P ($p<0.05$) when compared to that of BC, whereas this level was significantly higher ($p<0.001$) in DG-A-P than that of DC-A (Table I).

The mean fasting blood glucose level on day-3 was significantly ($p<0.001$) higher in DC-A and DG-A-P in comparison to that of BC. Then this level was significantly ($p<0.001$) lower in DG-A-P in comparison to that of DC-A on day-22. Moreover, significantly higher levels of HbA_{1c} were observed in DC-A ($p<0.001$) and DG-A-P ($p<0.05$) in comparison to those of BC. Again, significantly ($p<0.001$) lower level of blood HbA_{1c} were observed in DG-A-P than those of DC-A (Table II).

Fasting blood glucose level in DC-A were significantly higher in day-3 ($p<0.05$) and day-22 ($p<0.001$) in comparison to day-1. Moreover, in this group the level was significantly ($p<0.001$) higher in day-22 when compared to day-3. Again, in DG-A-P fasting blood glucose level was significantly ($p<0.05$) higher in day-3 and lower in day-22 in comparison to day-1 and day 3 respectively (Table III).

Table I: Body weight and pancreas weight of different groups of rats (n=35)

Parameters	Without peanut		With peanut
	BC	DC-A	DG-A-P
Initial body wt (g) Day-1	191.17±2.55	189.08±2.77	189.35±3.58
Final body wt (g) Day-22	198.33±6.43	177.09±6.31**	186.76±3.81*•
% of change from final (F) to initial (I) body wt [(F-I/I×100]	3.75±0.62	-6.35±2.59+	-1.37±0.49^
Pancreas wt (g)	0.67±0.05	0.34±0.10—	0.58±0.05-"

Values are means ±SD, Statistical analysis were performed by independent sample t-test and paired t-test. Final body wt (**p<0.001 & *p<0.05 BC vs DC-A & DG-A-P) (•p<0.001 DC-A vs DG-A-P). % change of body wt (+p<0.001 BCvsDC-A) (^p<0.001 DC-AvsDG-A-P). Pancreas wt (—p<0.001 & -p<0.05 BCvsDC-A & DG-A-P) ("p<0.001 DC-AvsDG-A-P). BC = Baseline control DC-A = Diabetic control with alloxan DG-A-P = Diabetic group with alloxan after peanut treatment.

Table II: Fasting blood glucose and blood HbA_{1c} levels in different groups of rats (n=35)

Parameters	Without peanut		With peanut
	BC	DC-A	DG-A-P
Fasting blood glucose mmol/L Day-1	5.38±0.52	5.43±0.46	5.21±0.39
Day-3	5.39±0.55	8.06±0.27**	8.00±0.18*
Day-22	5.38±0.72	13.53±2.02•	5.79±0.63^
HbA_{1c}	5.11±0.63	8.84±1.99++	6.32±0.83+"

Values are expressed as means ±SD.Statistical analysis was done by ANOVA test and then Bonferroni test was performed to compare between groups. Fasting blood glucose (Day-3 **p<0.001 & *p<0.001 BC vs DC-A & DG-A-P) (Day-22 •p<0.001 BC vs DC-A & ^p<0.001 DC-A vs DG-A-P). Blood HbA_{1C} (++p<0.001 & +p<0.05 BC vsDC-A & DG-A-P) ("p<0.001 DC-AvsDG-A-P). BC = Baseline control DC-A = Diabetic control with alloxan DG-A-P = Diabetic group with alloxan after peanut treatment.

Table III: Fasting blood glucose level in different days in rats (n=35)

Fsting blood glucose mmol/L	Without peanut		With peanut
	BC	DC-A	DG-A-P
Day-1	5.38±0.52	5.43±0.46	5.21±0.39
Day-3	5.39±0.55	8.06±0.27**	8.00±0.18+
Day-22	5.38±0.72	13.53±2.02*•	5.79±0.63^

Values are mean ±SD. Statistical analysis was done by Paired t-test to compare between days. Fasting blood glucose for DC-A (**p<0.05 & *p<0.001 Day-1vsDay-3 & Day-22) (•p<0.001 Day-3vsDay-22). DG-A-P (+p<0.05 Day-1vsDay-3) (^p<0.05 Day-3vsDay-22). BC = Baseline control DC-A = Diabetic control with alloxan DG-A-P = Diabetic group with alloxan after peanut treatment.

Discussion

In this study the % change of body weight was significantly lower in DC-A in comparison to that of BC. This finding is consistent with that of some other investigators[13]. The pancreas weight was significantly lower in DC-A and DG-A-P (p<0.05) in comparison to that of BC. Again, this level was significantly (p<0.05) higher in DG-A-P in comparison to that of DC-A. Similar findings was reported by different investigators[14].

In the present study, fasting blood glucose level on day-3 was significantly higher in DC-A and DG-A-P in comparison to that of BC. However, on day-22 this level was significantly lower in DG-A-P in comparison to that of DC-A. Similar finding was also observed by different researchers by using different herbal plants [13,15]. In DC-A fasting blood glucose level was significantly higher from day-1 to day-3 (p<0.05) and then to day-22. Again, in DG-A-P this level was significantly higher from day-1 to day-3 and then decreased towards the level of day-1 on day-22 and the difference was not statistically significant. This finding was equivocal with that of some other researchers by using different nut [16]. On the contrary, another researchers find no significant blood glucose lowering effect by using low dose of vinca rosea (nayantara). This discrepancy may be due to the fact that in that study different species of plant was used at a low dose[12].

In this study, significantly, higher level of blood HbA_{1c} was observed in DC-A and DG-A-P in comparison to that of BC. Again, this level was significantly lower in DG-A-P in comparison to that of DC-A. Some researchers also made similar observation by using resveratrol[17]. In contrast, another investigators did not find any significant change of blood HbA_{1c} level by using low dose (30g/day) of walnut[18].

Elevated levels of fasting blood glucose and blood HbA_{1c} with decreased pancreatic weights were observed in DC-A of the present study.

The diabetogenic agent alloxan inhibits glucokinase enzyme , glucose sensitivity of â-cell and decrease glucose-induced insulin secretions thereby re sult in hypoinsulinaemia and then hyperglycemia [19,20].However, chronic hyperglycemia causes non enzymatic glycation of Hemoglobin A and thus causes increased blood HbA_{1c} level [21].

Alloxan-induced Hyperglycemia causes decrease cellular density, severe vaculation and reduces the number of â-cells, which in turn leads to decrease pancreatic weight [22].Again, decreased serum insulin level causes decreased protein synthesis, increased endogenous protein breakdown and thereby decreased body weight [1].

It has been postulated that resveratrol, a poly-phenol phytoalexin present in peanut increases insulin secretion and sensitivity [17].The

flavonoids and phytosterols in peanut show anti-diabetic effects via lowering the blood glucose and HbA_{1c} levels[16]. Again, peanut supplementation may significantly decrease blood glucose concentration and insulin requirements by increasing peripheral utilization of glucose [16].

Oleic acid which is the predominant mono-unsaturated fatty acid in peanut improves insulin sensitivity, increases insulin secretion and reduces blood glucose level thereby reduces the risk of diabetes [23].In the present study, alloxan induced diabetes was observed in Wistar albino rats as evidenced by their measured higher fasting blood glucose level. Again, decreased pancreatic weight and body weight of this study indicate chronic hyperglycemia, which is further supported by their measured higher level of HbA_{1c}.

Again, lower levels of fasting blood glucose, blood HbA_{1c} in alloxan and peanut treated rats of this study suggested the anti-diabetic effect of peanut in this group of animals. The anti-diabetic effect may be due to mono-unsaturated fatty acid content and the free radical scavenging activity of peanut. However, the exact mechanism involved cannot be elucidated from this type of study due to time and financial constrains.

Conclusion

From this study, it can be concluded that peanut (Arachis hypogoea L.) may have some anti-diabetic role by reducing blood glucose, HbA_{1c}.The high mono-unsaturated fatty acid content and free radical scavenging activity of peanut may be responsible for this anti-diabetic effect.

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