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Effect of Supplementation of Spirulina on the Haematological Profile and Intellectual Status of School Girls (7-9 years)

Rajbir Sachdeva, Ravinder Kaur and Jasvinder Kaur Sangha

Malnutrition adversely affects the growth potential of a nation and obstructs its development. It is a complex problem emneshed in circumstances of poverty, ignorance and despair and its eradication requires substantial social and economic reforms (Vazir, 1998). While malnutrition affects people of all ages, children in general are the most sufferers from its ravages. Nutritional assessment is an important facet of medical and health care of children. An accurate assessment allows for the early detection and treatment of nutrient deficiencies (Maquaid, 1990).

Minerals viz. iron, zinc and copper play a very important role in human nutriture and are recognized as essential micro nutrients. Iron deficiency adversely affects attention, intelligence, test performance and school achievement (Pollit and Leiber, 1986). Intelligence is considered to be the highest mental ability of an individual and is the core of competency in every field. A consistent effort is being made to establish the relationship between nutrition and intelligence (Sharma and Sharma, 1993).

Spirulina, blue green micro algae is gaining popularity in the recent years as a food supplement because of its ability to synthesize high quality concentrated food than any other algae (Murate, 1993). Spirulina has a unique blend of nutrient that no single plant source can provide. It provides highest amount of protein (65-71%), various vitamins, minerals including chelated minerals along with pigments like phycocyanin (Venkataraman, 1993). It has high levels of β-carotene, gamma linolenic acid, iron and vitamin B_{12}

So the present investigation was undertaken to see the impact of supplementation of spirulina on haematological and intellectual status of school girls (7-9 years).

MATERIAL AND METHODS

Selection of Subjects: A sample of 60 girls aged 7-9 years were selected by random sampling technique and equally divided into two groups viz. Experimental (E) and Control (C) group.

Haematological Profile of the Subjects: Haemoglobin (Hb) PCV, RBC count were determined both at T_1 and T_2 for both the groups. MCV, MCH and MCHC were also calculated.

Intellectual Status of the Subjects: Raven's coloured progressive matrices with 36 total scores was used to assess the intellectual status of the subjects both at T_1 and T_2. Respondents were also classified into five different categories as per Raven's classification.

Supplementation: Spirulina powder in the form of "Dabur Sunova" capsules were used for supplementation. Two capsules (1g) were opened and thoroughly mixed in one serving of *Panjiri* (30g) and fed for five days a week for a period of two months to the subjects of E group.

Statistical Analysis: The results were statistically analysed in the computer. Student's t-test was used to see the effect of spirulina supplementation on the haematological and intellectual status.

RESULTS AND DISCUSSION

Haematological Profile of the Subjects

Hemoglobin (Hb): The mean value of Hb level of respondents of both the groups are given in Table 1. The Hb levels of E and C group at T_1 was 11.7±0.7 and 11.2±0.9g/dl respectively. However the value increased to 12.5±0.7 g/dl for E group with no change in the values of C group at T_2. The increase in value for E group at T_2 was statistically significant ($P \leq 0.01$), which could be attributed to highly available form of iron present in spirulina. An average increase of 1.1 g/dl in Hb level as a result of supplementation of 1 g of spirulina/ day for three months was also reported by Kauser et al. (2001). Respondents were also classified according to NIN (1986) and WHO (1972) classification, which are given in Table 2 and 3. According to these classification, none of the respondents in both the groups fell in severe and moderate anaemic category (Hb≤10g/dl). An improvement in Hb level was reported as there was increase in the number of subjects towards normal category.

Packed Cell Volume (PCV): The mean PCV

Table 1: Haemotological profile of respondents (Mean±S.E.)

Profile Experimental group	*(n=30)*	*Control group (n=30)*			*Standard suggested*	*t-value*
	T_1	T_2	T_1	T_2	*value*	
Hb (g/dl)	11.7 ± 0.7	12.5 ± 0.7	11.2 ± 0.9	11.2 ± 0.9	12-16^{+}	4.36**
PCV (%age)	42 ± 2.2	44.4 ± 2.4	40.9 ± 2.8	40.93 ± 2.9	36-47^{++}	3.32**
RBC count (10^6/mm^3)	3.97 ± 0.4	4.09 ± 0.3	3.90 ± 0.3	3.93 ± 3.8	3.9-5.6^{++}	1.29
MCV (fl)	99.5 ±4.49	108.6 ± 4.72	104.9 ±4.74	104.89 ±4.74	84-95^{+}	7.53**
MCHC (g/dl)	32.15 ±0.95	30.4 ± 0.81	29.8 ±0.75	29.8 ±0.70	33-38^{+}	7.55**
MCH (pg)	31.99 ±0.51	33 ± 0.59	31.3 ± 1.1	31.27 ±0.97	28-32^{+}	6.98**
Serum protein (g/dl)	7.31 ± 1.4	8.23 ± 1.3	7.08 ± 1.3	7.09 ± 1.3	7.5^{+}	2.55*
Serum retinol (µg/dl)	17.8 ± 3.3	27.9 ± 2.9	18.45 ± 2.4	19.75 ± 2.3	20^{+++}	12.5**

T_1 Before supplementation
T_2 After supplementation
$^{+}$ Harper (1965)
$^{++}$ Davidson and Passmore (1987)
$^{+++}$ Olson (1984)
** Significant (P≤0.01)
* Significant (P≤0.05)

Table 2: Classification of Haemoglobin according to NIN (1986)

Haemoglobin	*Experimental group)*				*Control group*			
	T_1		T_2		T_1		T_2	
(g/dl)	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Severe anaemic (< 7)	-		-		-		-	
Moderate anaemic (8.0 - 10.0)	-		-		-		-	
Mildanaemic (10.0 - 11.0)	1	3.3	-		3	10	2	6.7
Marginal anaemic (11.0 - 12.0)	21	70	-	-	11	36.7	12	40
Non-anaemic (>12.0)	8	26.7	15	50	16	53.3	16	53.3

Table 3: Classification of Haemoglobin according to WHO (1972)

Haemoglobin	*Experimental group)*				*Control group*			
	T_1	T_2	T_1	T_2				
(g/dl)	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Anaemic (<12)	22	73.3	-	-	9	30	10	33.3
Non-anaemic (≥12)	8	26.7	30	100	21	70	20	66.7

T_1 Before supplementation
T_2 After supplementation

values among respondents of E and C groups at T_1 was 42±2.2 and 40.9±2.8 percent. However, after supplementation the value increased to 44.4±2.4 per cent in E group. A statistically significant (P≤0.01) difference was observed in E group.

Red Blood Cell Count (RBC): The mean values of RBC count in E and C groups at T_1 and T_2 was 3.97±0.4 x 10^6 & 3.90±0.3 x10^6 mm^3 and 4.09±0.3 x 10^6 & 3.8 x10^6 mm^3 respectively. The values in both the groups were within the normal range of 3.9±5.6 x 10^6 mm^3 as given by Davidson and Passmore (1987). An improvement in RBC count was found for subjects of E group, though non-significant.

Mean Corpuscular Volume (MCV): The mean value of MCV among the respondents of E and C group at T_1 was 99.50±4.49 and 104.9±4.74 fl. The mean values were above the normal range of 84 - 95 fl as suggested by Harper (1965). A significant increase in MCV value was found in E group after supplementation.

Table 4: Average intelligence level of the respondents

Group		*IQ (Mean±S.E.)*	*t-value*	*Low intelligence score (0-18)*		*High intelligence score (19-36)*	
				n	*%*	*n*	*%*
Experimental group	T_1	16.5 ± 2.8	1.94*	23	76.7	7	23.3
	T_2	17.8 ± 2.9		17	56.7	13	43.3
Control group	T_1	16.6 ± 2.7	-	24	80.0	6	20.0
	T_2	16.74 ± 2.8		23	76.7	7	23.3

* Significant (P≤0.05)

Mean Corpuscular Hemoglobin Concentration (MCHC): The mean value of MCHC among the respondents was 32.15±0.95 and 29.8±0.75 per cent in E and C group respectively. It was observed that mean MCHC value was below the normal range in both the groups before as well as after the supplementation.

Mean Corpuscular Hemoglobin (MCH): The mean values of MCH among subjects belonging to E and C group at T_1 was 31.9±0.51 and 31.3±1.01pg respectively. The value of MCH was within the normal range of 28-32 pg as per Harper (1965) in both the groups at T_1 and T_2.

INTELLIGENCE QUOTIENT (IQ) OF THE RESPONDENTS

The mean IQ scores are given in Table 4. Data showed that mean scores of respondents in groups E and C at T_1 was 16.5 and 16.4 and at T_2 the IQ scores increased to 17.8 and 16.7 respectively. A significant (P<0.05) improvement was observed in the IQ scores of E group after supplementation. This could be attributed to improved nutrition supplied through spirulina. Similar improvement in intelligence scores as a result of spirulina supplementation was also reported by Kauser et al. (2001). Further, respondents were also classified into five different categories as per Raven's classification (Table 5). It was observed that only 3.3 per cent respondents were intellectually superior while more than half of the respondents fell in intellectually average category in both the groups. An overall improvement was observed with an increase in percentage of respondents falling in above the average category.

COEFFICIENT OF CORRELATION BETWEEN HAEMATOLOGICAL INDICES AND IQ

The perusal of the data indicated that haematological indices were positively correlated to IQ of respondents. Hb level was significantly (P≤0.01) correlated to IQ in the subjects of E group, the value of r being 0.49. These results

Table 5: Raven's classification of intellectual level of respondents

Classification (Percentile points)*	*Experimental group (n=30)*				*Control group (n=30)*			
	T_1		*T_2*		*T_1*		*T_2*	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Intellectually superior (95 percentile or more) Grade-I	1	3.3	1	3.3	-		-	
Definitely above the average (75^{th} - 95^{th} percentile) Grade-III	2	6.7	5	16.7	1	3.3	1	3.3
Intellectually average (25^{th} - 75^{th} percentile) Grade-III	19	63.4	20	66.7	17	56.7	18	60.0
Definitely below the average (5^{th} – 25^{th} percentile) Grade-IV	3	10	2	6.7	4	13.3	4	13.3
Intellectually defective (5^{th} percentile or less) Grade-V	5	16.7	2	6.7	8	26.7	7	23.3

* Raven (1965)

were in line with findings of Allen (1990) who reported mild and moderate anaemia to impair performance on mental development scales in children.

CONCLUSION AND SUGGESTION

It is concluded from the present study that spirulina can be used as a food supplement to make up for the deficiencies, resulting in better nutritional status which further improved intellectual status of the subjects. Spirulina supplementation also improved haematological profile of the subjects. Central Government should formulate some policy of supplying spirulina capsules free of cost to the vulnerable sections of the society especially children in the rural and slum areas to eradicate iron deficiency and to improve intellectual status.

KEYWORDS Haematological Profile. Intellectual Status. Spirulina. Supplementation.

ABSTRACT A sample of sixty girls aged between 7-9 years belonging to low middle income group were selected from Government senior secondary school, P.A.U., Ludhiana. The subjects were equally divided into two groups viz. Experimental (E) and Control (C) group. The mean per capita monthly income was Rs. 837/- and Rs. 869/- in group E and C respectively. Subjects of E group were supplemented with two capsules (1g) of spirulina daily after mixing in one serving (30g) of *Panjiri* daily for five days a week for a period of two months, while C group was given placebo for the same period. Haemoglobin (Hb), PCV, RBC count were estimated before (T_1) as well as after supplementation (T_2). "Raven's coloured progressive matrices" was used to assess the intellectual status at T_1 and T_2. An improvement in the haematological as well as intellectual status among respondents of E group when compared to C group showed positive effect of spirulina and proved to be an effective source of protein as well as iron and retinol.

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Authors' Address: **Rajbir Sachdeva, Ravinder Kaur and Jasvinder Kaur Sangha,** Department of Food and Nutrition, College of Home Science**,** Punjab Agricultural University, Ludhiana 141 004, Punjab, India