

# In vivo and in vitro Antidiabetic and Antioxidant Activity of Spirulina

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Submitted: 10-09-2018

Revised: 19-09-2018

Published: 26-04-2019

## ABSTRACT

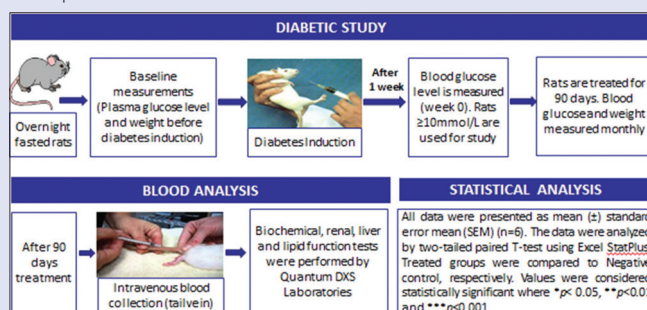
**Objective:** This study aims to evaluate the effect of spirulina, a biomass produced by cyanobacteria, on the level of plasma glucose, oxidative stress, and other biochemical parameters in diabetes in streptozocin (STZ) 50 mg/kg-induced diabetic-induced rat model. **Materials and Methods:** The *in vitro* antioxidant property of spirulina was assessed by measuring its ability to scavenge free radicals and reactive oxygen species (ROS) such as superoxide anion, nitric oxide, and hydroxyl and lipid peroxyl radicals. The inhibition of diabetic link enzymes alpha-glucosidase, alpha-amylase, and dipeptidyl peptidase-4 inhibitor (DPP-IV) were tested *in vitro*. Thirty female Sprague-Dawley rats weighing 150–250 g were divided into five groups: normal, diabetes (negative control), metformin in single dose of 300 mg/kg, spirulina in a single dose of 300 mg/kg and spirulina combined with metformin at dose of 150 mg/kg, and spirulina at dose of 150 mg/kg (spirulina + metformin 300 mg/kg) ( $n = 6$ ). After an acclimation period of 2 weeks, diabetes was induced in the rats through STZ intraperitoneal injection. Spirulina (300 mg/kg) was dissolved in water and was administered orally for 12 weeks, and the rats' that plasma glucose level reached  $\geq 11$  mmol/L after 12 weeks treatment was selected for the study. After the treatment, the blood and liver were used for the evaluation of antioxidant enzyme activities, lipid, liver, kidney, and hematology profile. **Results:** Spirulina was able to reduce hyperglycemia-induced oxidative stress by reducing plasma glucose levels and scavenging or reducing the production of ROS and free radicals. It was also able to inhibit the activities of the alpha-glucosidase, alpha-amylase, and DPP-IV. With this, it significantly reduced the effect of STZ on the liver and kidney at the organ level and on antioxidant enzymes at the cellular level. **Conclusion:** Spirulina is able to reduce the lipid, liver, and kidney disease markers in STZ-induced rats and therefore is a potential supplement for diabetic patients. The antidiabetic effect of spirulina may be based on the antioxidant effect of the biomass as a whole, or it is based on specific bioactive components present in spirulina.

**Key words:** Antidiabetic effects, antioxidant, oxidative stress, spirulina

## SUMMARY

- Spirulina is not cytotoxic to the cells; it possesses *in vitro* and *in vivo* antioxidant and antidiabetic activities and able to moderate the biochemical lipid, liver, and kidney disease markers in streptozocin-induced diabetic rat models. The mechanism of action of spirulina may be through the increase in concentrations of active incretin hormones, glucagon-like peptide-1, and glucose-dependent insulinotropic polypeptide. It also possesses a very

strong *in vitro* and *in vivo* antioxidant property which plays an active role in type 2 diabetes treatment. Antioxidant effect of spirulina maybe because of the presence of significant amounts of phytoconstituents such as chromium, iron phycocyanins, carotenoid, Vitamin E, chlorophyll, flavonoids, saponins, and phenolic compounds which have previously shown antioxidant activity. Based on this finding, spirulina can be a very good potential natural alternative for the treatment and management of diabetes-associated liver and kidney complications.



**Abbreviations used:** DPPH: 2,2-diphenyl-1-picrylhydrazyl; STZ: Streptozocin; OGTT-Oral glucose tolerance test; DPP-IV: Dipeptidyl peptidase-4 inhibitor; DM: Diabetes mellitus; DMEM: Dulbecco's Modified Eagle's Medium; FBS: Fetal Bovine Serum; MTT: 3-(4,5-Dimethylthiazol-2-yl)-2,5-Diphenyltetrazolium Bromide; HbA1C: Glycated hemoglobin; AP: Alkaline Phosphatase; AST: Aspartate transaminase; ALT: Alanine aminotransferase; HDL: High density lipoproteins; LDL: Low density lipoproteins; GSH: Glutathione Reductase; LPO: Lipid peroxidation; SOD: Superoxide dismutase; CAT: Catalase; RBC: Red blood cell; WBC: White cell count.

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DOI: 10.4103/pm.pm\_431\_18

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## INTRODUCTION

Spirulina is a microscopic, filamentous, dried biomass of *Arthrospira plantensis*, an oxygenic photosynthetic cyanobacterium found in fresh and marine waters worldwide. It can be consumed by humans and animals as a food supplement or as a whole food. Spirulina has been labeled as a superfood because of its richness in proteins, carbohydrates, polyunsaturated fatty acids, sterols and minerals such as calcium,

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**Cite this article as:** Okechukwu PN, Ekeuku SO, Sharma M, Nee CP, Chan HK, Mohamed N, et al. *In vivo* and *in vitro* antidiabetic and antioxidant activity of spirulina. Phcog Mag 2019;15:S17-29.