

An Intervention Study to Combat Iron Deficiency Anaemia in Adolescent Girls - Food Fortification Strategy

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The study aimed at assessing the impact of nutrition education and intervention with a novel iron rich fortified beet-root extract among adolescent (12-18yrs) girls on the haemoglobin level and clinical symptoms related to nutritional iron deficiency anaemia. 80 study participants (Haemoglobin <9gm/dl) were randomly assigned to two study groups. 150ml of fortified beetroot extract was served to each of the interventional subject on every alternate days for three months(45days). Control group was served with a placebo. Nutrition education was given to the study participants(n=80). Haemoglobin(cyanmethaemoglobin) and clinical assessment on nutritional iron deficiency anaemia assessed. one way anova and students paired 't' test was performed. Hypothesis was tested at 95 per cent confidence interval. Results: Conjunctival- paleness declined from seventy five percent (n=15) at the pre-test (13-15yrs) level to 5 per cent(n=1), with a significant (t=18.47, p< .0001) impact(16-18yrs) in the mean haemoglobin level. Conclusion: Fortified beet-root extract intervention had high impact on the nutritional status and blood profile. School girls model was found to be an effective intervention strategy to reach the susceptible population.

Key words: Fortification, Iron deficiency anaemia, Intervention, Placebo.

Iron deficiency anaemia is one of the most common nutritional disorder in developing country like India. Chronic anaemia in adolescents when associated with severe micronutrient deficiency may affect school performance and physical work capacity¹. The haemoglobin count in most of the adolescent girls in India is less than the standard (12 g/dl) accepted worldwide². Widespread prevalence of anaemia in adolescent girls is gaining increased recognition. Adolescent girls are stated as important beneficiary group in national and state level nutrition policy^{3,4}. This has resulted in various programmes to combat under nutrition and iron

deficiency anaemia in recent years in this group.

Though iron and folic acid supplementation remains the corner stone in treatment of anaemia nutrition education and food supplementation are long term measures in preventing the recurrence. Food based approaches are gaining high potential for long lasting benefits in improving nutritional status of folate and serum iron status. Fortification of a micronutrient poor staple food with a micronutrient dense food is an under explored strategy⁵. For effective food fortification, the fortified food consumed by the target population must be low in cost with good organoleptic properties. The process of selecting the best food vehicle and iron source may appear simple but is actually a complex process that requires evaluation at every step⁶. Beet-root extract

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is possibly the best natural remedy for anaemia. Folate, a major form of iron in beet-root is a novel and natural alternative to iron supplementation. Beet-root provides 37 per cent of daily requirement of folate and 6 per cent of iron⁷.

The study aimed at assessing the impact of nutrition education and intervention of a novel iron rich fortified beet-root extract among adolescent (12-18yrs) girls of nutritional iron deficiency anaemia.

MATERIALS AND METHODS

The study protocol was approved by the research committee of Sri Avinashilingam deemed university. Government-aided girls school at zone x (mylapore) of Chennai city was selected and designed to include eligible adolescent students in the age group of 12 – 18 years. Consent was obtained from school authorities, students and parents. They were briefed about the supplementation study with fortified beetroot extract and collection of blood through letter and meetings.

Sample Size

A double blind placebo control randomised trial was followed. 118 adolescent students (12–18 yrs) were screened for baseline haemoglobin (cyanmethaemoglobin method) with the help of trained biochemist. 98 adolescents were found to be anaemic (Haemoglobin <9gm/dl). The inclusion criteria for the supplementation study consists of those willing to participate in the study with haemoglobin level > 9gm/dl. The exclusion criteria was those unwilling to participate in the study, haemoglobin level > 5mg/dl and subjects allergic to beetroot extract. After several stages of inclusion and exclusion criteria 80 study participants were randomly assigned to two study groups. The intervention group 12 -15yrs (n=20), control 12 -15yrs (n=20) and intervention group 16–18yrs (n=20), control 16–18yrs (n=20). The participants were appraised of anaemia and the importance of fortified beetroot extract in combating anaemia through nutrition lecture.

Product Development

Idea generation and screening of ideas were the initial step in product development using food-to-food fortification strategy. After a series of trials using ingredients in various proportion

the concept of the enriched product took shape.

Beetroot(fresh)
↓
Washed and cut to pieces (1kg)
↓ + Ginger(10gms)
Crushed(Food mixer)
↓
Pulp+Water (2lit)
w/v: 1:2
↓
Freshlime juice (30ml) +sugar
↓ To prevent oxidation of vitamin C
add at the time of consumption.
Fortified Beetroot Extract.

2000ml of extract contains 1000gms beetroot

100ml contains 50gms beetroot

150ml contains 75gms beetroot

Intervention

Helminthes infection is an important contribution to anaemia. The study participants were dewormed (Bitter-gourd). 150ml of beetroot extract was given to each of the intervention subject on every alternate days for three months (45days). In rare cases some people observe beeturia (red urine) after consumption of beetroot in any form, while it is not a problem but an indicator of defect in iron metabolism⁸. The control group were served with a placebo containing fruit essence in water sweetened with sugar. Nutrition education was given to all the study participants (n=80).

Haematology and Assessment

The haemoglobin (cyanmethaemoglobin) was estimated every month. The study participants were screened for clinical symptoms related to nutritional iron deficiency anaemia based on standard WHO (1963) procedure.

Statistical analysis results

Consists of performing one way anova to test the hypothesis that the mean at period of interval differ. Students paired 't' test was performed to analyse the difference between pre and post intervention data. Hypothesis testing was done at 95 per cent confidence interval.

RESULTS

Majority of adolescent girls (13-15yrs) had symptoms related to nutritional iron deficiency anaemia (Table-1a). Seventy five percent (n=15) of adolescents in the pre-intervention stage were

screened with pale-conjunctiva. Fortified beet-root extract intervention for three months (45-days) had clinical significance as the symptoms came down to five percent (n=1). Food to food fortification is a simple and effective way of iron enrichment. Vitamin-C content of lime juice increases the bio-availability of iron from beet-root and helps in regeneration of red blood cells⁹.

In the control with seventy percent (n=14) symptoms and only nutrition education

conjunctival-paleness persisted in fifty five percent (n=11) adolescents. Angular stomatitis is the real bane and sorrowful symptom in young adolescent girls. Thirty five percent (n=7) of adolescents were screened with the symptoms in the pre-intervention and control group. The impact study clinically nullified the symptoms in the post-intervention stage. If a deficiency for one micronutrient exists it is likely that multiple deficiencies are also present¹⁰. Lack luster and dry brittle hair clinically observed

Table 1(a). Clinical assessment on nutritional status of adolescent girls

S. No	Factors	13-15Years							
		Intervention (n=20)				Control(n=20)			
		Pre-test		Post-test		Pre-test		Post-test	
		No	Percent	No	Percent	No	Percent	No	Percent
1	Paleconjunctiva	15	75	1	5	14	70	11	55
2	Angular stomatitis	7	35	-	-	7	35	6	30
3	Cheilosis	-	-	-	-	-	-	-	-
4	Glossitis	-	-	-	-	-	-	-	-
5	Swollen,bleeding gums	3	15	-	-	3	15	3	15
6	Loss of luster	11	55	1	5	10	50	9	45
7	Dry brittle hair	11	55	1	5	10	50	10	50
8	Dermatitis	9	45	2	10	12	60	12	60
9	Pallor of skin	10	50	-	-	10	50	8	40
10	Brittle nails	11	55	-	-	12	60	10	50
11	Dry nails	11	55	1	5	12	60	10	50
12	Dental caries	6	30	2	10	4	20	4	20

Table 1(b). Clinical assessment on nutritional status of adolescent girls

S. No	Factors	16-18Years							
		Intervention (n=20)				Control(n=20)			
		Pre-test		Post-test		Pre-test		Post-test	
		No	Percent	No	Percent	No	Percent	No	Percent
1	Paleconjunctiva	16	80	1	5	15	75	11	55
2	Angular stomatitis	8	40	-	-	7	35	6	30
3	Cheilosis	-	-	-	-	-	-	-	-
4	Glossitis	-	-	-	-	-	-	-	-
5	Swollen,bleeding gums	3	15	-	-	3	15	3	15
6	Loss of luster	12	60	2	10	12	60	9	45
7	Dry brittle hair	11	55	1	5	13	65	10	50
8	Dermatitis	10	50	2	10	10	50	12	60
9	Pallor of skin	10	50	2	10	9	45	8	40
10	Brittle nails	11	55	1	5	11	55	10	50
11	Dry nails	11	55	1	5	11	55	10	50
12	Dental caries	5	25	2	10	6	30	4	20

in fifty five percent(n=11) completely diminished to five per cent(n=1) after intervention. The percentage of ionisable iron increases during processing of foods and enhances iron bio-availability. At the pre- intervention stage Paleness of skin observed in fifty percent (n=10) and brittleness of nails in fifty five percent(n=11) adolescents were completely cured with fortified beet-root extract intervention. Drinking beet-root extract helps in healthy and glowing skin.

Post- adolescent (16-18yrs) age group as evident (Table-1b) were susceptible to nutrition related iron deficiency anaemia. Adolescent period is an age of rapid growth stress, strain and peer group influence. Conjunctival- paleness clinically screened in eighty percent (n=16) adolescents declined with fortified beet-root extract intervention(45days) to five percent(n=1). The anthocyanin in beet root is a blue purple pigment similar to chlorophyll capable of enhancing the haemoglobin status. With nutrition education alone in the control the impact was not clinically significant and symptoms was prevalent in fifty five percent (n=11).

Angular stomatitis clinically observed in forty percent of adolescents in the pre-intervention group was absent.in the post- intervention stage. The detoxifying ability of beet-root helps in curing skin problem and helps to hydrate the skin. Symptoms like dermatitis and paleness of skin clinically was present only in ten percent (n=2) after intervention. Iron availability is influenced by the adequacy of intestinal secretions, various components in foods and the degree of iron deficiency of the individual¹¹. The nail colour was seen brighter in the interventional group. Lack luster hair observed in sixty percent (n=12) of the intervention group declined significantly to five percent (n=1).

Significant increase in the mean haemoglobin level (Table-2) was observed across different age groups with fortified beet-root extract intervention. In the pre- adolescent (13-15years) age group the baseline mean haemoglobin value of 8.73±0.68 improved significantly. Towards the first month(15days) the iron status reached 9.56±0.67. The deficiency of iron is not always due to absolute lack of the element in the diet but rather due to its poor bioavailability.

After three months (45days) of

Table 2. Mean serum haemoglobin values of adolescents

Groups	Baseline	First Month 15 days	Second Month 30 days	Third Month 45 days	Mean diff	T value	WHO 1992
Experimental(13-15yrs) A ₁	8.73±0.68	9.56±0.67	11.46±0.65	12.29±0.46	3.6±0.36	20.62	P<.0001
Control(13-15yrs) B ₁	8.62±0.44	8.73±0.53	8.8±0.48	8.88±0.51	0.26±0.11	4.77	P= 0.0007
Experimental(16-8yrs) A ₂	8.55±0.46	9.6±0.82	11.43±0.49	12.44±0.70	3.9±0.38	A ₁ vs B ₁ : 26.96	P<.0001
Control(16-18yrs) B ₂	8.41±0.52	8.4±0.54	8.44±0.55	8.57±0.49	0.15±0.12	2.15	P<.0001
						2.64	P= 0.0161
						A ₂ vs B ₂ : 18.47	P<.0001

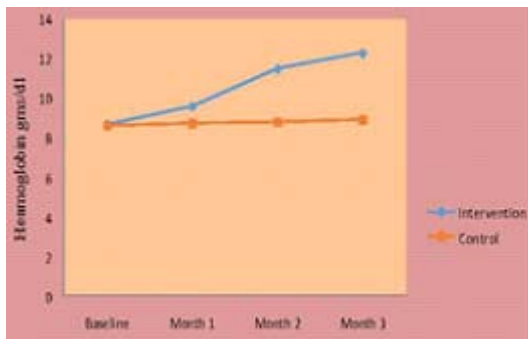


Fig. 1. Mean Hemoglobin value (13-15 years)

intervention haemoglobin level improved to 12.29 ± 0.46 (Figure 1). Compared to oral iron, fortified food supplementation is a sustainable strategy to maintain blood haemoglobin level even after cessation¹². The mean difference between the baseline and post-test level was highly significant ($t=20.62$, $p<.0001$). The addition of certain vegetables or fruits containing ascorbic acid can double or triple iron absorption thereby counteracting the effects of the iron inhibitors. The impact of fortified beet-root extract had statistically high significance ($t=26.96$, $p<.0001$) in the intervention group as compared to the control.

A review of Indian studies on anaemia revealed that more than seventy percent of adolescent girls in the low socio-economic communities had haemoglobin level less than 9gms/dl¹³. In the post-adolescent (16-18yrs) age group the baseline mean haemoglobin value of 8.55 ± 0.46 gradually improved with fortified beet-root extract to 9.6 ± 0.82 in the first month (15days) and thereafter to 11.43 ± 0.49 in the second month (30days). Home food processing is a natural way of increasing the iron bio-availability. It includes fortification, soaking, germination, fermentation and malting of grains. They help to activate phytases that break down phytic acid, the important anti-nutrient that inhibits iron absorption¹⁴. After forty five days of intervention the mean haemoglobin level improved to 12.44 ± 0.70 (figure 2). The mean difference (3.9 ± 0.38) was statistically significant ($t=21.15$, $p<.0001$). Beet-root is known to be a good home remedy for menstrual disorders and menopause symptoms.

In the control group with only nutrition education the mean difference (0.15 ± 0.12) between

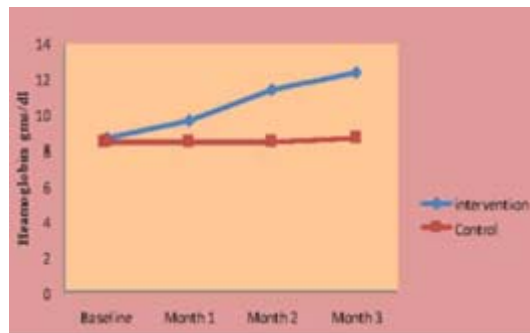


Fig. 2. Mean Hemoglobin value (16-18 years)

the baseline haemoglobin and the third month intervention was not significant ($t=2.64$, $p=.0161$). cereals are only fair source of iron, hence iron rich foods are to be included in the diet to fulfill the requirements. Fortified beet-root extract intervention for three months (45days) had significant ($t=18.47$, $p<.0001$) impact on the mean haemoglobin level compared to control.

DISCUSSION

The study explored an alternative strategy to supplement iron in adolescent school girls with iron deficiency anaemia. Fortified beet-root extract intervention on alternate days for three months (45days) was statistically and clinically significant. It had a high impact on clinical symptoms related to nutritional iron deficiency anemia and blood haemoglobin status. Symptoms like bleeding gums and paleness of skin and dermatitis (13-15yrs) clinically subsided after intervention. The nail colour was seen enhanced in both age groups. The antioxidant property of beet-root helps to scavenge free radicals to prevent aging, cancer and reduce blood pressure to help the muscles in uptake of oxygen¹⁵.

Lack luster hair observed in sixty percent ($n=12$) at the pre-test level (16-18yrs) declined significantly to five percent ($n=1$). There was a good bounce and a glistening sheen in the hair. Most of the clinical symptoms related to the external face value, glow of skin and general appearance were completely treated by fortified beet-root extract intervention. Traditional processing procedures can improve the bio-availability of iron. Similar study has been quoted by Monica Jain-

2013 with two iron enriched variants each of biscuit, handwa, idli and soy chat. The majority of the population in india rely on plant foods for most of the nutrients. The availability of iron from these plant sources are very low. Low dietary intake of iron, excess menstrual flow and stress of education are the leading causes of high prevalence of IDA in this age group. The haemoglobin level improved significantly each month in both the groups. Beet-root extract is the best natural remedy for anaemia and the bio-availability of iron can be enhanced by fortification with lime juice containig vitamin-c. Each meal preferably should contain at least 25 mg of ascorbic acid and possibly more if the meal contains many inhibitors of iron absorption.. Beet-root is to be used only in its raw state as the betalin in beet-root when cooked is reduced and oxalic acid crystals are released forming calcium stones. Fortified beet-root extract intervention with nutrition education can improve the haemoglobin level and nutritional status of adolescents.

A change from pill to natural food is a difficult challenge but should be considered as the best and most natural solution for iron deficiency anaemia.

CONCLUSION

Fortified beet-root extract supplementation on alternate days along with nutrition education proved its potential of improving the nutritional status, haemoglobin level and circulating iron index. As compared to oral iron, fortified food supplementation is a sustainable strategy to maintain blood haemoglobin level even after cessation. School girls model was found to be an effective intervention strategy to reach the susceptible population.

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