Toxicology Reports 1 (2014) 674–681

Contents lists available at ScienceDirect

Toxicology Reports

journal homepage: www.elsevier.com/locate/toxrep

Effect of livingstonepotato (*Plectranthus esculenthus* N.E.Br) on hyperglycemia, antioxidant activity and lipid metabolism of streptozotocin induced diabetic rats

C.O. Eleazu[a,*], K.C. Eleazu[b], S.C. Chukwuma[a], J. Okoronkwo[a], C.U. Emelike[b]

[a] *National Root Crops Research Institute, Umudike, Nigeria*
[b] *Michael Okpara University of Agriculture, Umudike, Nigeria*

ARTICLE INFO

Article history:
Received 16 May 2014
Received in revised form 22 August 2014
Accepted 22 August 2014
Available online 29 August 2014

Keywords:
Diabetic complications
Livingstone potato
Streptozotocin
Rats
Incorporated feeds

Chemical compounds studied in this article:
Streptozotocin (PubChem CID-29327)
Isocitric acid (PubChem CID-5318532)
Triethanolamine (PubChem CID-7618)
Gallic Acid (PubChem CID-370)
DPPH (PubChem CID-2735032)
Quercetin (PubChem CID-5280343)
NADPH (PubChem CID-12598259)
GlyGly (PubChem CID-11161)
Glucose (PubChem CID-79025)
Triethanolamine (PubChem CID-7618)
NADP (PubChem CID-5886)

ABSTRACT

The effect of livingstone potato (*Plectranthus esculenthus* N.E.Br) on serum glucose, glycated hemoglobin (HbA_{1C}), serum triglyceride, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL), hepatic malic enzyme (ME), isocitrate dehydrogenase (IDH) and catalase activities of Streptozotocin induced diabetic rats were investigated using standard techniques. The atherogenic index (AI) and coronary risk index (CRI) of the rats were calculated as the ratios of LDL to HDL and total cholesterol to HDL, respectively. The serum glucose of the non-diabetic, diabetic control and diabetic rats given livingstone potato incorporated feeds (test feed) were 92.58 ± 3.97, 352.30 ± 4.88 and 165.50 ± 7.88 mg/dl, respectively. Intake of the test feed by the diabetic rats of group 3, resulted in significant ($P < 0.05$) decrease of their serum glucose, HbA_{1c}, triglyceride, cholesterol, LDL, VLDL, AI and CRI but significant increase ($P < 0.05$) of hepatic levels of ME, IDH, catalase and serum HDL compared with the diabetic control rats that had significant alteration of these parameters ($P < 0.05$) compared with the non-diabetic rats. The feed intakes of the non-diabetic, diabetic control and diabetic rats given the test feed were 133.34 ± 1.32, 137.84 ± 5.77 and 146.38 ± 4.33 g/rat/week by the last week of experimentation. The diabetic control rats recorded significant loss of weight ($P < 0.05$) compared with the non diabetic rats despite increased feed intake. Chemical analysis of the standard and test feeds showed that the standard rat feed contained 15.00 ± 0.78% protein, 7.24 ± 1.20% fat, 31.55 ± 2.62% carbohydrates, energy value of 290.65 ± 4.77 kcal/100 g, 10% crude fiber and 0.12 ± 0.04 mg Gallic Acid Equivalent while the test feed contained 40.10 ± 0.16% carbohydrates, 17.22 ± 0.40% protein, 22.16 ± 0.34% fat, energy value of 428.70 ± 2.12 kcal/100 g, 8.51 ± 0.16% crude fiber, 1.3 ± 0.2 mg Gallic Acid Equivalent/g of sample and strong antioxidant activity comparable to standard quercetin. The study shows the potentials of livingstone potato in the management of diabetes and hyperlipidemia.

1. Introduction

The alteration of lipid metabolism is one of the major causes of complications arising from diabetes mellitus as it leads to increased risk of cardiovascular diseases [1]. The reversal of diabetic dyslipidaemia is thus a major strategy in diabetes treatment [2,3].

Abbreviations: HbA1c, glycated hemoglobin; IDH, isocitrate dehydrogenase; ME, malic enzyme; AI, atherogenic index; CRI, coronary risk index; HDL, high density lipoprotein; LDL, low density lipoprotein; VLDL, very low density lipoprotein; GAE, gallic acid equivalence; NADPH, nicotinamide adenine dinucleotide phosphate reduced; $NADP^+$, nicotinamide adenine dinucleotide phosphate oxidized; NADH, nicotinamide adenine dinucleotide reduced; NAD^+, nicotinamide adenine dinucleotide oxidized.

* Corresponding author. Tel.: +234 8034164686.
E-mail address: eleazon@yahoo.com (C.O. Eleazu).

http://dx.doi.org/10.1016/j.toxrep.2014.08.013

In many countries of the world, much attention has been paid to find novel types of natural anti-diabetic drugs from various medicinal plants. These medicinal plants play important roles in the lives of rural people, particularly those in the remote parts of developing countries that have limited access to adequate health facilities. In addition, the effectiveness, limited side effects and relatively low costs of these medicinal plants make them to be widely prescribed even when their biologically active compounds are unknown [4].

Livingstone potato (*Plectranthus esculenthus* N.E.Br) which is known by its local name in Nigeria as *rizga*, is one of the widely cultivated minor root crops in the middle belt regions especially Kaduna and Plateau States of Nigeria for its finger like tubers [5]. The plant is also commonly found in Southern Africa, Malawi, Zimbabwe, Congo, Zambia and Asia [5].

Livingstone potato is used in ethnopharmacology in Africa in the treatment of digestive problems [5], stomach ache [6], pains [7] and cancer.

In our previous study [8], we described for the first time, the anti-diabetic potentials of this plant in streptozotocin induced diabetic rat models. However, there is no experimental evidence presently available in the literature with regard to its effect on serum glucose, glycated hemoglobin and lipid profiles of diabetic animals. Moreover, despite the usage of new diagnostic devices, strict glycemic targets, better treatment guidelines and increased awareness of the disease, baseline glycosylated hemoglobin has continued to remain relatively high in subjects diagnosed and treated for type 2 diabetes.

Since the alteration of lipid metabolism is one of the pathological basis for the development of diabetic complications and being that glycated hemoglobin is regarded as the best marker for glycemic control, this study was initiated to investigate the effect of livingstone potato on serum glucose, glycated hemoglobin and lipid metabolism of streptozotocin induced diabetes in rats.

2. Materials and methods

2.1. Plant materials

The fresh samples of livingstone potato (*Plectranthus esculenta*) were obtained at harvest from National Root Crops Research Institute (NRCRI), Umudike, Nigeria. They were identified by NRCRI, Umudike that has livingstone potato as a National Mandate as well as by a Taxonomist in Michael Okpara University of Agriculture, Umudike, Nigeria and deposited in their herbarium for authentication.

2.2. Chemicals

Streptozotocin (STZ), DL-isocitric acid, β-nicotinamide adenine dinucleotide phosphate-sodium salt, triethanolamine, hydrochloride Gly–Gly, free base, L(−)malic acid, free acid, gallic acid, DPPH and standard quercetin used were products of Sigma and Aldrich Chemical Company, United Kingdom. The kits used for lipid profile assays were obtained from Randox Laboratories Limited (UK).

2.3. Processing of the plant materials

The samples were properly washed, chopped and oven dried at 60 °C for 48 h. The dry samples were then processed to flour and incorporated into the standard rat feeds at 19.55% incorporation.

3. Animal experiments

3.1. Selection of animals

Thirty male albino rats of the wistar strain (140–208 g) obtained from the animal house of the Department of Biochemistry, University of Nigeria, Nsukka, Enugu State, Nigeria, were used for the study. The animals were kept in metabolic cages in the animal house of the Department of Biochemistry, Michael Okpara University of Agriculture, Umudike, Nigeria. The animals were acclimatized for two weeks to their diets prior to the commencement of the experiment and were maintained under a constant 12-h light and dark cycle and a room temperature of 27–30 °C. The National Institutes of Health Principles of Laboratory Animal Care [9] were observed.

3.2. Induction of diabetes

After two weeks of acclimatization, freshly prepared solution of streptozotocin (0.1 g dissolved in 5 ml of freshly prepared sodium citrate buffer 0.1 M, pH 4.5) was injected intraperitoneally to 24 of the rats at a dosage of 65 mg/kg body weight at fasting state while the remaining 6 rats were taken as the non-diabetic groups. Blood was collected from the tail vein and the blood glucose concentration was analyzed prior to the commencement of the dietary feeding using a blood glucose meter (Double G glucometer, USA). The STZ-treated rats with fasting blood glucose levels >200 mg/dl after twelve days of induction of STZ and evidence of glycosuria, were considered to be diabetic and used for the study.

3.3. Experimental procedure

The STZ treated brats with stable diabetic condition were then divided into 2 subgroups (groups 2 and 3) comprising of six animals per group while the non-diabetic group formed the first group as follows:

Group 1. Normal rats fed standard rat feeds (Non-diabetic control).
Group 2. Diabetic control rats which also received standard rat feeds.
Group 3. Diabetic rats fed livingstone potato incorporated feeds (test feed).

Their diets and water were both administered *ad libitum* for 28 days, after which the rats were stunned by blow, sacrificed and blood was drawn from their heart using 10 ml syringes and poured into heparin tubes for HbA_{1C} assays