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Efficacy of leaf concentrate as micronutrient fortifier in the supplementary nutrition of Integrated Child Development Services (ICDS)

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In developing countries like India, micronutrient deficiency especially of iron is most prevalent among children. Besides culminating into anemia, the consequences of iron deficiency are grave and affect the health and quality of life of the people and the nation as a whole. The objectives of this study were to assess the effect of using leaf concentrate (LC), a novel food prepared from the extract of Lucerne grass for supplementation as micronutrient fortifier in the hot meals of Integrated Child Development Services (ICDS) Anganwadi Centres and to assess the impact on hemoglobin levels and morbidity profile of the children, aged 3 to 6 years attending ICDS Anganwadi Centres of Jaipur City. A total of sixty four children of either sex, aged 3 to 6 years were selected from the two Anganwadi Centres (AWC) of Jaipur City. Two AWC were selected randomly from the seven AWC running in a slum area of Jaipur, known as Jawahar Nagar slum. One Anganwadi Centre served as control group and another as experimental group. At each center, 32 children were enrolled. The supplementary feed provided to the two AWC was the same, the only difference was that 3% LC was incorporated in the supplementary nutrition of the experimental centre. Supplementation with LC was continued for a period of 24 months. At baseline blood hemoglobin (Hb), weight, height and morbidity profile were assessed. The hemoglobin levels and the morbidity profile of the children were assessed in every six months, while the weights (kg) and heights (cm) were recorded every third month. The results showed a significant increase in the Hb levels of the experimental group while it decreased in the control group. The difference between the two groups was statistically significant ($p<0.01$). Morbidity profile of the experimental group improved while it remained unchanged in the control group. The anthropometric measurements did not show a significant difference in the two groups.

Key words: Micronutrient, leaf concentrate, integrated child development services (ICDS), morbidity profile.

INTRODUCTION

India has often been referred to as 'a nation of the young' and not without reason since India has the second largest child population in the world. About 40% of its population is children under 14 years of age. Children under 5 years constitute about 14% of the population (UNICEF, 2005).

These children constitute one of the most vulnerable segments of our population from the nutritional point of view, because the foundation for a life time health, physical strength and intellectual vitality is laid during this period (Thakar and Patel, 1990). But children are dependent on their families and communities to provide a nurturing environment that will enable them to become healthy and productive adults. From all accounts, an adequate nutrition and sound health go hand in hand. Food continues to be a major determinant of good health throughout the growing years. The balance diet

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provides all the macro and micronutrients.

Micronutrients, especially vitamin A, iodine and iron are essential for sound physical and mental growth and well being of a person. The World Health report published recently by WHO cites these deficiencies as three of the most prevalent and critical nutrient deficiencies in the world. Micronutrient malnutrition affects approximately a billion people worldwide.

Iron deficiency is the most important cause of nutritional anemia and is the most common micronutrient deficiency worldwide; it leads to impairment of health, growth, development and performance. It has been estimated in various studies that 63% of children below 3 years and 45% between 3 and 5 years are found to be anemic. This in turn affects productivity, morbidity and mortality.

Nutritional deprivation robs the children of their ability to cope with stress situations like infection. Superimposed upon a background of under nutrition, the consequences of these episodes of illness are often disastrous leading to major setback in growth and development (Batra and Sood, 2005). With common childhood illness, malnutrition drags millions of children in downward spiral of ill health, poor growth, often an early death. According to UNICEF (2000), children in developing countries may have an average of up to 160 days of illness each year, with 3 to 4 episodes of diarrhea and 4 to 5 illness bouts due to severe respiratory infection. Each infection lowers the nutritional status and leaves the child weaker and more susceptible to further infection. This vicious cycle traps a child in a continuous downward slope.

The protection for growing bodies and minds of young ought to have 'a first call on society's resources'. It should be an unwritten principle that the essential needs of children should be given high priority in the allocation of resources and should reach a child at an individual family level.

The government of India has thus initiated several early childhood service programmes to improve the status of children especially the weaker and more vulnerable section of the community (Paladugu, 1994).

Integrated Child Development Services (ICDS) is one of the popular early childhood service aimed to deliver a package of services to millions of children in India, who are caught in the grip of malnutrition, disease, illiteracy, ignorance and poverty (Paladugu, 1994). The government's ICDS programme reaches 34 million children of age 0 to 6 years and 7 million pregnant and nursing mothers. One of the important tasks of ICDS is to provide supplementary feeding to the children and pregnant and nursing mothers. The aim is to supplement the intake by 300 calories and 8 to 10 g of proteins for children, 600 calories and 20 g of protein for severely malnourished children and 500 calories and 20 to 25 g protein for expectant and nursing mothers.

During the past 15 to 20 years, the state government provided supplementary nutrition in various forms which included raw rations, roasted powders and extruded 'ready to eat foods'. The extruded food "murmura" was being fed to the children of ages 3 to 6 years for the last 20 years.

Recently, the supreme court of India has ordered to provide hot meals to the children attending ICDS centers. Hot meal is either provided by a Non Governmental Organization (NGO), 'Akshaya Patra' or is prepared by the Anganwadi staff at the centre. The only disadvantage of the hot meals provided is that it is not being fortified with micronutrients.

The government/Department of Women and Child Development are considering this issue of fortifying meal with micronutrient. This can be done by adding chemical mixtures of micronutrient but these days WHO is laying stress on food based strategy to combat micronutrient malnutrition. Leaf concentrate (LC), a novel food based natural product, is one option to be used as micronutrient fortifier.

LC is a product made by fractioning Lucerne grass and is perhaps the richest food resource on the earth. It is a medium energy food, equivalent to cheese in its protein content with the essential amino acid pattern as good as meat, fish and cow's milk and can be compared to the FAO/WHO reference protein. Besides, having good quality protein, LC is the richest source of beta carotene, iron, and folic acid and contains appreciable amount of calcium, copper, zinc and vitamin E (Mathur et al., 2005).

As little as 3 g LC can supply the whole day's requirements for beta carotene. Thus, it could be used as a fortifier to enrich the meals provided at the Anganwadi Centers *(*AWC*).* This study was planned to study the efficacy of LC as a micronutrient fortifier and to see the impact of LC incorporation on the blood hemoglobin and morbidity profile of the children attending Anganwadi Centers.

METHODOLOGY

There are two ICDS projects in Jaipur City each having 100 AWC each at different locations. AWC of Jawahar Nagar urban slum were taken as the locale of the study. The slum area is divided into 7 units called *tilas* with AWC in each unit/*tila.* Out of the 7 units/*tilas, tila* 6 and 7 were randomly selected for the study. AWC at both *tila* comprised 32 children in the age group of 3 to 6 years. The children attending AWC of *tila 6* formed the control group while the children attending AWC of *tila 7* were taken as the experimental group. All the children in the age group of 3 to 6 years registered in the AWC were the subjects of the study. Initial haemoglobin levels, weight, height and morbidity profile of the subjects in both AWC were recorded.

In both AWC, the hot meals were provided by the NGO 'Akshay Patra' thus the food provided was alike in consistency, taste and nutritive value. The only difference was that the subjects in AWC 6 (control group) were receiving the meals, while 3% LC was incorporated into the meals of the subjects attending AWC of tila 7. The LC was incorporated in the food just before the distribution of the meals and it was assured that the children are having the complete meals regularly. LC incorporated meals were provided to the experimental group for a period of 24 months. The change in

Table 1. Comparison of mean (±1SD) weight, height and hemoglobin levels of subjects at different time interval.

Variable	Baseline	3 months	6 months	9 months	12 months	15 months	18 months	21 months	24 months
Weight (E)	10.0±2.4	10.6±2.5	11.2±2.5	11.7±2.5	12.5±2.4	12.7±2.2	13.2±2.3	13.6±2.3	14.0±2.2
Weight (C)	10.9±2.2	11.4±2.2	11.8±2.2	12.3±2.2	12.8±2.2	12.4±2.4	12.8±2.5	13.2±2.4	13.6±2.5
t-test (p-value)	0.132	0.164	0.255	0.308	0.629	0.554	0.564	0.551	0.501
Height (E)	83.7±10.0	87.5±10.5	90.5±10.0	94.1±10.2	98.1±10.2	94.6±5.8	98.3±6.3	101.1±6.1	104.0±5.8
Height (C)	84.6±10.7	87.9±10.7	91.3±10.8	94.8±10.8	98.1±10.9	94.6±3.9	98.1±4.5	100.7±4.5	103.3±4.3
t-test (p-value)	0.736	0.879	0.747	0.795	0.991	0.988	0.874	0.764	0.611
Hb (E)	10.0±0.43	-	10.8±0.43	-	10.3±1.02	-	10.3±0.84	-	10.3±1.33
Hb (C)	11.0±0.51	-	11.2±0.44	-	10.2±1.42	-	9.01±1.52	-	7.8±1.77

*Significant value, p<0.000.

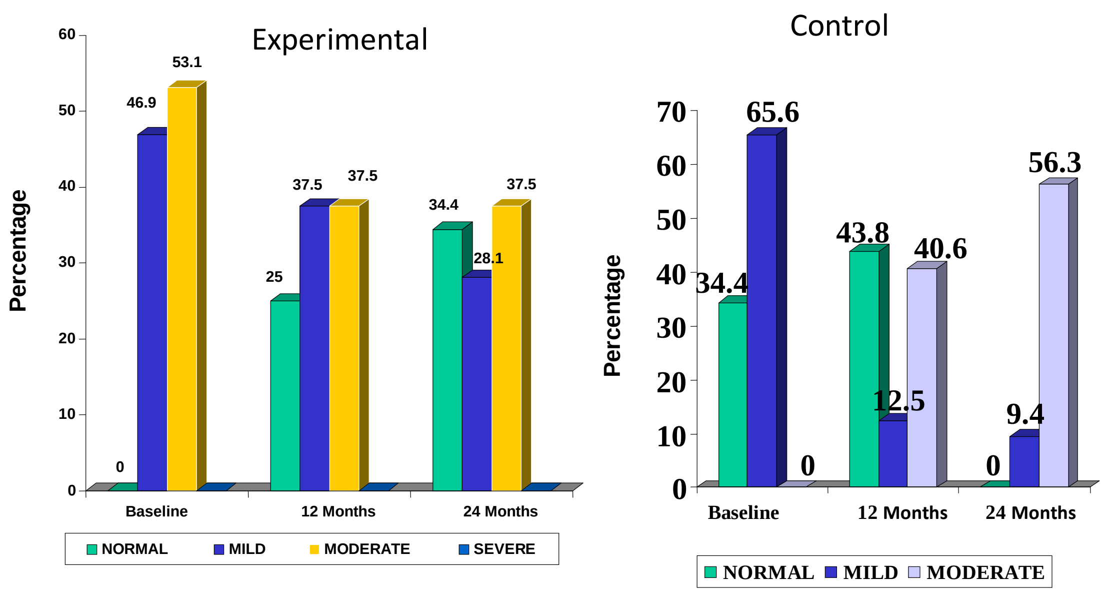

Figure 1. Distribution of subjects according to degree of anemia in experimental and control group.

the heights and weights of the two centres were recorded quarterly while morbidity profile and Hb levels were measured in every 6 months. Weight in kilogram was recorded using spring balance and height in centimeter was recorded using non stretchable tapes. Hemoglobin level was measured using Cynmethhemoglobin method. The blood was drawn by finger prick method by trained technician which was then collected in the heparin coated vials and was transported to the diagnostic centre where the Hb levels were measured through semi automated blood analyzer. The data obtained from the mothers and child care takers for morbidity profile were pooled and analyzed for every 6 months period under reporting. The data of anthropometric measurements, blood hemoglobin and morbidity profile of 24 months of control and experimental group were then tabulated compared and statistically analyzed making use of Statistical Package for Social Sciences (SPSS) version 10.

RESULTS AND DISCUSSION

A total of 64 subjects; 32 in each arm were analyzed at baseline and after every 3 months for anthropometry and after six months for hemoglobin and morbidity profile.

As shown in Table 1 and Figure 1, the baseline mean Hb levels of experimental and control groups was 10.0 ± 0.43 and 11.0 ± 0.51 g/dl, respectively and the difference was statistically significant ($p<0.000$). This clearly shows that at baseline, the control group had better Hb levels than experimental group. After six months intervention, there was 8% increase in the Hb levels of the experimental group, while in the control group it was raised just by 1.86%. The rise in Hb was because of LC supplemented diet provided to the experimental group. Thus after 6 months of intervention, the experimental group had Hb levels 10.8±0.43 and control group had 11.2±0.44 g/dl. But after 6 months, the control group was on the higher side with a statistically significant difference ($p<0.01$). After 12 months of intervention, the Hb levels of experimental group remained unchanged ($p>0.05$) while

Table 2. Comparison of median (IQR) weight, height and hemoglobin levels of subjects at different time interval.

Variable	Baseline	3 months	6 months	9 months	12 months	15 months	18 months	21 months	24 months
Weight (E)	9.4 (8.5-12.2)	9.9 (9.0-12.9)	10.45 (9.4-13.8)	11.2 (9.9-14.2)	12.0 (11.0-15.0)	13.5 (10.9-14.5)	14.0 (11.1-15.0)	14.3 (11.7-15.5)	14.7 (12.3-16.0)
Weight (C)	10.4 (8.8-13.2)	10.9 (9.3-13.7)	11.4 (9.8-14.0)	11.9 (10.1-14.5)	12.3 (10.6-15.0)	13.0 (10.2-14.5)	13.5 (10.6-15.0)	13.9 (11.1-15.3)	14.2 (11.5-15.8)
Height (E)	80.5 (76.0-92.0)	84.0 (79.3-96.0)	87.0 (83.3-98.8)	90.0 (87.0-103.3)	95.0 (91.0-106)	97.0 (90.3-100)	102.5 (94.0-104)	104.5 (97.0-106)	107.5 (100-109)
Height (C)	87.0 (74.3-93.0)	90.5 (77.3-96.8)	94.0 (80.3-100.8)	97.5 (84.0-104)	101 (87.3-107)	95.5 (92.3-98.0)	98.5 (95.3-98.3)	101 (98-105)	103 (100-107)
Hb (E)	9.90 (9.65-10.3)	-	10.7 (10.5-11.1)	-	10.5 (9.4-11.0)	-	10.3 (9.9-10.8)	-	10.5 (9.0-11.2)
Hb (C)	10.9 (10.8-11.0)	-	11.2 (10.9-11.2)	-	10.45 (9.13-11.3)	-	9.0 (8.03-10.2)	-	7.9 (6.0-9.2)

there was a fall in the Hb levels of the control group making the Hb levels of the two groups almost similar and the difference between the two groups turned insignificant (p>0.05). The fall in Hb levels of the control group continued at 18 and 24 months, while Hb level in the experimental group remained unchanged (Table 4). The difference in the Hb levels of the two groups became significantly different after 24 months, thus showing a clear cut impact of the LC.

Distribution of subjects according to grades of anemia showed that at baseline, no subject in theexperimental group was in normal category, 46.9% (n=15) had mild anemia and 53.1% (n=17) had moderate anemia. While in the control group, 34.4% (n=11) was normal and 65.6% (n=21) was mild anemic and no subject had moderate or severe anemia (p<0.000) (Table 5).

After 12 months of LC supplementation, the experimental group 25% (n=8) shifted to normal, 37.5% (n=12) had mild anemia and 37.5% (n=12) had moderate anemia. In control group, 43.8% (n=14) became normal, this increment was seen as three of the children were from comparatively well to do families and when they came to know about the anemic status of their children they started giving them special care. 12.5% (n=4) mild anemia, 40.6% (n=13) shifted to moderate anemia and 3.1% (n=1) shifted to severe anemia, except the three cases otherwise of the results are supporting the effect of LC; the number of subjects falling prey to moderate anaemia increased in the control group while there was a constant gradual shift of anemic subjects towards normalization in the experimental group. After 24 months of intervention in experimental group, 34.4% (n=11) shifted to normal, 28% (n=9), mild anemia and 37.5% (n=12) had moderate anemia.

Due to drop in Hb levels in the control group, no subject was in normal category, 9.4% (n=3) were mildly anemic, 56.3% (n=18) were moderate anemia and 34.4% (n=11) had severe anemia (p<0.000). The results are in agreement with the study done by Dewan et al. (2007) on children suffering from protein energy malnutrition. The study showed that supplementation of diet with leaf protein concentrate for about two weeks to children with moderate to severe malnutrition produced significant improvement in weight and hemoglobin levels. Analysis of anthropometric data (Table 3) showed that at baseline, the weight of the experimental and control subject was 10.0±2.4 and 10.9± 2.2kg which was statistically not significant (p>0.05). Median weight and interquartile range (IQR) (Table 2) showed that the control group had better weight status than experimental group (9.4 IQR 8.5-12.2 vs. 10.4 IQR 8.8-13.2). After 12 months of intervention, the mean weight of both groups became same and no difference in median and IQR was seen. After 12 and 24 months of interval, improved trends in weight of experimental group were seen throughout although the results were not statistically significant. Similar observations were noted for height also. At baseline, the height of the experimental and control subject was 83.7 ± 10.0 and 84.6 ± 10.7 cm which was statistically not significant (p>0.05). Median height and IQR showed that the control group had better height status than experimental group (80.5 IQR 76.0-92.0 vs. 87.0 IQR 74.3-93.0). After 12 and 24 months of intervention, the mean height of both groups became same and no difference in median and IQR was seen. Thus, from the results it is clear that the impact of LC supplementation was observed on the physical growth as the experimental group had lower weights and heights initially which became the same/ increased by the end of the study. The change in the physical growth was gradual. The immediate impact was not expected as the food provided for the two groups was isocaloric and isoproteinous. It can be assumed that if the intervention was continued for a longer duration of time, it would have brought significant changes in the anthropometric measurements.

Morbidity profile

Initially morbidity profile for both groups of sub-

Table 3. Percentage (mean ± SD) increase in weight and height at different interval.

Time interval	Experimental	Control	t-test (p-value)
Weight			
Baseline-6 months	12.09±4.45	9.01±2.24	3.46 (0.001)
Baseline-12 months	27.33±14.19	18.09±4.28	3.53 (0.001)
Baseline-18 months	36.68±33.77	20.36±27.62	2.11 (0.04)
Baseline-24 months	46.08±35.40	28.28±28.21	2.23 (0.030)
Height			
Baseline-6 months	8.26±1.93	8.14±1.72	0.270 (0.788)
Baseline-12 months	17.45±4.63	16.26±3.42	1.17 (0.248)
Baseline-18 months	18.48±10.65)	17.55±13.76	0.303 (0.763)
Baseline-24 months	25.40±11.22	23.86±14.48	0.474 (0.637)

Table 4. Percentage increase in hemoglobin at different intervals (mean ± SD, min to max).

Hb	Experimental	Control	t-test (p-value)
Baseline -6 months	8.01±0.34 (7.41 to 8.51)	1.86±1.89 (0.00 to 3.88)	18.13 (0.000)
Baseline -12 months	2.84±10.15 (-16.3 to 25.0)	-7.47±12.8 (-38.5 to 14.6)	3.57 (0.001)
Baseline -18 months	3.29±10.6 (-24.3 to 27.4)	-17.69±14.39 (-46.7 to 12.96)	6.64 (0.000)
Baseline -24 months	3.34±13.45 (-20 to 29.0)	-29.34±16.75 (-60.19 to 3.68)	0.150 (0.000)

Table 5. Distribution of subjects according to grades of anemia.

Variable	Baseline	6 months	12 months	18 months	24 months
Normal (E)	-	10 (31.3)	8 (25)	4 (12.5)	11 (34.4)
Normal (C)	11 (34.4)	24 (75.0)	14 (43.8)	3 (9.4)	-
Mild anemia (E)	15 (46.9)	22 (68.8)	12 (37.5)	18 (56.3)	9 (28.1)
Mild anemia (C)	21 (65.6)	8 (25.0)	4 (12.5)	9 (28.1)	3 (9.4)
Moderate anemia (E)	17 (53.1)	-	12 (37.5)	10 (31.3)	12 (37.5)
Moderate anemia (C)	-	-	13 (40.6)	15 (46.9)	18 (56.3)
Severe anemia (E)	-	-	-	-	
Severe anemia (C)	-	-	1 (3.1)	5 (15.6)	11 (34.4)
Chi square (p-value)	29.0 (0.000)	12.3 (0.000)	6.68 (0.083)	9.14 (0.02)	26.2 (0.000)

jects was similar. Number of children reporting no fever, colds/coughs and diarrhea in experimental group was 46.9, 68.8 and 71.9% respectively and in the control group 56.3, 46.9 and 75% subjects reported no fevers, colds and coughs and diarrhea, respectively. After 24 months of intervention, the percent of the subjects reporting no illness increased in the experimental group to a significant level while it dropped in the control group. 68.8% of the subjects in the experimental group denied any kind of fevers, colds and cough and 71.9% did not suffer from diarrhea while in the control group, 50% of subjects reported having no fevers, 34.4% of the subjects denied having colds and coughs and 31.3% reported not having diarrhea (Table 6).

After intervention, it was found that the incidences of morbidity among the control group of the subjects were higher than that of the experimental group of children. Three fourths of the experimental children during this period were reported to have not suffered from any illness; the corresponding figure for the control subjects was lower. Moreover, it was observed that the percentage of children for whom three or more than three episodes of illness were reported during this period, too, was higher among the control group children (Table 6). The morbidity data for 6 to 12 and 18 to 24 months were collected during the months of June to December.

Table 6. Illness reported by subjects at different interval.

Time interval	Experimental	Control	t-test (p-value)
10 months	21 (65.6)	24 (75.0)	0.673 (0.411)
18 months	18 (56.3)	26 (81.3)	4.65 (0.03)*
24 months	17 (53.1)	28 (87.5)	9.06 (0.002)**

During the monsoon period in this phase, Jaipur city experience incessant rains, these rains in their wake brought in problems of water logging and epidemics of diarrhea and viral fever. These heavy rains exacted its toll on the health of the study subjects as well, with most of them falling prey to various illness like diarrhea and upper respiratory tract infections. Despite the prevailing environmental conditions, the experimental subjects were able to withstand the stress relatively better than their control counterparts. This could be correlated well with the results of hemoglobin that the hemoglobin levels of the control group were reducing while the subjects of the experimental group were able to maintain their Hb levels. A small-scale study jointly conducted by SOYNICA and the Haematology and Oncology Department found that patients receiving Lucerne leaf concentrate (LLC), when compared with a similar group who did not have this supplement, saw a marked improvement in their haemoglobin indices and had a lower incidence of anaemia and gained weight. Although LLC has other ingredients that could contribute to reducing the infection rate or improving patient response, these were disregarded in this study; but it may be assumed that a patient enjoying better nutritional status and free of anaemia can withstand infection better and tolerate anti-cancer treatment more easily. Deficiency of iron affects the immune system. Various studies have depicted that incidences of illness and diarrhea among iron deficient subjects are more than the iron sufficient subjects (Basta et al., 1979; Batra and Sood, 2005; Hallberg, 2001; Rao, 2007). Evidences have suggested that the immunological alterations occurring in the essential nutrient deficiencies were reversible on replenishment of the respective nutrients (Bhaskaram et al., 1989; Bothwell and Charlton, 1970). Some intervention trials have demonstrated that iron/vitamin A supplementation reduces the incidence of acute respiratory infection (ARI) and gastro-intestinal disorders (GID) (Barreto et al., 1994). Conversely, others have demonstrated that iron supplementation increases the susceptibility to infections and vitamin supplementation does not have any significant effect on morbidity (Beaton et al., 1993; Hussey and Klein, 1990; Ramakrishna et al., 1995). But iron supplements in combination with vitamin A showed a significant reduction in the markers of infection (Bloem et al., 1997; Meija et al., 1977) as both the deficiencies are often co-existent. LC used as a micronutrient fortifier is also a rich source of iron and betacarotene which may have worked in combination to improve the immunity of the experimental subjects.

Conclusion

The findings of this study highlight a decrease in the morbidity and increase in the Hb levels of the subjects receiving LC supplemented hot meals. Both groups of the subjects were receiving isocaloric meals, but the experimental group of the subjects had a better growth than their counterparts in the control group. Improved growth performance of the experimental subjects could be a function of reduced morbidity. LC fortification showed a significant improvement in the Hb levels of the experimental group. With better Hb levels, the cell mediated immunity of the children improved which had a direct impact on the morbidity profile of the children of experimental group in terms of incidence of illness as compared to the children of the control group. Thus, it could be concluded that LC is an effective micronutrient fortifier.

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REFERENCES

Barreto ML, Sartos LMP, Assis AM (1994). Effects of vitamin A supplementation on diarrhoea and acute lower respiratory tract infections in young children in Brazil. Lancet 344:228-231.

Basta SS, Soekirman Karyadi D, Scrimshaw NS (1979). Iron deficiency anemia and the productivity of adult males in Indonesia. Am. J. clin. Nutr. 32:916-925.

Batra J, Sood A (2005). Iron deficiency anaemia: effect on cognitive development in children: A review. Indian J. Clin. Biochem. 20(2):119-125.

Beaton GH, Martorell R, Aronson KJ, Edmonston B, Maccabe G, Ross AC, Harvey B (1993). Effectiveness of Vitamin A supplementation in the control of young child morbidity and mortality in developing countries. *ACC/SCN,* State of art Series, Nutrtion Policy Discussion Paper No. 13, ACC/SCN, Geneva.

Bhaskaram P, Jyothi AS, Rai VK, Rao NBS (1989). Effects of subclinical Vitamin A deficiency and administration of vitamin A as a

single dose on immune function in children. Nutr. Res. 9:1017-1025.
Bloem MW, Pee SD, Darnton-Hill I (1997). Vitamin A deficiency in India, Bangladesh and Nepal. In: Malnutrition South Asia: A Regional Profile pp 125-134.
Bothwell TH, Charlton RW (1970). Absorption of iron. Ann. Rev. Med. 21:145-147.
Dewan P, Kaur I, Chattopadya D, Faridi MMA, Agarwal KN (2007). A pilot study on effect of curd (dahi) and leaf protein concentrate in children with protein energy malnutrition (PEM). Indian J. Med. Res. 126:199-203.
Hallberg L (2001). Perspectives on nutritional iron deficiency.Annu. Rev. Nutr. 21:1-21.
Hussey GD, Klein MA (1990). Randomized controlled trial of Vitamin A in children with severe measles. N. Engl. J. Med. 323:568-577.
Mathur B, Magon A, Joshi P (2005). Improving maternal nutrition with leaf concentrate supplementation. In: Technologies for empowering women, a compendium produced on the occasion of the international conference- “impact of women’s research in science and technology in the new millennium”. Compiled and edited by Vinita Sharma, DST, New Delhi, and K Vijayalakshmi Centre for Indian Knowledge Systems, Chennai, India.
Meija A, Hodges RE, Arroyave G, Viteri F, Torun B (1977). Vitamin A deficiency and anaemia in Central American children. Am. J. Clin. Nutr. 30:1175-1814.
Paladugu K (1994). Role of anganwadi workers in integrated child development services programme. Discovery Publishing House. New Delhi.
Rao NBS (2007). Bioavalobility of dietary iron and iron deficiency. Nutrition Foundation of India. NFI Bull. 28(3):1-6.