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"Effect of Spirulina on Anthropometry and Bio-Chemical Parameters in School Children"

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Abstract: *An experimental study was conducted to study the effect of spirulina on anthropometric parameters and the bio-chemical parameters before and after its use as nutritional supplement in school children.*

The study was conducted in a residential girl's school in the age group between 11 to 13 years. Three capsules of spirulina were given during dinner time for 3 months. At the initial survey and at the end of 6th month the anthropometric and bio-chemical findings were recorded. Blood samples were taken to analyse hemoglobin (Hb), serum ferrtin, serum zinc, serum protein and serum albumin levels at 0, 3 and 6 months.

Result: *There was a significant increase in anthropometric measurements and Hemoglobin, serum ferrtin, serum zinc, serum protein and serum albumin levels in the study sample after 6 months.*

Conclusion: *The anthropometric and bio-chemical parameters improved after the use of spirulina.*

I. Introduction

Each day around forty thousand children die because of severe malnutrition and related diseases across the world. Malnutrition disempowers and affects the lives of around 852 million people globally in a drastic way. According to the United Nations World Health Organization (WHO:1996), more than starvation the real challenge today is malnutrition and deficiency of micronutrients (vitamins, minerals and essential amino acids) that no longer allows the body to ensure growth and maintain its vital functions[1].

Children with the malnutrition and deficiency of micro nutritients are in greater danger of infections. To promote immunity and to improve the nutritional status it becomes imperative to give better nutrition and food supplement with greater calorific values.

Spirulina offers remarkable health benefits to an undernourished children. It is rich in beta-carotene that can overcome eye problems caused by vitamin A deficiency[2]. It provides the daily dietary requirement of beta-carotene which can help prevent blindness and eye diseases[3].The protein and B-vitamin complex makes a major nutritional improvement in an infant's diet. It is the only food source other than breast milk containing substantial amounts of essential fatty acid, essential amino acids and GLA that helps to regulate the entire hormone system[1].

The United Nations World Health Organization (WHO) has confirmed that spirulina represents an interesting food for multiple reasons, rich in iron and protein, it can be safely administered to children without any risk[4].

Advantage of spirulina is that it has 60% protein by weight that is higher than any other food source. It is the most easily digestible form of protein food especially important for malnourished people[5].

There are very many strategies that can be adopted for diet supplementation, which in turn contributes to immune ability of the children. In the present study, it was proposed to examine the effect of spirulina on the anthropometric parameters and the bio-chemical changes which increase the immune power as well as the growth of the children.

II. Materials and Methods

The study was conducted in a residential girl's school at Parangipettai – Seva mandir 15km from Rajah Muthiah Medical College and Hospital (RMMC&H).

A preliminary meeting was held with the children and parents of the school in the presence of the school health officer. A team of doctors along with the HOD of Pediatrics, RMMC&H gave lectures on the importance of nutrition and basic hygiene. They also gave lectures on spirulina as a nutritional supplement.

INCLUSION CRITERIA: All girls in the age group of 11 to 13 years were enrolled in the study.

EXCLUSION CRITERIA: Girls with systemic illness were excluded from the study.

At the initial survey, all the anthropometric and clinical findings were recorded in a proforma. Initial blood samples were taken to analyse Hb, serum ferrtin, serum zinc, serum protein and serum albumin. They were given one table of albendazole. Three capsules of spirulina(each containing 300mg of pure spirulina) were

given to the study group every day for 3 months. At the end of 3rd and 6th month, the anthropometric measurements and blood investigations were repeated.
Initially 150 students were enrolled in the study. All of them received spirulina for 3 months. Out of this, 100 students continued their spirulina capsules for a further period of 3 months. At the end of 6th month, 91 students completed the study. Anthropometric measurements and blood samples were repeated for these students.

III. Data Analysis

With a view to examine the validity of hypothesis relating to the change in the levels of different blood parameters statistical tools such as mean, S.D, students "t" test for paired observation and one way ANOVA for repeated measures were used. Since the observations taken on successive occasions are likely to be related with each other, the possibility of correlation makes it imperative to apply the above statistical tools.

IV. Results

The effect of spirulina on the anthropometric parameters and the bio-chemical parameters after the administration of spirulina at 3rd and 6th months were analysed and results are given below.

1 ANTHROPOMETRY PARAMETERS

Anthropometry parameters such as weight, height, BMI have significantly increased after spirulina. The results have given below,

(a) Weight parameter: Weight gain in kilograms (kgs) after the administration of spirulina were given in Table 1

Table 1: Weight gain after the administration of spirulina

Weight gain in Kgs	No. of Girls	Percentage
0 -1	2	2.19%
1 – 2	9	9.98%
2 – 3	29	31.86%
3 – 4	27	29.67%
4 – 5	15	16.48%

Nearly 89% of girls have significant weight gain after intake of spirulina.

(b) Height parameter: Height gain in centimeters (cms) after the administration of spirulina were given in Table 2

Table 2: Height gain after the administration of spirulina

Height gain in cms	No. of Girls	Percentage
0 -1	2	2.19%
1 – 2	5	5.49%
2 – 3	15	16.48%
3 – 4	26	28.57%
4 – 5	28	30.76%
5 – 6	10	10.98%
6 – 7	4	4.3%
> 7	1	1%

There exists a significant increase in height difference of >1.5cms in 87 children.

(c) BMI

BMI increased after the administration of spirulina were given in Table 3

Table 3-Increase in BMI after the administration of spirulina

BMI	No. of Girls	Percentage
0.1	61	67%
1.2	24	26.3%
2.3	4	4.3%
3.4	1	1.09%
4.5	1	1.09%

Though BMI is expected to remain more or less constant the borderline increase suggest that the weight gain is more than the height gain.

V. BIO-CHEMICAL PARAMETERS

The results of bio-chemical parameters such as Haemoglobin level, serum ferrtin levels, serum zinc levels, serum protein levels and serum albumin levels are given below.

(a) Haemoglobin level: The results of Hb level at pre and post treatment mean & S.D are given in Table – 4.

TABLE -4 : HAEMOGLOBIN LEVELS PRE AND POST TREATMENT

DESCRIPTIVE STATISTICS

Haemoglobin Level	Mean	Std.Deviation
Pre-Treatment Hb	11.713	1.250
Post Treatment Hb	12.828	1.299

From Table-4 it is inferred that the mean of baseline and Hb post level treatment is 11.71 and 12.52 with the corresponding S.D value of 1.250 and 1.299 respectively. Paired "t" was used to compare the pre and post difference of Hb. The "t" value is -17.47 with the corresponding p value less than 0.01.It implies that there exists a significant difference between the mean values of Hb before and after treatment, which proves the efficacy of treatment. There is a significant increase in the Hb value due to the spirulina suplimentation.

(b) SERUM FERRTIN LEVELS : The results of serum ferrtin at the baseline, 3rd and 6th months mean & S.D and one way ANOVA for repeated measures are given in Table –5.

TABLE – 5: SERUM FERRTIN LEVELS AT BASELINE - 3rd MONTH AND 6th MONTH

DESCRIPTIVE STATISTICS

Ferrtin Level	Mean	Std. Deviation
Baseline	54.098	12.034
3rd Month	58.725	10.170
6th Month	68.318	8.616

REPEATED MEASURES ANOVA

F	Sig(2-tailed)
158.430	.000

PAIRWISE COMPARISONS	T	P
Baseline and 3rd month	9.498	0.000
3rd month and 6th months	11.872	0.000
Baseline and 6th months	13.546	0.000

From Table – 5, it is inferred that the mean of baseline, 3rd month and 6th month ferrtin is 54.09, 58.72 and 68.31 with the corresponding S.D values of 12.034, 10.170 and 8.61 respectively. Repeated Measures Analysis of variance (ANOVA) was used to study the mean difference at three varying times. The F value is 158.430 with the corresponding P value of 0.000. Since the P value is less than 0.01 there is a significant difference of three values. The Ferrtin levels significantly increased at 3rd month and 6th month in comparison to baseline with the maximum increase at 6th month.

(c) SERUM ZINC LEVELS : The results of serum zinc at the baseline, 3rd and 6th months mean & S.D and one way ANOVA for repeated measures are given in Table –6

TABLE – 6 : SERUM ZINC LEVELS AT BASELINE 3rd MONTH AND 6th MONTH

DESCRIPTIVE STATISTICS

Zinc Level	Mean	Std.Deviation
Baseline	93.291	34.424
3rd Month	129.186	42.144
6th Month	1333.669	38.876

REPEATED MEASURES ANOVA

F	Sig
37.292	.000

PAIRWISE COMPARISONS	T	P
Baseline and 3rd month	11.347	0.000
3rd month and 6th month	0.748	0.000
Baseline and 6th month	7.020	0.000

From Table – 6 it is inferred that the mean of Zinc level, compared to baseline 3rd month and 6th month increases gradually and the corresponding standard deviation values are 34.424, 42.144 and 38.87 respectively. The F value is 37.292 with the corresponding P value is less than 0.01. It implies there is a significant difference of three values, i.e Zinc levels are significantly increased at 3rd month and 6th month in comparison to baseline. Pairwise comparison shows that there is significant improvement between 3rd and 6th month. Hence, greater improvement in the Zinc values obtained at 3rd month. There after only mild improvement obtained.

(d) SERUM PROTEIN LEVELS : The results of serum protein at the baseline, 3rd and 6th months mean & S.D and one way ANOVA for repeated measures are given in Table –7

TABLE – 7 : SERUM PROTEIN LEVELS AT BASELINE 3rd MONTH AND 6th MONTH
DESCRIPTIVE STATISTICS

Protein Level	Mean	Std.Deviation
Baseline	8.594	0.837
3rd Month	8.516	0.975
6th Month	8.746	0.999

REPEATED MEASURES ANOVA

F	Sig
2.134	.000

PAIRWISE COMPARISONS	T	Sig Value
Baseline and 3rd month	0.598	0.552
3rd Month and 6th Month	3.981	0.261
Baseline and 6th month	1.130	0.000

From Table – 7, it is inferred that the mean of baseline 3rd and 6th month level Protein is 8.59, 8.51 and 8.74 with the corresponding S.D of 0.837, 0.975 and 0.999 respectively. The F value is 2.134 with the corresponding P value of 0.121. The obtained P value is more than 0.05 and hence there is no significant difference of these values. Hence the protein levels on the average have not shown significant increase. But comparing observations pairwise it is seen that there is significant change of protein values between 3rd and 6th months. It shows that there is improvement in protein value between 3rd and 6th month following treatment, but change is not significant when compared with baseline values.

(e) SERUM ALBUMIN LEVELS : The results of serum albumin at the baseline, 3rd and 6th months mean & S.D and one way ANOVA for repeated measures are given in Table –8

TABLE – 8 : SERUM ALBUMIN LEVELS AT BASELINE 3rd MONTH AND 6th MONTH
DESCRIPTIVE STATISTICS

ALBUMIN LEVELS	Mean	Std.Deviation
Baseline	4.313	0.185
3rd Month	4.375	0.346
6th Month	4.629	0.343

REPEATED MEASURES ANOVA

F	Sig
29.820	.000

PAIRWISE COMPARISONS	T	Sig Value
Baseline and 3rd month	1.496	0.138
3rd Month and 6th Month	5.682	0.000
Baseline and 6th month	7.255	0.000

From Table – 8, it is inferred that the mean of baseline 3rd month and 6th level of Albumin is 4.313,4.375 and 4.629 with the corresponding S.D of 0.185, 0.346 and 0.343 respectively. The F value is 29.820 with the corresponding P value of 0.000. The obtained P value is less than 0.01 and hence there is significant difference between the mean levels of Albumin. But pairwise comparison shows that there was no significant improvement in the Albumin level during first 3 months and greater improvement obtained between 3rd and 6th months of treatment.

VI. Discussion

The effect of spirulina as nutritional supplement in 150 school children was studied. Ninety one students completed the course of spirulina for 6 months. The growth parameters and the bio-chemical parameters before and after the administration of spirulina were recorded. The blood samples were analysed for Haemoglobin, serum ferrtin, serum zinc, serum protein and serum albumin at 0, 3rd and 6th months.

In our study 89% of girls showed significant weight gain after intake of spirulina .There exists a significant increase in weight gain >3kg in 75 children and <3kg in 16 children. With spirulina the patients gained weight and their proteinograms improved[9].

There exists a significant increase in height difference of >1.5cms in 87 children and <1.5cms in 4 children. There is an increase in head circumference of >0.5cm in 68 children who completed the study after 6 months.

A significant difference was observed between the baseline and post Hb values. This implies that there is an increase in the Hb value was due to the effect of spirulina as the diet was more or less same during the study period. The blood hemoglobin increased to a satisfactory level especially in children with hypochronic anemia which is similar to the study of Takeuchi, et al [6]

The Serum Ferrtin levels have significantly increased at 3rd and 6th month (99% difference) in comparison to baseline with the maximum increase at 6th month.

The Serum Zinc had greater improvement in values at 3rd month, there after only mild improvement obtained. But there is significant (99%) increase at 6th month value. Spirulina with a high content of zinc may be twice as effective as a supplement in curing zinc deficiency in children. It has many bioactive and nutritious substances that improve mineral absorption, general health and the immune system[7].

In 95% of the children the serum protein value improved between 3rd and 6th month though there was no marked difference between initial and 3rd month values.

Even though there was no marked difference in the albumin levels at initial and 3rd months of treatment greater improvement obtained between 3rd and 6th months of treatment.

The spirulina normalizes the peroxide lipid oxidation with its anti-oxidant activity[9]. The clinical effect showed spirulina is a good nutritional supplement for children with poor appetite, diarrhea and constipation[10].

V. Conclusion

The anthropometric and bio-chemical parameters have improved after the use of spirulina thus making it an ideal nutritional supplement which is cost effective and shows positive results within a short span of time

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