



IMPACT OF SUPPLEMENTATION OF PEARL MILLET (Pennisetum typhoides) PRODUCTS ON ANEMIA, MALNUTRITION AND PSYCHOLOGICAL ATTRIBUTES IN SCHOOL AGE CHILDREN OF JODHPUR, A DESERT DISTRICT OF RAJASTHAN, INDIA

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ABSTRACT **Objectives:** Pearl millet cookies were prepared and supplemented to observe its impact on Anemia, Malnutrition and Psychological attributes in school age children.

Methodology: 311 School children of 6-11 years were examined for hemoglobin estimation, nutritional deficiency signs, anthropometry, Psychological Tests-IQ level, before and after supplementation of Pearl Millet products daily for 180 days.

Findings: Pearl millet products supplementation reduced anemia, from 79.4 to 61.8%. Non anemic children increased significantly from 20.6 to 38.2% ($p < 0.01$) after supplementation. For Cognitive development & Intelligence level, Colored Progressive Matrices Test grades were assessed which showed that 42 percent children shifted from IV grade (Below Average) to III grade (Average) which is good impact on the Cognitive development & Intelligence level of children ($p < 0.01$).

Conclusion: Significant increase in non anemic children along with significant positive effect on malnutrition and on psychological tests performed on learning attributes in terms of memory, intelligence, cognition after supplementation.

KEYWORDS : Pearl Millet, Supplementation, anemia

Introduction:

Micronutrient deficiency disorders (MDDs) is one of the burning problem in India. In desert area, climatic conditions are very harsh. Rural inhabitants of desert area mostly consume pearl millet and wheat in their diet. Pearl millet is a rich source of iron. An attempt has been made in the present study in the direction of reducing the anemia and other MDDs considering the local diet of desert area. With this aim, pearl millet products have been prepared considering that supplementation of these products will help in reduction of anemia and other MDDs in school children of desert area. Hypothesis: Supplementation of pearl millet products will reduce the prevalence of anemia examined through Haemoglobin estimation in school age children of Jodhpur district of Rajasthan. The main objective was to study the effect of pearl millet products supplementation on anemia Malnutrition and Psychological attributes in school age children of Jodhpur, a desert district of Rajasthan, India

Methodology

According to WHO/UNICEF/ICCIDD [1] for school based survey, 30 cluster sampling approach have to be adopted keeping in view the operational feasibility. Recently DGHS (2005) has given new guidelines for sampling according to which sample size is calculated on the basis of prevalence of IDD as 10 %, level of confidence - 95 %, relative precision - 20 % and design effect – 2 using formula $(Z)2 Q / (L)2 P$. Using formula $(Z)2 Q / (L)2 P$, sample size worked out to be 180 children from the district. Nutrition intervention has been conducted on 311 school children (15 percent of calculated sample size i.e. 270 and consideration of 15 percent non response of 270 i.e. 41). These children have been supplied with supplements daily for the period of 180 days. These supplements have been developed and supplied by Defence Food Research Laboratory, Mysore with pearl millet. These children have been re-examined after period of 180 days supplementation for all the parameters observing the impact of the supplements on reduction of micronutrient deficiency disorders on school children of Rajasthan.

As a first step, list of all the government and private schools with children 6+-11+ years of age from both rural and urban areas was obtained from district education office of Jodhpur. Secondly cumulative enrollment was determined. Finally schools were selected using PPS sampling technique as recommended by WHO. In the selected schools, children were selected randomly using Tippets random number table. Equal proportion of boys and girls and proportionate distribution of children from 6+-11+ years were covered in the selected school.

Administration & Follow up: Each registered school child from 6+-11+ years served as one single unit for the purpose of administration

of products. Each child under study has been followed up to six months.

In this project 311 school children of 6+-11+ years age groups belonging to 4 schools of 4 villages i.e. Bucheti, Sewaki Khurd, Bodavi and Gangani of Jodhpur tehsil of Jodhpur district were registered for supplementation. All registered children were interviewed / examined for Socio-demographic profile, nutritional deficiency signs and morbidity for last 15 days. All registered children were examined for Anemia assessed by Hemoglobin levels (Cyanmethaemoglobin technique), and have been classified as per WHO classification. Iodine deficiency disorders have been assessed by clinical examination of thyroid gland using the standard method as recommended by the joint WHO/UNICEF/ICCIDD consultation [1]. A casual urine sample has been collected for estimation of Urinary Iodine Excretion (UIE) levels to assess the Iodine nutriture status. UIE have been determined by Ammonium Persulphate Digestion on Microplate method (APDM) using standard laboratory technique. UIE level less than 10 mcg/dl have been considered as indicator of iodine deficient nutriture. Children were requested to bring sample of 20 gm. salt consumed in their families in auto seal LDPE pouches. Iodine content of salt sample was estimated using standard iodometric titration method. Salt samples having iodine content less than 15 ppm was classified as with inadequate iodine. Each child was assessed for psychological tests on learning attributes in terms of memory, intelligence, reasoning and attention etc before supplementation.

Four Psychological Tests were performed to test the IQ level of children of age group 6+-11+ years. These were Colored Progressive Matrices Test (CPM) grades (For Cognitive development & Intelligence level of children- Grade 1 Excellent, Grade II Above Average, Grade III Average, Grade IV Below Average, Grade V Impaired or mentally retarded), Knox Cubes Test, KCT test grades (Intelligence level and short term memory- Grade 1 Idiot, Grade 2 Imbecile, Grade 3 Moron, Grade 4 Border line seeble minded, Grade 5 Dull, Grade 6 Average, Grade 7 Superior, Grade 8 Very superior and Grade 9 Genius), Techistoscope Test, (TT) points (concentration and short term memory- Score points <5 Below Average, Score points 72 i.e. 5-9 Average, Score points >9 Above Average) and Digit Span Test. (DST) points (short term memory- Score points <5 Below Average, Score points 72 i.e. 5-9 Average, Score points >9 Above Average). Hand on Training was imparted by Dr. Ravi Kumar Gunthe, Associate Professor, Psychology Department, JNV University, Jodhpur for performing these psychological tests and their interpretation and analysis.

All the Registered school children were administered with supplements daily for a period of 180 days. These supplements have

been supplied by Defence Food Research Laboratory, Mysore. These registered children were re-examined after period of 180 days supplementation for all above mentioned parameters to observe the impact of the supplements on reduction of micronutrient deficiency disorders, malnutrition and psychological parameters in school children of Rajasthan. Salt, urine analysis and haemoglobin estimation have been done at laboratory by trained technician and project staff at DMRC. Data collected in the field have been computerized under the supervision of biostatistician. The computer program has been developed in FOX- PRO software and used for analyzing the data. As regards to the specific analysis, the extent of increase in haemoglobin levels i.e decline in anemia, decrease in IDD through UIE levels have been carried out and the same have been compared before and after the initiation of the supplementation of the products using students t-test in order to observe its impact. Statistical test of significance has been applied in other associated parameters such as psychological tests, morbidities, nutritional deficiencies and malnutrition in order to observe the impact of pearl millet products before and after the supplementation.

Results

Analysis of 311 children registered for the study revealed that out of 311 children, 129 were boys and 182, girls. 89.1 percent children belong to Hindu religion whereas 10.9 percent belong to Muslim religion. Forty six percent children belong to OBC caste and 25.7 percent to SC caste. Illiteracy was high among the parents i.e. 46.5 percent belong to illiterate category whereas 1.6 percent were studied up to college level. 43.3 percent children belong to category of monthly income group of Rs. 285 to Rs. 569 following modified Prasad classification, 1997. Children who has given the blood samples before (311 children) and after (267 Children) the supplementation indicating that Non response was 14.1 percent.

Table 1. revealed the distribution of overall school age children according to Hb estimation before supplementation and observed that overall only 20.6 percent children were in non anemic category. Overall 56.9 percent children belong to mild category of anemia whereas 21.9 percent to moderate and 0.6 percent to severe category. In case of boys, 53.5% belong to mild category and 0.8% to severe category. Table 2 revealed the distribution of overall school age children according to Hb estimation after supplementation and observed that overall 38.2 percent children were non anemic category. Overall 55.8 percent children belong to mild category of anemia whereas only 6.0 percent to moderate category. No case was observed in severe category.

Results of table 1 & 2 revealed that supplementation of pearl millet products has reduced anemia from 79.4 percent to 61.8 percent i.e. decline of 17.6 percent. After supplementation, decline was observed in moderate category of anemia i.e. from 21.9 percent to 6.0 percent and no case of severe anemia was found after supplementation. Decline in anemia was more in case of girls than boys. The overall percentage of non anemic children increased significantly from 20.6 to 38.2 percent (p<0.01) after supplementation.

Before supplementation, only 174 children gave adequate quantity of urine samples and rest of them either denied to give due to fear or gave inadequate quantity of urine sample. But after supplementation, 245 children gave urine samples which were adequate in quantity for analysis. Analysis revealed that overall 71.3 percent children were deficient in UIE levels whereas 23.6 percent were in normal category. After supplementation, 38.8 percent children were observed in normal category whereas 30 percent deficient in UIE level. Results showed that there was a significant decline in UIE deficiency after supplementation (p<0.01). The percentage of use of salt inadequate in iodine content i.e. less than 15 ppm was 2 percent.

Table 1. Age-wise distribution of school age children according to Anemia (Hemoglobin Estimation) before the supplementation

Haemoglobin Values → Age group years	On the basis of Haemoglobin Estimation								
	Non-anemic				Anemic				
	Normal (12 g/dl)		Mild (10-12 g/dl)		Moderate (7-10 g/dl)		Severe (<7 g/dl)		
	N	%	N	%	N	%	N	%	
6+	45	8	17.7	25	55.6	12	26.7	0	0.0
7+	40	10	25.0	21	52.5	8	20.0	1	2.5
8+	54	6	11.1	31	57.4	16	29.6	1	1.9

9+	65	14	21.5	41	63.1	10	15.4	0	0.0
10+	60	15	25.0	31	51.7	14	23.3	0	0.0
11+	47	11	23.4	28	59.6	8	17.0	0	0.0
Total	311	64	20.6	177	56.9	68	21.9	2	0.6

Table 2: Age-wise distribution of school age children according Anemia to (Hemoglobin Estimation) after the supplementation

Hemoglobin Values → Age group years	On the basis of Haemoglobin Estimation								
	Non-anemic				Anemic				
	Normal (12 g/dl)		Mild (10-12 g/dl)		Moderate (7-10g/dl)		Severe (<7 g/dl)		
	N	%	N	%	N	%	N	%	
6+	38	13	34.2	24	63.2	1	2.6	0	0.0
7+	35	12	34.3	20	57.1	3	8.6	0	0.0
8+	48	20	41.7	26	54.2	2	4.1	0	0.0
9+	54	23	42.6	29	53.7	2	3.7	0	0.0
10+	52	22	42.3	24	46.2	6	11.5	0	0.0
11+	41	13	31.7	26	63.4	2	4.9	0	0.0
Total	267	102	38.2	149	55.8	16	6.0	0	0.0

P<0.05 Non-anemic Before supplementation Vs Non-anemic After supplementation

-Non Response= 44 (14.1%)

Analysis of total children according to Colored Progressive Matrices Test (CPM) grades (For Cognitive development & Intelligence level of children) before and after the supplementation revealed that overall 31.6 percent children were in III grade (average category) whereas 63.1 in Grade IV before supplementation. After supplementation, 3.2 percent were observed in II grade (Good) whereas 73.6 percent in III grade (average category) and only 18.2 percent in Grade IV. Analysis showed that supplementation has shifted 42 percent children from IV grade (Below Average) to III grade (Average) which is good impact on the Cognitive development & Intelligence level of children (p<0.01). Analysis revealed that overall 84.6 percent children showed increase in CPM grades after supplementation.

Analysis of distribution of total children according to Knox Cubes Test, KCT test grades (Intelligence level and short term memory) before and after the supplementation revealed that overall 10.6 percent children were observed in Grade 9 (average IQ level) whereas 11.0 percent in Grade 5 IQ level before supplementation. After supplementation, children observed in Grade 9 (average IQ level) were 16.7 percent, 30.9 percent in grade 7 (superior Q level), 7.1 percent in grade 8 (Very superior IQ level and 16.0 percent in grade 9 (genius IQ level). Significant increase in percentage of children in grade 7 to 9 were observed (p<0.05) after supplementation.

Distribution of total children according to Techistoscope Test, (TT) points (concentration and short term memory) before and after the supplementation revealed that overall 67.7 percent children were observed in Scale of 72 (average) whereas 25.5 percent in Scale of >9 (above average) before supplementation. After supplementation, children observed in Scale of 72 (average) were 76.6 percent. Supplementation has shown significant increase in percentage of children in average category (p<0.01).

Distribution of total children according to Digit Span Test. (DST) points (short term memory) before and after the supplementation showed that overall 42.2 percent children were observed in Scale of 72 points (average) whereas 0.7 percent in Scale of >9 points (above average) before supplementation. After supplementation, children observed in Scale of 72 points (average) were 98.5 percent whereas 1.1 percent in Scale of >9 points (above average). Supplementation has shown significant increase in percentage of children in average category (p<0.01) i.e. from 42.2 to 98.5 percent. Analysis revealed that overall 68.7 percent children showed increase in DST points scale after supplementation.

Distribution of children according to Standard Deviation classification for weight for age before and after the supplementation revealed that 76.0 percent boys and 71.1 percent girls were observed to be in normal category whereas 23.3% boys and 28.3% girls in the category of Moderate malnutrition and 0.6 to 0.8% in severe category before supplementation. The percentage of children observed in normal category were 87.4% boys and 83.2% girls after supplementation.

Results showed that there is a decline of moderate malnutrition from 26.2 to 14.3 percent after supplementation. Significant increase in percentage of children belonging to normal category has been observed i.e. from 73.1 to 85 percent ($p < 0.01$).

Distribution of children according to SD classification for height for age before and after the supplementation revealed that 87.4% boys and 79.1 percent girls were observed to be in normal category whereas 12.6% boys and 15.4% girls in the category of Moderate malnutrition and 3.3% in severe category before supplementation. The percentage of children observed in normal category were 93.3% boys and 87.6% girls after supplementation. Results showed that overall there is a significant incline of children in normal category from 82.5 to 90.0 percent after supplementation ($p < 0.05$).

Analysis of the distribution of children according to Nutritional deficiency signs before and after the supplementation revealed that the overall percentage of Hair discoloration, Bitot spot, Angular stomatitis and Cheliosis were 24.3, 1.3, 0.3, 0.7 percent before supplementation and 26.8, 0.7, 0.0, 0.7 percent after supplementation respectively ($p > 0.05$). The overall percentage of UTI, Fever, GIT and respiratory complaints were 0.6, 1.9, 1.3, 3.9 respectively before supplementation whereas the overall percentages after supplementation were 0.3, 3.2, 1.3, 3.8 respectively ($p > 0.05$).

Discussion

Young children are nutritionally the most vulnerable group, especially in developing regions of the world. In desert areas, children are in a constant state of nutritional stress. Moreover, the problem of micronutrient malnutrition is also one of the burning problems in developing countries, out of which those of major public health significance are deficiency of one or more of the three micronutrients iron, iodine and vitamin A. Despite many years of supplementation approaches, deficiencies of iron, vitamin A and iodine are still largely prevalent and could be due to single micronutrient supplementation programs existing in our county. Also sub clinical deficiencies of other micronutrients can reduce the effect of a single micronutrient, when it is not limiting. Multi-centric studies carried out [2-5] showed that the prevalence of anemia, vitamin A deficiency and iodine deficiency disorders continues to be high, though there is a small decline in IDD in India.

A plan for a "Minimum package" for nutritional health was introduced for Mexican city [6]. Some studies showed that supplementation with red palm oil increased alpha and B-carotene concentrations significantly in both plasma and breast milk [7]. Some work has also been done in India [8-12]. But few work has been done in the desert areas of Rajasthan demanding a great amount of work. Some work has been done on pearl millet in desert area where staple diet was found to be pearl millet followed by wheat and zinc deficiency was observed high [13-14]. Another study [15] showed that in cooked recipes of pearl millet in Nagaur district, retention of Zinc and iron increased in rab1 (PM Grains) preparation i.e. 3.64 to 4.40 mg/100g and 5.99 to 10.5mg/100g respectively and Phytates were reduced as in Rab 1, the processes of Soaking, Pounding and Dehusking were involved due to which Iron retention increased and Phytates reduced. The appropriate preparations of pearl millet have to be promoted to enhance quantity of micronutrients especially, iron and zinc. Pearl millet has high content of iron (8mg/100g) and Zinc along with high content of fiber which helps in the reduction of anemia, constipation and other non communicable diseases. Potential health benefits and its possible nutraceutical properties of pearl millet have been highlighted in the literature [16]

Present study showed that the supplementation of pearl millet products has reduced anemia, on the basis of haemoglobin estimation, from 79.4 percent to 61.8 percent i.e. decline of 17.6 percent. After supplementation, decline was observed in moderate category of anemia i.e. from 21.9 percent to 6.0 percent and no case of severe anemia was found after supplementation. Decline in anemia was more in case of girls than boys. The overall percentage of non anemic children increased significantly from 20.6 to 38.2 percent ($p < 0.01$) after supplementation. There was a good decline in UIE deficiency from 71.3 to 30 percent after supplementation. Results showed that there was a significant decline in UIE deficiency from 71.3 to 31 percent after supplementation ($p < 0.01$).

For Cognitive development & Intelligence level of children, Colored

Progressive Matrices Test (CPM) grades were assessed before and after the supplementation. Analysis showed that supplementation has shifted 42 percent children from IV grade (Below Average) to III grade (Average) which is good impact on the Cognitive development & Intelligence level of children ($p < 0.01$). Analysis revealed that overall 84.6 percent children showed increase in CPM grades after supplementation. Knox Cubes Test, KCT test grades measured for Intelligence level and short term memory revealed that supplementation has increased the percentage of children (6.1%) in average IQ level. Significant increase in percentage of children in grade 7 to 9 were observed ($p < 0.05$) after supplementation.

Techistoscope Test, (TT) points were used to measure the concentration and short term memory revealed that 8.9 percent children increased in average scale of 72 after supplementation. Supplementation has shown significant increase in percentage of children in average category ($p < 0.01$). Digit Span Test (DST) points used for short term memory revealed that overall 68.7 percent children showed increase in DST points scale after supplementation. Supplementation has shown significant increase in percentage of children in average category ($p < 0.01$) i.e. from 42.2 to 98.5 percent.

SD classification for weight for age showed a decline of moderate malnutrition from 26.2 to 14.3 percent after supplementation. Significant increase in percentage of normal category has been observed i.e. from 73.1 to 85 percent ($p < 0.01$). SD classification for height for age showed that overall there is a significant incline of children in normal category from 82.5 to 90.0 percent after supplementation. Slight decline has been observed in prevalence of Bitot spot and Angular stomatitis though statistically insignificant.

Conclusion / Recommendations

1. The supplementation of pearl millet products had improved haemoglobin levels and declined anemia. Significant increase in non anemic children was observed after supplementation in rural school children residing in desert areas of Rajasthan who are in a constant state of stress due to extreme environmental conditions of desert. The findings suggest that these products can also be included, in the ongoing national programs in the study/arid areas as pearl millet is staple diet of desert area.
2. The supplementation of pearl millet products also had significant positive effect on iodine nutriture and malnutrition.
3. The supplementation of pearl millet products also had significant positive effect on psychological tests performed on learning attributes in terms of memory, intelligence, cognition i.e. reasoning and attention after supplementation.
4. Study suggests large scale field trial to validate/strengthen these findings in desert area.

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