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ANTIOBESITY ACTIVITY OF *SPIRULINA PLATENSIS* IN HIGH FAT DIET INDUCED RATS

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ABSTRACT

Present study was aimed to investigate the anti-obesity activity of *Spirulina platensis* in high fat induced rats. *Spirulina platensis* was administered at a dose of 1000mg/kg to fat induced Rats for 30 days and changes in body weight, lipid profile, total proteins, albumin was evaluated in HFD (High Fat Diet) induced rats and was compared with the normal rats. The results demonstrated that feeding with HFD had caused a significant increase in weight gain compared with the normal chow diet fed rats, which was significantly decreased by the co-administration of *spirulina platensis* in a dose dependent manner. The present study clearly showed that giving *spirulina platensis* is beneficial for the suppression of diet induced obesity. This study indicates that the decrease in body weight might be contributed by the increased use of glucose by the tissues. There was a marked alteration in the values of hematological parameters. At the same time, liver enzymes such as AST, ALT and ALP considered responsible for cell damage are reduced by the *spirulina platensis*.

key words: Fatty Diet -Induced Rats, Obesity, *Spirulina platensis*; Triglycerides.

INTRODUCTION

Obesity is a chronic disease that causes risks including ill health, impaired quality of life, and premature mortality. Obesity results from a complex interaction of genetic predisposition, environmental, societal and individual psychological factors that all summate to produce a chronic positive energy balance [1].Obesity results from a positive energy balance i.e., when caloric intake chronically exceeds energy expenditure. This in turn causes excess of adipose tissue mass with body mass index [2] (BMI > 30 kg/m^2).

Spirulina platensis is referred to free-floating filamentous microalgae with spiral characteristics of its filaments. It is formally called *Arthrospira*, belonging to the class of cyanobacteria with characteristic photosynthetic capability. *Spirulina platensis* was initially classified in the plant kingdom because of its richness in plant pigments as well as its ability of photosynthesis. It was later placed in the bacteria kingdom based on new understanding on its genetics, physiology and biochemical properties [3].

Spirulina platensis is 100% natural and a highly nutritious micro salt water plant. *Spirulina platensis* is a blue-green algae. It is a simple, one-celled form of algae that thrives in warm, alkaline fresh-water bodies. *Spirulina platensis* is loaded with protein, vitamins, minerals, and carotenoids. It is also provided with antioxidants that can help protect cells from damage. *Spirulina platensis* is full of nutrients and very simply digested. Commercially, *Spirulina platensis* is available as a powder, tablet and capsule or added to foods and health tonics [3, 4].

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MATERIALS AND METHODS

Material

Spirulina platensis powder is obtained from Purpurea biotech, Hyderabad. All other chemicals were of analytical grade and were purchased from Fine Chemicals, Mumbai.

Animals

Albino rats (wistar strain) of 6-8 weeks of age of either sex were procured from Teena Biolabs Pvt. Lmtd., Hyderabad for experimental purpose. Then the animals were acclimatized for 7days under standard husbandry condition.

Instruments

Biochemical analyzer, Biochemical kit, Haematological analyzer.

Phytochemical evaluation

Spirulina platensis powder was subjected for Preliminary phytochemical analysis [5,6].

Anti-obesity activity

Divide animals into 4 groups of 6 animals each.

- Group I : *Ad libitum* Diet & Water
- Group II: Receives sibutramine (5mg/kg) + High fat diet
- Group III : *Ad libitum* Diet & Water along with high cholesterol diet (Cow Ghee, Vanaspathi, ground nut oil, lard oil for 20 days)
- Group IV: receives Spirulina (1000mg/kg) and high fat diet.

Evaluation parameters

Body weight**,** Serum glucose, Blood Cholesterol (HDL, LDL), Triglycerides, Serum bilirubin, SGPT, SGOT, Serum Alkaline Phosphate, Protein, Albumin, Serum creatinin and Urea [10-11].

Statistical analysis

All the values of the experimental results were analyzed by one way ANOVA followed by "Dunnett's Test using Graphpad Prism, version 5 and the values were expressed as mean ± SEM.

RESULTS

Phytochemical evaluation

The results of phytochemical screening of *Spirulina platensis* was Positive for Alkaloids, Flavonoids, Glycosides, Proteins & amino acids, Saponins, Sterols, Tannins and Phenolic Compounds was shown in table 1.

Effect of *Spirulina platensis* on Body weight

Table 2 and Figure 1 showed the changes in body weight of all groups during the study. Feeding a high-fat diet (HFD) containing 19% protein and 60% total fat for six weeks produced significant increases ($p<0.05$) in body weight. Throughout the experiment, the food and water intake of each group did not differ. Rats fed on a HFD experienced a significant increase in body weight gain, and *spirulina platensis* has anti-obesity properties on this model [4,7]. The present result clearly showed that giving *spirulina platensis* is beneficial for the suppression of diet induced obesity.

Effect of spirulina on blood glucose and lipid profile

The effects of the *Spirulina platensis* on blood glucose levels were shown in Table 3. It showed that the *Spirulina platensis* produced a significant decrease ($p<0.05$) in the blood glucose levels when compared to group 2 animals.

From this study, it was found that animals that received 0.5g/day of *Spirulina platensis* showed reduction in total cholesterol (TC) levels as compared to HFD. The triglyceride (TG) levels of the treated groups showed a decrease after 30 days of treatment.

High density lipoprotein-cholesterol (HDL-C) levels showed an increase in *Spirulina platensis* treated animals. The low density lipoprotein-cholesterol (LDL-C) levels showed a reduction in value in *Spirulina platensis* treated animals as compared to HFD treated animals. HFD also induced fatty liver, with accumulation of triacylglycerides. In the treated group, body weight, total cholesterol and low density lipoprotein-cholesterol level were reduced significantly ($p<0.05$) as compared to normal groups.

Effect of *Spirulina plantensis* on Livers of HFD induced obese rats

Liver function test is crucial because liver is the central organ in detoxification of compounds. Organ or tissue damage causes the release of increased amounts of many enzymes into the blood stream [14,15] reported that the activities of most enzymes normally detectable in blood remain constant in healthy and normal person. The activities of serum enzymes (AST, ALT, ALP), total protein, albumin,, total bilirubin concentrations were shown in Table 4. There were no significant differences in parameters like Bilirubin, Total Protein (TP) and ALT, in treated group as compared to HFD. There were significant differences ($p<0.05$) in AST, ALP and Albumin levels in treated group as compared to HFD group.

Effect of *Spirulina plantensis* on Kidneys of HFD induced obese rats

Kidney is the second organ most frequently affected by any compounds. Therefore, renal functions can be assessed by measuring the concentrations of creatinine and urea in plasma [12]. Plasma urea and creatinine concentrations are often used as an index of renal glomerular function and will be increased in renal injuries [13]. Urea is synthesized in the liver, primarily as a by-

product of the deamination of amino acids. Creatinine, a by-product from muscle mass, will affect its concentration in blood. Table 5 Showed significant changes (p<0.05) in urea concentrations in treated animals as compared to HFD. Creatinine concentrations did not show any significant differences in treated group.

Figure 1. Effect of *Spirulina platensis* on Mean body weight

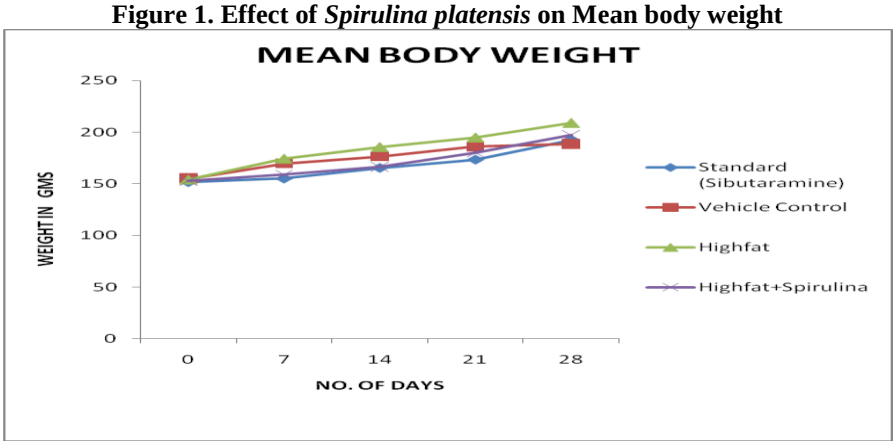

Table 1. Phytochemical screening of *Spirulina platensis*

PHYTOCHEMICAL TEST	RESULT
Flavonoids: Shinoda test **Lead acetate test**	+
Alkaloids: Dragendrof's reaction **Mayer's reagent**	+
Dragendorff's reaction	+
Glycosides: Modified Borntraers' test	+
Sterols: Libermann's Burchard test **Salkowski test**	+
Tannins and Phenolic compounds: **Ferric chloride solution test** **Lead acetate test**	+
Proteins and amino acids: Xanthoproteic test	+
Saponins : Foam test	+

Table 2. Effect of *Spirulina platensis* on body weight of high fat diet at different intervals

	Body weight (g)				
GROUP	**Initial (0 Day)**	**7th Day**	**14th Day**	**21stDay**	**30th Day**
Vehicle Control (VC)	155.17 ± 1.74	169.67 ± 1.28	176.50 ± 2.01	186.17 ± 1.96	188.67 ± 1.82
Standard (Sibutramine) +HFD	151.83 ± 1.30	155.33 ± 1.12	165.67 ± 1.36	173.67 ± 1.36	192.67 ± 1.28***
High fat (HF)	154.33 ± 1.50	174.33 ± 1.63	185.67 ± 4.46	194.83 ± 4.09	208.83 ± 1.35*
High fat + Spirulina (HFS)	152.83 ± 1.54	158.83 ± 1.30	166.50 ± 1.18	180.17 ± 2.09	197.17 ± 1.35**

*p <0.05, ***p< 0.001, ns- non significant, Values are Mean ± SEM and were analyzed by one way ANOVA followed by Dunnett's test.

Table 3. Blood glucose and lipid profile of HFD induced-obese rats supplemented with *Spirulina platensis*

Group (*n=6*)	Blood Glucose	Total Cholesterol	Triglycerides	LDLC	HDLC
Normal	95.4 ±0.954	75.1±1.03	85.9±0.73	29.1±0.68	44.4±0.265
HFD+ Sibutramine (5mg/kg)	96.6±0.854*	74.12±0.532*	72.2±2.4***	30.3±1.24**	57.4±6.70*
Control (HFD)	95.6±1.20*	98.70±2.37***	96.8±0.754*	32.3±0.916*	42.4±0.908*
HFD + Spirulina (0.5g/day)	92.3±1.23**	72.4±0.963***	84.8±0.788***	23.7±0.219***	54.6±2.55***

*p <0.05, ***p< 0.001, ns- non significant, Values are Mean ± SEM Data was analyzed by one- way ANOVA followed by Dunnett's test.

Table 4. Liver function test of HFD induced-obese rats supplemented with *Spirulina platensis*

Group (n=6)	Total bilirubin	SGPT (ALT)	SGOT (AST)	ALP	T P	Albumin
Normal	0.163±0.163	49.4±1.09	141±2.85	198±1.52	6.40±0.151	3.85±0.272
HFD+ Sibutramine (5mg/kg)	0.26±0.03*	54.42±1.60**	153.16±1.20*	195.1±1.54*	5.93±0.265*	3.45±0.365**
Control (HFD)	0.217±0.016**	52.4±1.33*	144±2.44*	204±1.85	6.87±0.207	3.94±0.234*
HFD + Spirulina (1000mg/kg)	0.153±0.0167***	48.3±0.943**	136±1.35**	191±1.37***	5.99±0.167**	3.48±0.370**

*p <0.05, ***p< 0.001, (n=6) ns- non significant, Values are Mean ± SEM Data was analyzed by one- way ANOVA followed by Dunnett's test.

Table 5. Kidney function test of HFD induce-obese rats supplemented with *Spirulina platensis*

Group (*n=6*)	Blood Urea Nitrogen (BUN)	Creatinine
Normal	14.1. ± 0.532	0.532 ± 0.0536
HFD+ Sibutramine (5mg/kg)	16.44 ± 0.594*	0.620 ± 0.054**
Control (HFD)	16.2 ± 0.839**	0.580 ± 0.052*
HFD + Spirulina (1000mg/kg)	14.8 ± 0.799*	0.505 ± 0.060*

*p <0.05, ***p< 0.001, (n=6) ns- non significant, Values are Mean ± SEM Data was analyzed by one- way ANOVA followed by Dunnett's test.

DISCUSSION

Obesity is a chronic metabolic disorder that results from the imbalance between energy intake and energy expenditure, characterized by enlarged fat mass and elevated lipid concentration in blood. Obesity is also a primary risk factor for CVD (Cardio Vascular Disorders). It has reached epidemic proportions globally, with approximately 1.6 billion persons (aged 15 years old and above) being overweight. Many attempts have been made to correct the metabolic disparity of the obesity condition, producing a number of reagents, including fibrates, Sibutramine (an anoretic or appetite suppressant), and Orlistat, but no one is free from the severe side effects.

At present, because of dissatisfaction with high costs and potentially hazardous side-effects, the potential of natural products for treating obesity is under exploration and this may be an excellent alternative strategy for developing an effective and safe anti-obesity drugs. A variety of natural products including crude extracts and isolated compounds from plants can induce body weight reduction and prevent diet-induced obesity. Therefore, they have been widely used in treating obesity.

The present study was aimed to evaluate the effects of *Spirulina plantensis* for 30 consecutive days, by P.O administration, on body weight, lipid profile, total proteins, albumin, in normal and HFD fed rats.

Rats that are fed HFD (High fat diet) are a widely, used model for obesity. The so called "High fat diet" involves feeding experimental animals a mixture of palatable commercially available supermarket foods, to stimulate energy intake. Characteristic for such diets is the combination of high fat content with high carbohydrate content.

Furthermore, the components of the cafeteria diet are a variety of foods high in fat and sugar, but usually low in protein, Vitamins, and minerals. Such diets have pronounced implications in the development of obesity, leading to significant body weight gain, fat deposition, and also insulin resistance, resembling that in human beings. It has been suggested that rats become more obese with high fat diet.

Spirulina platensis is reported to have high crude fiber and mineral content, especially potassium, sodium, magnesium and iron reported that moderate feeding of *Spirulina platensis* caused changes in dietary fatty acids and carbohydrates. Obesity that is related to hypercholesterolemia and hypertriglyceridemia is a major risk factor for the development of cardiovascular disease. Oxidative damaged LDLs are taken up by macrophages, which accumulate in the endothelial wall as lipid-laden foam cell in the initial phases of atherosclerotic fatty streak lesions. Therefore, a reduction in circulating TGs, TC and LDLs is primary in prevention of vascular disease. In addition, prevention of LDL oxidation by dietary antioxidants could delay the development of atherosclerosis. This model was used to study the potential of *Spirulina platensis* supplementation that contained significant amounts of antioxidants properties and useful minerals.

Presence of poly unsaturated fatty acids such as Palmitic acid, Stearic acid, Oleic acid, Linoleic acid, Gamma-linoleic acid. Phytochemical constituents like polyunsaturated fatty acids, fixed oils, amino acids, flavonoids are responsible for its antiobesity activity [16]. The presence of phycocyanin pigment in *Spirulina platensis*, which is responsible for oxidation of fatty acids or lipolysis [17,18] .

The results demonstrated that feeding with HFD had caused a significant increase in weight gain compared with the normal chow diet feed rats, which was significantly decreased by the co-administration of *spirulina platensis* in a dose dependent manner.

CONCLUSION

This study demonstrates that supplementing 0.5g/day of *spirulina platensis* exhibited a decrease in body weight, total cholesterol, triglycerides, total protein, blood glucose, urea, creatinine and decrease the activity of serum enzymes (AST, ALT and ALP) and increased a HDL cholesterol levels. The microalgae *spirulina platensis* presented polyunsaturated fatty acids which is responsible for anti-obesity activity and presence of phycocyanin pigment in *spirulina platensis* which is responsible for oxidation of fatty acids or lipolysis.

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