Comparative Effects of Quail Eggs, Quail Eggs/Vit C and Glibenclamide on Streptozocin-induced Diabetes mellitus

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Abstract

In recent years, quail eggs have become a subject of interest because of its properties and medical benefits. In this study, the separate and combined effects of quail eggs and vitamin C on the blood glucose level and body weight of streptozotocin-induced diabetic rats were investigated. The 30 wistar rats were randomly assigned into five groups; Group I (control), Group II (diabetic rats without treatment), Group III (diabetic rats treated with raw quail eggs only), Group IV (diabetic rats treated with raw quail eggs and vitamin C) and Group V (diabetic rats treated with Glibenclamide 600 µg/kg body weight). Diabetes mellitus was induced in fasted rats with a single intraperitoneal injection of streptozotocin (50 mg/kg body weight). The induced rats were then treated with the Quail eggs, Quail eggs/vit C, and Glibenclamide. At the end of the 10 days of treatment, the group treated with quail eggs and vitamin C at 0.15 ml/kg and 200 mg/kg body weight per day, respectively showed a significant (p< 0.05) hypoglycaemic effect, as the mean blood glucose level in the group decreased with an increase in the mean body weight. The group treated with Glibenclamide showed similar and stronger effect of hypoglycaemia. The group treated with quail eggs alone did not show any significant hypoglycaemic effect. Consequently, the groups treated quail eggs/vit C and Glibenclamide lost significant body weight. Quail eggs alone, quail eggs combined with vit C and Glibenclamide have hypoglycaemic effect after 10 days of administration, and could therefore be used to manage diabetes mellitus. Glibenclamide is however more potent for this purpose than quail egg/vit C, which is also more potent than quail egg alone.

Keywords:
Quails Egg, Streptozotocin, Vitamin C, Diabetes mellitus, Blood Glucose, Hypoglycaemic effect

1 Introduction

Diabetes mellitus is a chronic metabolic disorder that has numerous causes. It is characterised by defects in insulin secretion and/or insulin action; leading to chronic hyperglycaemia with disturbances of carbohydrate, protein and fat metabolism that occurs because the insulin plays an important role in stimulating glucose uptake in non-hepatic tissues like the adipose tissue and skeletal muscle. Diabetes mellitus is associated with an increased risk of thrombotic, atherosclerotic and cardiovascular disease. The effects of diabetes mellitus include long-term damage, dysfunction and failure of various organs.

Hyperglycemia is the primary clinical manifestation of diabetes mellitus and is thought to contribute to diabetic complications by altering vascular cellular metabolism, vascular matrix molecules and circulating lipoproteins. About 70 - 80% of deaths in diabetic patients are due to vascular disease. The hyperglycemia is caused as a consequence of a deficiency in insulin in type I diabetes, and is a feature of late type II diabetes.

Streptozotocin (STZ) is a toxin that possesses the ability to induce selective destruction of pancreatic beta cells, resulting in insulin deficiency and hyperglycemia. In STZ-induced diabetic rats, the concentration of insulin decreases rapidly after beta
cell destruction by STZ and the blood glucose levels increase to be greater than 11.1 mmol/L (200 mg/dL). STZ has long been used as a drug of choice to induce diabetes in various animal models because it liberates toxic amounts of nitric oxide that participates in mitochondrial DNA damage; impairing the signalling function of beta cell mitochondrial metabolism and also inhibiting glucose-induced insulin secretion. The STZ rat model of diabetes has been widely investigated since 1963. It is one of the most commonly used models of human disease because it is known to mimic many of the acute, and some of the chronic complications observed in humans with diabetes mellitus. This model is therefore considered an appropriate model to assess mechanisms of diabetes and evaluate potential therapies. American Diabetes Association (ADA) criteria include; symptoms of diabetes mellitus (for example; polyuria, polydipsia, and unexplained weight loss) and a random plasma glucose concentration of greater than 200 mg/dl (11.1mM), a fasting plasma glucose concentration of greater than 126 mg/dl (7 mM), or a plasma glucose concentration of greater than 200 mg/dl (11 mM) 2 hours after the ingestion of an oral glucose load. Some additional symptoms of diabetes mellitus include glucosuria, lipemia and unusual hunger.

Despite the DNA breakthrough in 1978 which allowed for the artificial synthesis of insulin (which has been effective in the management of diabetes mellitus), many research works have been carried out and are still going on in order to get more improved ways of treating diabetes mellitus.

In view of this, quail eggs have become of great interest to modern medicine due to their therapeutic use in the treatment of a wide variety of diseases. Quail eggs are rich in proteins, mineral substances and have low carbohydrate content. They are recommended for diabetic patients because they do not increase the carbohydrate level in the body and they contain some fat-soluble and water-soluble vitamins that help in maintaining normal metabolism in the body.

Vitamin C (ascorbic acid or ascorbate) is a six-carbon lactone; synthesized from glucose in the liver of most mammalian species with the exception of humans, non-human primates and guinea pigs. These species lack the enzyme gulonolactone oxidase, which is essential for synthesis of the ascorbic acid. Vitamin C is a water-soluble vitamin and is also important in the management of diabetes mellitus because it mediates an increase in insulin action by improving non-oxidative glucose metabolism. The substances listed above have been considered with respect to the treatment and management of diabetes mellitus because of the antidiabetic effects they exert on the body.

This study therefore examined the hypoglycaemic effect of quail eggs and vitamins C on streptozotocin-induced diabetes mellitus in rats.

2 Material and Methods

2.1 Experimental animals

Thirty (30) wistar rats of both sexes weighing between 125-250g were purchased from Nigerian Institute of Trypanosomiasis Research in Vom, Plateau State and kept under suitable laboratory condition at the Animal House of the College of Medicine of Bingham University, Karu were used for the experiment. They grouped into five, and all fed with were standard rat pellets and water ad libitum.

2.2 Animal grouping/ experimental design

Group 1: Rats on normal feed + water (Control)
Group 2: STZ-induced diabetic rats + normal feed + water
Group 3: STZ-induced diabetic rats + 0.15 ml/kg body of raw quail eggs only
Group 4: STZ-induced diabetic rats + 0.15 ml/kg body of raw quail eggs + vitamin C (200mg/kg)
Group 5: STZ-induced Diabetic rats + Glibenclamide (600 µg/kg body)

2.3 Standard drugs

Streptozotocin (STZ) (Sigma, St. Louis, USA) (50mg/kg body weight) freshly dissolved in 0.1 M sodium citrate buffer; Glibenclamide and vitamin C were purchased from Sigma, MO, USA. The solvents and other chemicals of analytical grade were used and obtained from the institute’s central store.

2.4 Determination of body weight

The body weights of the rats were evaluated using a top loader weighing balance.

2.5 Collection of blood

Blood was obtained from the tail veins of the animals for evaluation of fasting glucose level using a glucometer (Accu-chek® Active, Roche Diagnostic, Germany) before and after diabetes was induced. The blood was also collected the diabetic rats were treated with quail eggs, vit C, and Glibenclamide.

2.6 Induction of diabetes mellitus

Diabetes mellitus was induced in each of the animals in groups 2 to 5 by intraperitoneal injection of STZ (50 mg/kg body weight) freshly dissolved in 0.1 M sodium citrate buffer pH 4.5 after an overnight fast. Diabetes mellitus was allowed to develop and stabilize in the test rats over a period of 5 days; with evidence of sustained hyperglycaemia. Animals with fasting blood glucose of ≥ 250mg/dl were considered hyperglycaemic.

2.7 Determination of blood glucose level and body weight

Blood sample was obtained from the tail vein of the rats before induction (on day 0), five days after the induction of diabetes, and 10 days after treating with quail eggs, Vit C, and
Glibenclamide to evaluate their blood glucose level in mg/dl using a digital glucometer (Accu-chek® Active, Roche Diagnostic, Germany) and compatible glucose test strips. The rats were fasted for a period of 16 hours before the measurement of their blood glucose level.

The body weights of the rats were also measured before the experiment, after the induction of diabetes and after treating with quail eggs, Vit C, and Glibenclamide, using a top loader weighing balance.

2.8 Statistical analysis

The data obtained was analysed using Microsoft excel 2007 (Microsoft Corporation, USA). All the values were presented as mean ± standard error of mean (SEM) for six (6) rats in each of the groups. The differences between the means were statistically analysed with paired-sample T-test and a p-value of < 0.05 (95% confidence interval).

3 Results

3.1 Effect of streptozotocin on the blood glucose level and body weight

The blood glucose level for the rats in group 2, 3, 4 and 5 (n=6) increased from 125.50±3.77 mg/dl to 315.50±53.40 mg/dl, from 83.75±6.86 mg/dl to 328.00±36.35 mg/dl, from 85.25±9.98 mg/dl to 321.00±44.32 mg/dl, and from 101.00±7.55 mg/dl to 234.00±21.29 mg/dl, respectively as shown in table 1. After induction of diabetes mellitus using Streptozotocin, indicating that streptozotocin caused a sustained increase in the mean blood glucose level, 5 days after it was injected into the test rats (Table 1). The mean body weight decreased, though not significantly, in these groups from 172.50±7.50 g to 167.50±4.79 g, 195.00±18.93 g to 191.25±17.12 g, 180.00±9.13 g to 172.50±11.09 g and 135.00±5.40 g to 131.00±6.25 g, respectively (Table 2).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A (mg/dl)</th>
<th>B (mg/dl)</th>
<th>C (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Control-Normal diet)</td>
<td>79.00±18.25</td>
<td>83.50±8.37</td>
<td>85.25±7.45</td>
</tr>
<tr>
<td>Group 2 (no quail egg, no vitamin C)</td>
<td>125.50±3.77</td>
<td>315.50±53.40*</td>
<td>409.50±12.99*</td>
</tr>
<tr>
<td>Group 3 (quail egg only)</td>
<td>83.75±6.86</td>
<td>328.00±36.35*</td>
<td>203.00±33.99#</td>
</tr>
<tr>
<td>Group 4 (quail egg + vit. C)</td>
<td>85.25±9.98</td>
<td>321.00±44.32*</td>
<td>142.75±51.47#</td>
</tr>
<tr>
<td>Group 5 (Glibenclamide)</td>
<td>101.00±7.55</td>
<td>234.00±21.29*</td>
<td>119.00±10.03#</td>
</tr>
</tbody>
</table>

Data are presented as mean ± standard error of mean (SEM); *means values significant increase in blood glucose level at P<0.05, #means values significant decrease in blood glucose level at P<0.05; A = Blood glucose level before rats were induced with diabetes; B = Blood glucose level five (5) days after the rats were induced with diabetes; C = Blood glucose level ten (10) days after diabetes-induced rats were treated with quail eggs, quail eggs/vit C and Glibenclamide.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A (g)</th>
<th>B (g)</th>
<th>C (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Control-Normal diet)</td>
<td>115.00±2.89</td>
<td>120.00±2.98</td>
<td>130.00±2.04</td>
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<tr>
<td>Group 2 (no quail egg, no vit C)</td>
<td>172.50±7.50</td>
<td>167.50±4.79</td>
<td>151.25±3.69</td>
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<tr>
<td>Group 3 (quail egg only)</td>
<td>195.00±18.93</td>
<td>191.25±17.12</td>
<td>195.50±26.10</td>
</tr>
<tr>
<td>Group 4 (quail egg + vit. C)</td>
<td>180.00±9.13</td>
<td>172.50±11.09</td>
<td>195.00±24.66*</td>
</tr>
<tr>
<td>Group 5 (Glibenclamide)</td>
<td>135.00±5.40</td>
<td>131.00±6.25</td>
<td>150.00±4.08*</td>
</tr>
</tbody>
</table>

Data are presented as mean ± standard error of mean (SEM); *means values significant increase at P<0.05; A = Body weight before rats were induced with diabetes; B = Body weight five (5) days after the rats were induced with diabetes; C = Body weight ten (10) days after diabetes-induced rats were treated with quail eggs, quail eggs/vit C and Glibenclamide.

3.2 Effect of quail egg on streptozotocin-induced diabetic rats

There was significant decrease in the mean blood glucose level of the rats in group 3 (treated with the quail egg only) from 328.00±36.35 mg/dl to 203.00±33.99 mg/dl, at p<0.05; and an increase in the mean body weight from 191.25±17.12 to 195.50±26.10 g (Tables 1 and 2), after 10 days of treatment.

3.3 Effect of quail egg and vitaminC on streptozotocin-induced diabetic rats

In group 4 (treated with both quail egg and vitamin C), there was also significant decrease in the mean blood glucose level from 321.00±44.3 mg/dl to 142.75±51.47 mg/dl, at p<0.05 (Table 1) and a significant increase in the mean body weight.
from 172.50±11.09 to 195.50±26.10 g (Table 2), after 10 days of treatment.

3.4 Effect of Glibenclamide on streptozotocin-induced diabetic rats

In group 5 (treated with glibenclamide at 600µg/kg body weight), there was a significant decrease in the mean blood glucose level from 234.00±21.29 to 119.00±10.03 mg/dl, at p<0.05 and a significant mean body weight increase from 131.00±6.25 to 150.00±4.08 g after 10 days of treatment, as shown in table 1 and table 2.

3.5 Streptozotocin-induced diabetic rats without treatment

The group induced with diabetes and not treated showed sustained and significant increase in the mean blood glucose level from 125.50±3.77 to 315.50±53.40 to 409.50±12.99, and sustained significant decrease in mean body weight from 172.50±7.50 to 167.50±4.79 to 151.25±3.69 throughout the period of the experiment (Tables 1 and 2).

4 Discussions

The study shows that Streptozotocin has the potential to induce diabetes rats and mice as earlier observed in previous studies. It has been reported that STZ induces dose-dependent diabetes when administered intravenously or intraperitoneally. In rats, dose ranging from 25 to 100 mg/kg STZ injected intravenously successfully induced hyperglycemia.

STZ is an antibiotic derived from Streptomyces acromogenes that induces diabetes mellitus by selectively destroying the beta islet cells of the pancreas, which leads to reduction in insulin release, also inhibiting glucose-induced insulin secretion.

In this experiment, 50 mg/dl of STZ injected intraperitoneally brought all the rats down with diabetes mellitus, evidenced by a sustained elevation of their fasting blood glucose level and a decrease in body weight over the period of the experiment. This agrees with the result of Periyar and Arikawe, which showed an increase in the blood glucose level after some days of streptozotocin administration. A research had shown that streptozotocin liberates toxic amounts of nitric oxide that participates in mitochondrial DNA damage; impairing the signalling function of beta cell mitochondrial metabolism and inhibiting glucose-induced insulin secretion.

The study also shows that quail eggs, quail eggs/Vit C (combined), and glibenclamide, all have hypoglycaemic potentials, having effectively decreased mean blood glucose level in diabetic rats after ten days of administration, and also increased mean body weight as seen in the tables.

However, their anti-diabetic potentials differ significantly, with glibenclamide showing strongest hypoglycaemic potential of the three. Quail eggs/Vit C (combined) also showed stronger hypoglycaemic effects than quail egg only.

Previous works had shown that quail egg is rich in fat soluble vitamins and B complex; in proteins, amino acids, macro and microelements, but are low in cholesterol, triglycerides and saturated fatty acids. It was placed 3rd in the Chinese natural medicine after snake venom and Ginseng because of its valuable chemical composition.

The ability of quails eggs to correct the STZ-induced hyperglycemia could be due to the presence of vitamin B complex present as part of its chemical composition. Vitamins generally are antioxidants that inhibit or delay oxidation of a substrate while present in minute amounts. Antioxidant molecules are thought to play a crucial role in counteracting free radical induced damage to macromolecules and has been found to prevent the free radical mediated cell damage. From previous studies, Vitamin C (L-ascorbic acid, ascorbate) has been known to be a simple glucose-related carbohydrate with rather unique properties. The presence of an enediol group in the molecule confers electron lability, which makes it a member of an oxidation-reduction system with electron-donating or accepting properties. A loss of the first electron results in formation of the ascorbate free radical, which can be further oxidized by another electron loss to give dehydroascorbic acid. Ascorbic acid and ascorbate free radical have a reducing potential low enough to react with most of the physiologically important radicals and oxidants, thereby enabling vitamin C to act as a powerful hydrosoluble antioxidant in body fluids, scavenging reactive oxygen and nitrogen species.

Vitamin B and vitamin C both belong to class of water soluble vitamins, therefore this study suggests that they may both have the same properties and activities on induced diabetic in the experimental animals.

Glibenclamide, like all other sulphonylurea drugs, has hypoglycaemic effect primarily by stimulating the beta islet cells of the pancreas to produce more insulin.

5 Conclusions

Quail egg only, and quail egg/vitamin C (combined) and indeed glibenclamide decreased the blood glucose level in STZ-induced diabetic rats, however, at a varying potency; with Glibenclamide having the strongest hypoglycaemic effect and Quail egg only having the least effect.

Quail egg is therefore recommended for diabetic patients because it contains some fat-soluble and water-soluble vitamins that help in maintaining normal metabolism in the body and reduces the incidence of diabetes mellitus. It also contains a small amount of carbohydrate, not significant to increase the carbohydrate level in the body.
6 Conflict of interests

No conflict of interest among all authors of this work

7 Author’s contribution

Research was designed by AGI and SAS. OBE and ORJ handled data analysis, while SAS handled manuscript writing and revising of content. All authors read and approved the final copy for publication

8 References


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