



Role of *Spirulina maxima* in the Control of Blood Glucose Levels and Body Weight in Streptozotocin induced Diabetic Male Wistar rats

Jai Prakash Pandey^{1*}, Amit Tiwari^{1,2}, Gyanendra Mishra², and R. M. Mishra³

¹Department of Biotechnology, Govt. T. R. S. College, Rewa (M.P.)

²Department of Zoology, Govt. T. R. S. College, Rewa (M.P.)

³School of Environmental Biology, A. P. S. University, Rewa (M.P.)

*- japy25@gmail.com

ABSTRACT

In the present investigation the effect of *Spirulina maxima* was optimized in terms of body weight and blood glucose in streptozotocin induced diabetic male wistar rats. The findings were compared between normal, diabetic and *Spirulina maxima* supplemented rats. The effect of *Spirulina maxima* at a dose 15 mg/kg body weight yielded a higher level of significance than the 5 and 10 mg/kg body weight. A total of 25 rats (20 diabetic surviving rats and 5 normal rats) were selected for study. The total sample was divided into five groups of five rats each: group 1 normal untreated rats, group 2 diabetic control rats, group 3, 4, 5 diabetic rats given *Spirulina maxima* 5, 10 and 15 mg/kg body weight respectively. From the study it can be concluded that *Spirulina maxima* is a potent nutraceutical as a hypoglycemic agent in Streptozotocin induced diabetic rats.

Key words: *Spirulina maxima*, Streptozotocin, Diabetes, Fasting blood glucose, Male wistar rat.

INTRODUCTION

Spirulina maxima is a photosynthesizing cyanophyte (blue green algae) that grows vigorously in strong sunshine under high temperatures and highly alkaline conditions. In 1967, *Spirulina* was established as a “Wonderful future food source” in the International Association of Applied Microbiology (Anita, *et. al.* 2010). The United Nations world food conference declared *Spirulina* as “the best for tomorrow”. *Spirulina maxima* is a cyanobacteria characterized by a high protein content (60–70%). It also contains carotenoids, vitamin E, phycocyanine and chlorophyll (Layam, *et. al.* 2006). The *Spirulina maxima* ability as a potent anti-viral (Patterson, 1993), anti-cancer (Schwartz, *et. al.* 1988), anti-diabetic (Panam *et. al.* 2001) and decreases body weight loosing (Rodriguez, *et. al.* 2001) agent is gaining attention as a nutraceutical and a source of potential pharmaceutical (Layam, *et. al.* 2006).

Diabetes mellitus is a syndrome that disturbs the metabolism of carbohydrates, fat and protein and results from shortage or lack of insulin secretion or reduced sensitivity of the tissues to insulin. Diabetes is a chronic disease that is relatively common throughout the world. In recent decades, various epidemiological studies have been carried out on prevalence of diabetes mellitus, according to the World Health Organization reports, more than 150 million people throughout the world suffered from diabetes (Akbarzadeh, *et. al.* 2007). Experimental diabetes mellitus has been induced in laboratory animals by injecting drugs such as Streptozotocin. Using 45 mg/kg Streptozotocin dose can

begin an autoimmune process that results in the destruction of the Langerhans islets beta cells (Layam, *et. al.* 2006).

The present study was designed to evaluate the effect of *Spirulina maxima* on fasting blood glucose levels in streptozotocin induced diabetes in male wistar rats. The efficacy of *Spirulina maxima* on body weight was also evaluated in diabetic rats.

MATERIALS AND METHODS

Material

Streptozotocin or Zanosar (STZ) is a synthetic antineoplastic agent that is classically an anti-tumor antibiotic and chemically is related to other nitrosoureas used in cancer chemotherapy. Streptozotocin sterile powders are provided and prepared as a chemotherapy agent. Each vial of sterilized Streptozotocin powder contains 1 gr. of Streptozotocin active ingredient with the chemical name, 2-Deoxy-2-[[[(methylnitrosoamino) - carbonyl] amino]-D-glucopyranose and 200 mg. citric acid (Akbarzadeh, *et. al.* 2007). Streptozotocin was supplied by Pharmacia Company. Streptozotocin is available for intravenous use as a dry-frozen, pale yellow, sterilized product. Pure Streptozotocin has alkaline pH. When it is dissolved inside the vial in distilled water as instructed, the pH in the solution inside the vial will be 3.5-4.5 because of the presence of citric acid. This material is prepared in 1-gr vials and kept in cold store and refrigerator temperature (2-8 °C) away from light.

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Experiment animals

The experiment would be carried out with male Wistar rats, *Rattus norvegicus* (strain 2187), aged 70-80 days (180-250 grams). These animals will be fed with standard pellet diet (Hindustan Lever) and water adds libitum acclimatized to local environment before inducing Diabetes Mellitus. The animals will be housed in temperature room (23°C to 27°C).

Induction of diabetes in rats

Adult Wistar rats weighting 180-250 grams (70-80 days) were used for inducing diabetes. The animals were injected by streptozotocin at the dose of 45 mg/kg of the body weight intravenously. Streptozotocin induces diabetes within 3 days by destroying the beta cells.

Experimental Design

Diabetes will be induced in albino Wistar rats. The Study would be conducted on 25 rats (20 diabetic surviving rats and 5 normal rats) which would be divided into five groups:-

- i) Normal control group (NC): The normal rats will be included in this group and continued depends on tap water till the end of experiment.
- ii) Diabetic control group (DC): This group will include diabetes-induced rats by streptozotocin (45 mg/kg body weight).
- iii) Diabetic group given 5 mg/kg body weight *Spirulina maxima*.
- iv) Diabetic group given 10 mg/kg body weight *Spirulina maxima*.
- v) Diabetic group given 15 mg/kg body weight *Spirulina maxima*.

Sample Collection

The experiment was carried out for 40 days with oral administration of *Spirulina maxima*. The blood was collected in sterilized tubes and kept at 4°C and after separating the clot, the serum was separated by centrifuging.

Analytical methods

Fasting blood glucose was estimated by glucose oxidase method (Layam, *et. al.* 2006). Body weight was measured in grams.

Statistical analysis

Analysis of variance (ANOVA) was used to compare the data during the experiments. All tests were considered significant at the $P < 0.05$ level.

RESULTS AND DISCUSSION

Previous studies have demonstrated the hypolipemic activity of *Spirulina maxima* in rats with and without toxic substances (Mazo, *et. al.* 2004). *Spirulina maxima* is a very popular dietary supplement. It is an alga containing a valuable combination of substances, including those practically absent in common food. *Spirulina maxima* contain about 14% of the protein complex phycocyanin. Research shows it to stimulate the immune system, build both red and white blood cells and assist detoxification. *Spirulina maxima* is a best balanced highly efficient dietary supplement, which satisfies the demands of all systems of the organism and, what is most important, improves the condition of its immune system and is a source of easily available iron (Kazys, *et. al.* 2004).

Diabetes mellitus is a disorder in which the level of blood glucose is persistently raised above the normal range. It may result from either lack of pancreatic insulin secretion or resistance to insulin action. There are many associated metabolic abnormalities with diabetes mellitus notably ketoacidosis, the progressive development of disease of capillaries of the kidney and retina, damage to the peripheral nerves and excessive arteriosclerosis (World Health Organization, WHO, 1980). On sever insulin lack; hyperketonaemia will develop together with alterations of lipid and protein turnover. In addition, diabetes mellitus initiates loss of body weight (Hotta, *et al.*, 1996 and Maged, 2004).

Streptozotocin is well known for its selective pancreatic islet beta-cell cytotoxicity and has been extensively used to induce diabetes mellitus in animals. Administration of streptozotocin (45 mg/kg) effectively induced diabetes in normal rats (Akbarzadeh, *et. al.* 2007).

Table 1 shows the levels of blood glucose and changes in body weight in normal and experimental rats. There was a significant increase in blood glucose levels and body weight decreased significantly in streptozotocin diabetic rats when compared with normal rats. The administration of *Spirulina maxima* tended to bring the parameters significantly towards normal. The effect of *Spirulina maxima* at a dose of 15 mg/kg body weight a higher level of significance than the doses of 5 and 10 mg/kg body weight. Layam, *et. al.* 2006 had reported that *Spirulina maxima* has antidiabetic property. In the present study, it was observed that oral administration of *Spirulina maxima* could reverse the diabetic effects. The ability of *Spirulina maxima* to recover body weight loss seems to be due to diabetes. Maged, *et. al.* 2004 had reported that *Spirulina maxima* increase body weight in diabetic rats. It also may be attributed to disturbances in one or many metabolic pathways and due to deficiency of protein or disturbances in different enzymatic activities. However, diabetic rats treated with *Spirulina maxima* showed increase in body weight which may be explained by increased insulin secretion or increased food consumption.

Table-1 Effect of *Spirulina maxima* on Blood glucose and body weight in normal and diabetic male wistar rats-

S. No.	Group	Fasting blood glucose (mg/dl)	Body weight (g)	
			Initial	Final
1.	Normal	90.57 ± 3.01	190.22 ± 6.89	200.76 ± 3.44
2.	Diabetic control	230.44 ± 4.50	192.54 ± 8.65	154.65 ± 3.56
3.	Diabetic + <i>Spirulina</i> 5 mg/kg	215.56 ± 10.65	186 ± 2.76	191.17 ± 8.44
4.	Diabetic + <i>Spirulina</i> 10 mg/kg	150.64 ± 7.15	189.98 ± 4.76	203.76 ± 5.56
5.	Diabetic + <i>Spirulina</i> 15 mg/kg	112.02 ± 7.42	198.65 ± 8.45	211.87 ± 6.75

CONCLUSION

Spirulina maxima blue - green algae are fast emerging as a whole answer for varied demands of diabetes. In the present course of investigation, we have concluded that *Spirulina maxima* has hypoglycemic effect which helps the diabetes to control on blood glucose levels and also increased body weight *Spirulina maxima* brought in favorable effect on blood glucose levels and body weight in streptozotocin induced diabetic animals. Our results also suggest that *Spirulina maxima* is a promising agent as a functional food for the management of diabetes.

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