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HYPOGLYCEMIC EFFECTS OF SPIRULINA (*Spirulina platensis*) LEAVES IN NORMAL AND ALLOXAN DIABETIC RAT

Mohammad Saiful Islam* and Sujan Kumar Sarkar

Department of Anatomy, Histology and Physiology, Faculty of Animal Science & Veterinary Medicine, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

***Corresponding author:** Dr. Mohammad Saiful Islam; E-mail: raselsaiful@sau.edu.bd

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Hypoglycemic effects was observed with Spirulina (*Spirulina platensis*) when given as leaf extract in normal and alloxan diabetic rat. In this study 150 rats were included and divided into three groups of ten rats in each group. First group was normal control (A), Second group was diabetic control (B), third group was diabetic with Spirulina treated (C). The rats were treated with aqueous extract of Spirulina at a dose rate of 20 mg/kg body weight respectively for 3 weeks. During experimental period, day 0, day 7, day 14 and day 21 blood samples were collected from all groups and determined their blood sugar level using diabetic kit. The blood glucose levels were reduced from 165.5±10.65 mg/dL to 158.17±5.49 mg/dL in group C after 3 weeks treatment. On the other hand the average body weight were increased from 255.67±7.35 g to 286.17±8.56 g in group C after 3 weeks treatment. From the findings it is concluded that the Spirulina can be used as anti-diabetogenic agent in food.

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INTRODUCTION

Diabetes is one of the major degenerative diseases in the world today. It is considered as one of the five leading causes of death in the world. Diabetes mellitus (DM) is characterized by elevated plasma glucose concentrations resulting from insufficient insulin, insulin resistance or both leading to metabolic abnormalities in carbohydrates, lipids and proteins (Bos and Agyemang, 2013; Pankaj and Varma, 2013). It is a major risk factor for the development of cardiovascular disease. About 70- 80% of deaths in diabetic patients are due to vascular disease. In particular, hyperglycemia, the primary clinical manifestation of diabetes, is thought to contribute to diabetic complications by altering vascular cellular metabolism, vascular matrix molecules and circulating lipoproteins. It can be hereditary and environmental which leads to metabolic abnormalities mainly characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both. Being a major degenerative disease, diabetes is found all over the world and it is becoming the third most lethal disease of mankind and increasing rapidly (Ogbonnia *et al*., 2008). Modern synthetic antidiabetic drugs have series of drawbacks including their adverse effects and high cost involvement (Abdel-Daim and Halawa, 2014). The common side effects associated with oral hypoglycemic agents are hypoglycemia, weight gain, gastrointestinal disorders, peripheral edema and impaired liver function. Since natural remedies are somehow safer and more efficacious than pharmaceutically derived remedies. Complementary and alternative medicine involves the use of medicinal plant alternatives to mainstream treatment.

A recent study has estimated that up to 30% of patients with diabetes mellitus use complementary and alternative medicine (Raman *et al.,* 2012). To avoid the harmful side effects of chemical drugs, researchers have investigated natural products that possess antidiabetic effects and contribute to the nutrient requirements, stimulate the endocrine system and intermediate nutrient metabolism and *Spirulina platensis Gomont (Phormidiaceae)* (SP) is one of them (Thormar, 2012). SP is a blue-green algae member of cyanobacteria family that is rich in active components like proteins, lipids, carbohydrates, trace elements (zinc, magnesium, manganese, selenium), pigments (phycocyanin, b-carotene), riboflavin, tocopherol and a-linoleic acid (Goksan and Kılıc¸ 2009; Yang and Zhang 2009; Yusuf *et al.,* 2016). It has wide range of applications as human and animal consumable nutrients, natural dyes in food and cosmetics and nutraceutical and food additives for pharmaceutical industries (Zheng *et al.,* 2013). Several researches worldwide have investigated and confirmed antidiabetic properties of Spirulina in experimental animals (Pankaj and Varma, 2013; Abdel-Daim, 2014; Ibrahim and Abdel-Daim, 2015; Abdel-Daim *et al.,* 2016). Phycocyanin, an active protein of SP possesses the antioxidant properties (Khan *et al.,* 2005). Some other active ingredients like phenolic components (Polyphenols, flavonoids), phycobiliproteins and carotenoids also found in SP. These particles act as scavengers of free radicals, play a major role in antioxidant activity and in stabilizing lipid oxidation (Aissaoui *et al*., 2017). The aim of this research was to evaluate the possible antidiabetic activity of *Spirulina platensis* and its medicinal potency responsible for the hypoglycemic activity by observing the blood glucose level and body weight of rats to strengthen the previous findings of other scientists.

MATERIALS AND METHODS

This research work was conducted in the Laboratory of Anatomy, Histology and Physiology, Faculty of Animal Science and Veterinary Medicine, Sher-e-Bangla Agricultural University; Dhaka for a period of 3 weeks to evaluate the efficacy of Spirulina on alloxan induced diabetic rats.

Collection and acclimatization of rats

Total 150 mixed albino rats (aged 3-4 months) and weighing (200 to 300g) were collected from local market. All the rats were grouped into 3 groups each containing 10 rats for five trials. Each group of rats was housed at serene bottomed wire cages arranged in rows and kept in the animal house of this department. The animals were fed with pellet at a recommended dose of 100 g/kg body weight. Drinking water was supplied *ad libitum*. The rats were reared in this condition for a period of two weeks to acclimatize them prior to experimental uses.

Experimental design

In this study, a total of 150 rats (50 normal rats and 100 alloxan induced diabetic rats) were used for each trial. The rats were divided into 3 groups each containing 10 individuals as follows:

Group A: Normal control group
Group B: Diabetic control group
Group C: Diabetic with Spirulina treated group

Induction of diabetes in rats

Diabetes mellitus was induced, Alloxan injection were injected through intraperitoneal route which increases the blood glucose level and at the same time body weight were decreased also. Single dose of alloxan administered intraperitonealy @ 150 mg/kg b.wt. (Mridha et al., 2010). In this experiment, polyuria, polydipsia and polyphagia after 24 hours of alloxan injection were observed that was found by others (Hussaini *et al.*, 2018).

Determination of Blood Glucose and Body Weight

After 18 hours of starvation, body weights and blood glucose level were measured after acclimatization of rats. Then alloxan injected at a dose rate of 150 mg/kg body weight in intraperitoneal route to each rat to induce diabetes in groups B and C. All the group of rats was reared under normal diet and water *ad libitum* from Day 0-15, on 15th day blood glucose level and the body weights were measured for the first time to ensure diabetic induction. Then all the rats of this group were kept for more 21 days for the treatment of diabetic condition. Aqueous extract of Spirulina are to be fed by gavages at a dose of 20 mg/kg body weight daily for 21 days in groups C. During that period on Day 0, Day 7, Day 14 and Day 21 blood glucose level and body weight were measured.

Statistical Analysis

Changes in body weight and blood sugar level in blood of rats were compared statistically by means of one way analysis of variance (ANOVA) test. *P*-values less than 0.05 were considered significant.

RESULTS AND DISCUSSION

The study was carried out to evaluate the effects of Spirulina on blood glucose and body weight.

Effects on blood glucose level (mg/dL)

Alloxan-treated rats show significant ($P<0.05$) increase in the level of glucose (Figure 1), which lies in the diabetic range (≥ 200 mg/dL). This result was found to be similar to several studies in diabetic rat models (Eidi *et al.,* 2006; Erejuwa *et al.,* 2011; Sadek and Shaheen 2014). The normal range of glucose level must be less than 140 mg/dL. Spirulina treated group was able to control the level in normal range (Sadek and Shaheen, 2014). The partial destruction of the beta cells by alloxan had led to increase in blood glucose levels which were brought to near normal levels by Spirulina administration. The blue green algae being studied extensively for its anti-oxidative activity might have reduced the extent of oxidative damage to the pancreatic beta cells (Aissaoui *et al.*, 2017).

Effects on body weight (g)

There was significant ($P<0.05$) decrease in the body weight of the diabetic rats compared to the control group (Table 1). There are various studies which prove the significant ($P<0.05$) decrease in body weight in diabetic rat model (Erejuwa *et al.,* 2011). The diabetic rats treated with Spirulina showed increase in body weight, which is similar to the normal group. The result suggested that SP substantially improved the general health status of animals by effective glycaemic control or a reversal of gluconeogenesis (Abdel-Daim, 2014; Yusuf *et al.,* 2016).

Table 1. Effect of Spirulina on body weight (g) of Alloxan-treated rats

Day	Group A[a]	Group B[b]	Group C[c]
0	300.67±9.65	260.83±8.11	255.67±7.35
7	305.5±9.42	238.5±8.22	267.33±5.5
14	306±8.24	227.5±6.75	277.67±4.63
21	308.67±7.0	210±6.42	286.17±8.56

[a] Normal control group, [b] Diabetic control group, [c] Diabetic with Spirulina treated group

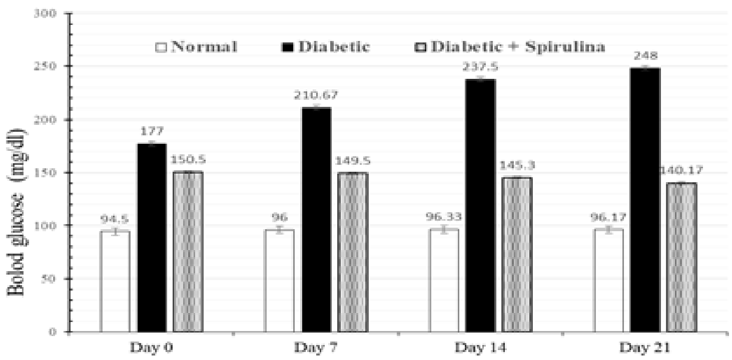

Figure 1. Effect of Spirulina on blood glucose levels (mg/dl) in Alloxan-induced diabetic rats. Each value represents the mean ± SD of six rats. Comparisons were made as follows: Group A vs groups B and C; Group B vs Group C, The symbols represent statistical significance at *$P < 0.05$*. Statistical analysis was calculated by one-way ANOVA followed by the Student Newman–Keul's test

CONCLUSION

The current study demonstrated the effectiveness of Spirulina in alloxan-induced diabetic rats probably due to its antioxidant activity. In conclusion, the data in our study suggests that Spirulina may have beneficial effects in established diabetes mellitus, and it may also delay or prevent the onset of the disease that is in agreement with the similar findings of previous works of other researchers. However, further studies are necessary on experimental animals and human beings to validate its usefulness and exact mode of action.

COMPETING INTEREST

The authors declared there is no conflict of interest.

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REFERENCES

1. Aissaoui O, Amiali M, Bouzid N, Belkacemi K, & Bitam A, 2017. Effect of *Spirulina platensis* ingestion on the abnormal biochemical and oxidative stress parameters in the pancreas and liver of alloxan-induced diabetic rats. Pharmaceutical Biology, 55(1): 1304–1312.
2. Abdel-Daim M, Halawa S, 2014. Synergistic hepatocardioprotective and antioxidant effects of myrrh and ascorbic acid against diazinon-induced toxicity in rabbits. International Research Journals of Humanities, Engineering and Pharmaceutical Sciences, 1: 1–7.
3. Abdel-Daim MM, 2014. Pharmacodynamic interaction of *Spirulina platensis* with erythromycin in Egyptian Baladi bucks (*Capra hircus*). Small Ruminant Research, 120: 234–241.
4. Abdel-Daim M, El-Bialy BE, Rahman HG, Radi AM, Hefny HA, Hassan AM, 2016. Antagonistic effects of *Spirulina platensis* against sub-acute deltamethrin toxicity in mice: biochemical and histopathological studies. Biomedicine and Pharmacotherapy, 77: 79–85.
5. Bos M, Agyemang C, 2013. Prevalence and complications of diabetes mellitus in Northern Africa, a systematic review. BMC Public Health, 13: 1–7.
6. Eidi A, Eidi M, Esmaeili E (2006). Antidiabetic effect of garlic (*Allium sativum L.*) in normal and streptozotocin-induced diabetic rats. Phytomedicine, 13: 624–629.
7. Erejuwa OO, Sulaiman SA, Wahab MS Sirajudeen KNS, Salleh MS and Gurtu S (2011). Effect of glibenclamide alone versus glibenclamide and honey on oxidative stress in pancreas of streptozotocin-induced diabetic rats. International Journal of Applied Research in Natural Product, 4: 1–10.
8. Goksan T, Kılıc C, 2009. Growth and biochemical composition of *Spirulina platensis* Geitler in summer period under the conditions of C¸anakkale, Turkey. Asian Journal of Chemistry, 21: 4947–4950.
9. Hussaini SM, Hossain MI, Islam MS and Rafiq K (2018). Effects of *Spirulina platensis* on alloxan induced diabetic rats. Progressive Agriculture, 29: 139-146.
10. Ibrahim A, Abdel-Daim M, 2015. Modulating effects of *Spirulina platensis* against tilmicosin-induced cardiotoxicity in mice. Cell Journal (Yakhteh), 17: 137–144.
11. Khan Z, Bhadouria P, Bisen PS, 2005. Nutritional and therapeutic potential of *Spirulina*. Current Pharmaceutical Biotechnology, 6(5): 373-379.
12. Mridha MO, Jahan MA, Akhtar N, Munshi JL and Nessa Z (2010). Study on hypoglycaemic effect of *Spirulina platensis* on long-evans rats. Bangladesh Journal of Scientific and Industrial Research, 45: 163-168.
13. Ogbonnia SO, Odimegwu JI, Enwuru VN, 2008. Evaluation of hypoglycaemic and hypolipidaemic effects of aqueous ethanolic extracts of *Treculia africana Decne* and *Bryophyllum pinnatum,/i> Lam*. and their mixture on streptozotocin (STZ)-induced diabetic rats. African Journal of Biotechnology, 7: 2535-2539.
14. Pankaj PP, Varma MC, 2013. Potential role of Spirulina platensis in maintaining blood parameters in alloxan-induced diabetic mice. International Journal of Pharmacy and Pharmaceutical Sciences, 5: 450–456.
15. Raman BV, Krishna NV, Rao NB, Saradhi PM, Rao BMV, 2012. Plants with antidiabetic activities and their medicinal values. International Research Journal of Pharmacy, 3: 11–15.
16. Sadek KM and Shaheen H (2014) .Biochemical efficacy of vitamin D in ameliorating endocrine and metabolic disorders in diabetic rats. Pharmaceutical Biology, 52: 591–596.
17. Thormar H, 2012. Patented non-antibiotic agents as animal feed additives. Recent Patents on Food, Nutrition and Agriculture, 4: 155–168.
18. Yusuf MS, Hassan MA, Abdel-Daim MM, El Nabtiti AS, Ahmed AM, Moawed SA, El-Sayed AK, Cui H, 2016. Value added by *Spirulina platensis* in two different diets on growth performance, gut microbiota, and meat quality of Japanese quails. Veterinary World, 9: 1287–1293.
19. Yang L, Zhang LM, 2009. Chemical structural and chain conformational characterization of some bioactive polysaccharides isolated from natural sources. Carbohydrate Polymer, 76: 349–361.
20. Zheng J, Inoguchi T, Sasaki S, Maeda Y, McCarty MF, Fujii M, Ikeda N, Kobayashi K, Sonoda N, Takayanagi R, 2013. Phycocyanin and phycocyanobilin from *Spirulina platensis* protect against diabetic nephropathy by inhibiting oxidative stress. The American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 304: 110–120.