

Feed Efficiency and Serobiochemical Profile of Wistar Rats Fed With Spirulina As Functional Food

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ABSTRACT

Spirulina is an algae that grow in fresh and sea water and itself known to the human community with its unique Nutraceuticals properties, generally produced from the species named *Arthrospira platensis*, and *Arthrospira maxima*. *Arthrospira* species were cultivated throughout the world to fulfil the need of human dietary supplementation. An experimental study was planned to know the effect of spirulina supplementation on serum biochemical profile of Wistar albino rats as model study. Test results clearly denoted that diet planned with spirulina fed rats showed better serobiochemical profile when compared with stock diet and rice based diet. The protein and albumin values were significantly higher in spirulina fed rats. Feed consumption rate is very low in spirulina diet but gained more weight when compared to stock and rice diets, this might be due to high biological value protein in spirulina.

Key-words: Spirulina, Rice, Serobiochemical profile, Feed consumption, Feed efficiency.

INTRODUCTION

One of the most important research areas in the field of nutritional science is to investigate the role of dietary active compounds in human nutrition. Food and diet not only supply the nutrients to the body to perform its functions, but also have several beneficial effects to maintain the health. Several findings have implicated food as a major factor behind majority of the metabolic and degenerative diseases¹. In recent years, researchers are identifying some of the specific bioactive components in food and assessing their mechanisms, role and effects within the body. Eating a diet high in refined carbohydrates in the form of white rice is appears to increase the risk of diabetes and coronary heart diseases.etc³.

Agribusiness decertifies the soil, reduces biodiversity, increases global warming and depletes food resources. Nutritionists and scientists have been searching the alternative resources, one such natural food is Spirulina, blue green algae with multi-nutrient contents, not only in abundance but also in balance⁴. Spirulina is emerging as an important therapeutic food because of its high concentration of functional components and has been studied extensively due to its therapeutic potential in several areas⁵. The key implications backed by scientific findings are as functional food and additives, antioxidant, anti-inflammatory, hypolipemic, anti-hypertensive, anti-diabetic, anti-cancer, immunostimulant, antimicrobial, hepatoprotective, neuroprotective, anti-anaemic and anti-leucopenic and tissue engineering⁶.

Being consumed since centuries, Spirulina has well established itself as a functional food against an array of nutritional deficiencies. In recent years, Spirulina has garnered enormous attention from research fraternity as well as food, pharma and nutraceutical industries⁶. In view of the inconclusive reports regarding benefits of Spirulina, an attempt was made to evaluate the efficacy of Spirulina diet in comparison with rice based and stock diet.

Methodology

A total number of 18 healthy albino Wistar rats of 21-25 days age were selected for the experiment. Rats were kept in polypropylene cages with 12 hour of dark and light cycle and maintained at normal and static laboratory conditions of temperature and relative humidity in the animal house of the department of Food Science and Nutrition, Sri Venkateswara University, Tirupati. They were initially fed with the feed procured from National Centre for Laboratory Animal Sciences, National Institute of Nutrition, Hyderabad. Rats were given ad-libitum feed and water during the period of acclimatization (one week).

Experimental Design

A randomized block design was adopted and a total of 18 rats were distributed into three groups. All the groups consists of six rats (n=6, each) i.e. three male and three female. All the rats were kept individually in separate cages. An identification mark was given to each rat and tags were prepared with respective identification mark and attached to the cages.

Experimental Diets

Three diets with different composition of nutrients were planned which were the test diets for the study. Stock diet, Spirulina, Rice based diets are the test diets which were served to the group I (Stock diet), group II (Spirulina), and group III (Rice based diets) respectively. The diet composition is presented in table 1.

Feed Consumption

Animals in each group were fed with the respective diets every day. Individual daily food consumption record was maintained. The feed that is served to each animal was weighed and recorded. Split and leftover food was weighed everyday to obtain an accurate weight of the food consumed. The food consumed and leftover feed by the rats was calculated to obtain feed conversion rate (FCR).

$$\text{FCR} = \frac{\text{Feed consumed (gm)}}{\text{Body weight gain (gm)}}$$

Feed Analysis

All the experimental diets prepared were analyzed for proximate analysis. Analysis of dry matter, moisture, crude protein, ether extract, total ash and acid insoluble ash were analysed using standard food analysis techniques⁸.

Biochemical Assays

At the end of the experimental period (6th week), animals were weighed and the readings were recorded. The blood was collected by retro orbital puncture in serum vacutainers. The blood was

Table 1: Composition of the test diets per 100 gm

Stock Diet		Spirulina Diet		Rice Diet	
Ingredients	Quantity (gm)	Ingredients	Quantity (gm)	Ingredients	Quantity (gm)
Wheat Rawa	50	Wheat Rawa	50	Rice	90
Sprouted green gram	16	Green gram dal	15	Red gram dhal	4
Amaranths	16	Amaranths and carrot	16	Brinjal	2
Carrot	16	Sugar	15	Plantain	2
Gingelly oil	2	Gingelly oil	2	Gingelly oil	2
Milk	20ml	Spirulina	2gm	-	-

allowed to settle for sometime in order to separate the serum and again it was centrifuged in order to obtain clear serum (9). This serum was used for analysis of various biochemical parameters like glucose, ALT, cholesterol, triglycerides, protein, albumin, urea, creatinine and calcium. The sero-biochemical parameters were estimated auto analyzer (model: Star 21 plus, Aspen Diagnostics Pvt. Ltd.).

Statistical Analysis

The data was analyzed by univariate analysis, ANOVA, Tukey’s HSD post-hoc using SPSS version 15.

RESULTS AND DISCUSSION

The results and relevant discussion on feed analysis and effect of the supplementation of Spirulina on feed efficiency and serum biochemical parameters of Albino rats are presented.

Feed Analysis

All the experimental diets prepared were analyzed for proximate values and are presented in Table 2. The data shows that Spirulina diet contains high amount of dry matter and acid insoluble ash when compared with stock diet and rice based diet. Spirulina itself contains an unusually high amount of protein depending upon the source. Spirulina contains all essential aminoacids, hence called as a complete protein. When compared to the animal proteins such as meat, eggs, and milk, spirulina has slightly lower concentrations of amino acids such as methionine, cysteine and lysine, but still it is superior to plant protein, and nearly three times higher than the protein of the ever popular soya bean¹⁰. Further

it is rich in linoleic acid, alpha linolenic acid, gamma-linolenic acid, stearidonic acid, eicosapentaenoic acid, docosahexaenoic acid, and arachadonic acid. Spirulina also contains vitamin B1, B2 , B3 , B6 , B9 , C, D, A, and vitamin E. It is a rich source of minerals such as potassium, calcium, chromium, copper, iron, magnesium, manganese, phosphorus, selenium, sodium and zinc^{11,12}.

Feed Efficiency

The mean values of feed consumed (FC) and feed conversion rate (FCR) are given in table 3. The mean values of feed consumed by group I, group II, and group III are 466.10±22.16, 307.57±13.87 and 583.19±6.08 respectively. And the mean values of FCR in group I, group II, and group III are 4.74±0.17, 2.70±0.25 and 10±1.11 respectively. The results revealed that rice diet showed significantly higher FC and FCR, indicating poor utilization. Spirulina was significantly lower than rice diet indicating better utilization. There was no significant difference was observed between spirulina and stock diets.

The protein content of Spirulina is very high, between 55% and 77% by dry weight, depending upon the source. As it contains all essential amino acids, spirulina is a complete protein. Hence the utilization was much higher compared with rice diet which is poor in protein content and poor quality of amino acids¹³.

Biochemical Assay

The mean values of various serum biochemical parameters like glucose (mg%), Alanine trans elements (IU/L), glucose (mg%), Cholesterol (mg%), triglycerides, urea (mg%), calcium (mg%),

Table 2: Proximate analysis of experimental diets

Nutrient	Stock Diet (%)	Spirulina Diet (%)	Rice Diet (%)
Dry matter	58.72	95.1	79.29
Moisture	41.28	4.9	20.71
Crude protein	31.63	15.68	8.78
Ether extract	7.85	7.79	0.38
Total ash	7.28	7.91	1.97
Acid insoluble ash	2.25	2.09	0.55

Table 3: Feed consumed (FC) and feed conversion rate (FCR) of Test diets

Group	FCR	FC
Stock diet	4.74±0.17	466.1±22.16
Spirulina diet	4.2±0.45	307.57±13.87
Rice diet	2.39±0.15	583.19±6.08
df	2,17	2,17
F	20.75	79.57
sig	0	0

Values are mean±S.E

Table 4: Protein and albumin levels in different groups of experimental rats

Group	Protein	Albumin
Stock diet	7.35±0.8	2.34±0.16
Spirulina diet	6.95±0.58	2.48±0.32
Rice diet	6.37±0.83	1.96±0.61
df	2,16	2,16
sig	0.128	0.113

Values are mean±S.E

creatinine (mg%) in rats fed with stock diet, Spirulina diet and rice based diet are presented in Table 5 and

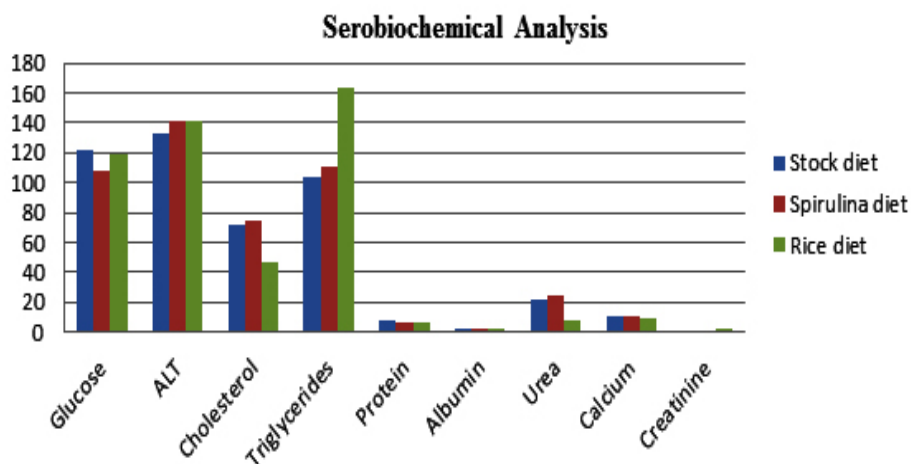
Fig 1. The mean values of protein (g%) and albumin (g%) are presented in Table 4 and Fig 2.

The mean glucose (mg%) values in group I,II and III were 121.77±50.04, 107±33.74 and 119.73±20.53, the mean ALT (IU/L) values were 133.38±9.11, 141.05±5.29 and 141.05±5.33, the mean cholesterol (mg%) were 72.08±15.96, 75.04±8.53 and 46.50±10.03, the mean triglyceride (mg%) values were 103.86±60.99, 110.36±60.77 and 164.15±53.77, the mean protein (mg%) values were 7.35±0.80, 6.95±0.58 and 6.37±0.83, the mean albumin (g%) were 2.34±0.16, 2.48±0.32 and 1.96±0.61, the mean urea (mg%) values were 22.48±9.84, 24.40±7.58 and 8.25±6.02, the mean calcium (mg%) values were 10.98±0.98, 11.04±1.42

Table 5: Serum biochemical parameters in different groups of experimental rats

Group	Glucose	ALT	Cholesterol	Triglycerides	Protein	Albumin	Urea	Calcium	Creatinine
Stock diet	121.77 ±50.04	133.38 ±9.11	72.08 ±6.52	103.86 ±24.9	7.35 ±0.32	2.34 ±0.06	22.48 ±4.01	10.98 ±0.4	1.55 ±0.06
Spirulina diet	107.7 ±33.74	141.05 ±5.29	75.04 ±3.49	110.36 ±24.05	6.95 ±0.24	2.48 ±0.12	24.4 ±3.09	11.04 ±0.58	1.56 ±0.72
Rice diet	119.73 ±20.53	141.05 ±5.33	46.5 ±4.48	164.15 ±24.8	6.37 ±0.37	1.96 ±0.27	8.26 ±2.69	9.52 ±1.16	2.59 ±0.07
df	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17	2,17
sig	0.778	0.113	0.003	0.408	0.128	0.113	0.11	0.298	0.873

Values are mean±S.E

**Fig. 1: Serum biochemical parameters in different groups of experimental rats**

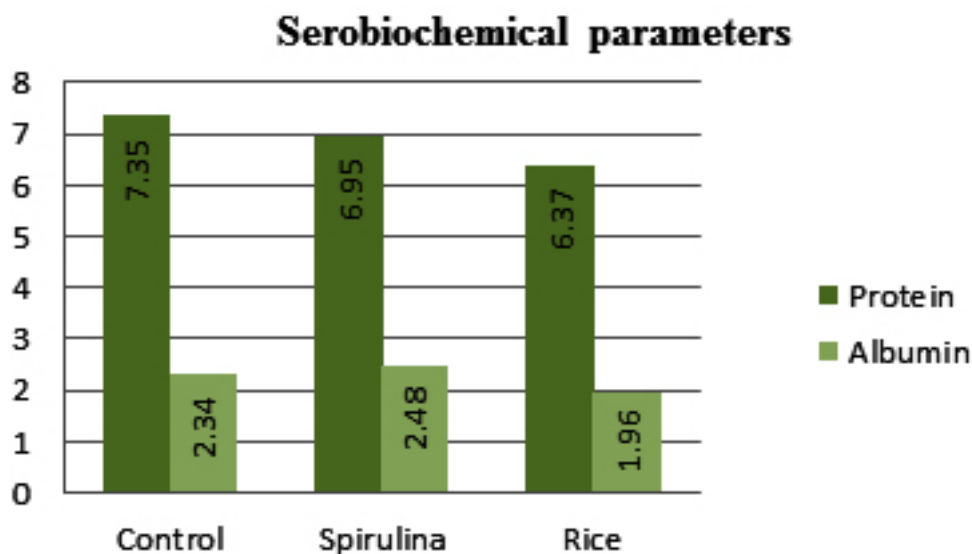


Fig. 2: serum protein and albumin levels in different groups of experimental rats

and 9.52 ± 2.60 and the mean creatinine values were 1.55 ± 0.06 , 1.56 ± 0.72 and 2.59 ± 0.07 respectively. There was no significant ($p < 0.05$) difference between sero-biochemical parameters except in cholesterol and urea in Group I and II, whereas in group III cholesterol and urea levels were very low compared to group I and group II.

The decrease in cholesterol by rice could be due to lack of cholesterol in foods from plant origin and moderate to high PUFA content which might have caused a decrease in serum cholesterol. Such a reduction in cholesterol level is attributed to the significant amounts of PUFA present in rice, which gets incorporated into and consequently weakens cell membranes when insufficient saturated fats are not available (15,16). Decrease in urea concentration could be attributed to the low crude protein content in rice diet (6-7%) and poor amino acid profile (17).

CONCLUSION

Spirulina has a high concentration of nutrients. It provides remarkable health benefits to malnourished people. The complete protein in Spirulina promotes growth, development and nutritional improvement in infants and children. It not only promotes growth, overall health and nutrition, it has been shown to lower cholesterol and has the ability to boost the immune system. As it contains a number of nutrients as well as many functional components, it is being recognized as a super food and efforts are being made to incorporate spirulina in medical, functional and therapeutic foods. In conclusion, Spirulina may play a beneficial role in promoting growth, preventing disease, improving nutritional status and maintaining health and wellness.

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