CHAPTER - II
REVIEW OF LITERATURE

The comprehensive review of literature is an essential part of any scientific investigation. The review of literature leads the researcher to conclude the findings with references to past studies. The review gives a clear perspective of the overall field of research and allows comparing the results of the past studies in the particular field with the present research. It also provides the investigator with an opportunity to gain insight into the methods and approaches employed by other researchers and helping in formulating the research design. Further literature having direct bearing on different aspect of the present study is limited. Hence, references having indirect bearing are also reviewed. A brief account of such literature reviewed has been presented under the following head.

2.1 Prevalence of Anemia
   2.1.1 Global prevalence of anemia
   2.1.2 National prevalence of anemia
   2.1.3 Prevalence of anemia in Gujarat

2.2 Etiology of Anemia
2.3 Pica i.e. eating disorder of non nutritional substances
2.4 Nutritional Status
2.5 Intervention strategies for eliminating anemia
   2.4.1 Supplementation
   2.4.2 Fortification
   2.4.3 Bio availability of dietary iron
   2.4.4 Improving bio availability of dietary iron
   2.4.5 Nutrition education
   2.4.6 Effect of garden cress seeds supplementation
2.1 Prevalence of anemia

2.1.1 Global prevalence of anemia

Table: 2.1.1 Population coverage (%) by anemia prevalence surveys (national or subnational) conducted between 1993 and 2005, by UN region (WHO – 2005)

<table>
<thead>
<tr>
<th>UN Region</th>
<th>PreSAC(^a)</th>
<th>PW</th>
<th>NPW</th>
<th>SAC</th>
<th>Men</th>
<th>Elderly</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa (53)</td>
<td>76.7 (30)(^c)</td>
<td>65.3 (25)</td>
<td>63.6 (26)</td>
<td>18.6 (10)</td>
<td>32.0 (14)</td>
<td>1.8 (1)</td>
<td>40.7</td>
</tr>
<tr>
<td>Asia (47)</td>
<td>82.1 (30)</td>
<td>80.9 (21)</td>
<td>88.8 (34)</td>
<td>37.0 (11)</td>
<td>47.6 (13)</td>
<td>54.1 (7)</td>
<td>58.0</td>
</tr>
<tr>
<td>Europe (41)</td>
<td>19.2 (5)</td>
<td>0.9 (1)</td>
<td>23.9 (5)</td>
<td>12.9 (3)</td>
<td>15.9 (2)</td>
<td>8.7 (2)</td>
<td>14.9</td>
</tr>
<tr>
<td>Lam and the Caribbean (33)</td>
<td>70.5 (15)</td>
<td>38.4 (14)</td>
<td>37.5 (12)</td>
<td>28.9 (8)</td>
<td>0.1 (1)</td>
<td>0.0 (0)</td>
<td>22.9</td>
</tr>
<tr>
<td>North America (2)</td>
<td>92.4 (1)</td>
<td>92.8 (1)</td>
<td>89.9 (1)</td>
<td>91.3 (1)</td>
<td>89.9 (1)</td>
<td>89.6 (1)</td>
<td>84.3</td>
</tr>
<tr>
<td>Oceania (16)</td>
<td>5.1 (3)</td>
<td>4.7 (2)</td>
<td>16.5 (4)</td>
<td>15.1 (3)</td>
<td>15.6 (3)</td>
<td>15.1 (2)</td>
<td>13.8</td>
</tr>
<tr>
<td>Global (192)</td>
<td>76.1 (84)</td>
<td>69.0 (64)</td>
<td>73.5 (82)</td>
<td>33.0 (36)</td>
<td>40.2 (34)</td>
<td>39.1 (13)</td>
<td>48.8</td>
</tr>
</tbody>
</table>

\(^a\) Population groups: PreSAC, preschool-age children (0.00-4.99 yrs); PW, pregnant women (no age range defined); NPW, non-pregnant women (15.00 – 49.99 yrs), SAC, school-age children (5.00-14.99 yrs), Men (15.00-59.99 yrs); Elderly (≥60.00 yrs).

\(^b\) Number of countries in each grouping.

\(^c\) Total number of countries with data, No Figure is provided for ‘All’ since each country may be partially covered by some population groups, but few countries have data on all 6 population groups and no countries have data for women 50-59 years of age.
Table: 2.1.2  Anemia prevalence and number of individuals affected in school-age children, pregnant women, and non-pregnant women in each UN region

<table>
<thead>
<tr>
<th>UN Region</th>
<th>Preschool-age children b</th>
<th>Pregnant Women</th>
<th>Non-Pregnant Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre. (%)</td>
<td># affected (mill.)</td>
<td>Pre. (%)</td>
</tr>
<tr>
<td>Africa</td>
<td>64.6</td>
<td>(61.7-67.5)c</td>
<td>55.8</td>
</tr>
<tr>
<td>Asia</td>
<td>47.7</td>
<td>(45.2-50.3)</td>
<td>41.6</td>
</tr>
<tr>
<td>Europe</td>
<td>16.7</td>
<td>(10.5-23.0)</td>
<td>6.1</td>
</tr>
<tr>
<td>LAC</td>
<td>39.5</td>
<td>(36.0-43.0)</td>
<td>22.3</td>
</tr>
<tr>
<td>NA</td>
<td>3.4</td>
<td>(2.0-4.9)</td>
<td>0.8</td>
</tr>
<tr>
<td>Oceania</td>
<td>28.0</td>
<td>(15.8-40.2)</td>
<td>0.7</td>
</tr>
<tr>
<td>Global</td>
<td>47.4</td>
<td>(45.7-49.1)</td>
<td>293.1</td>
</tr>
</tbody>
</table>

a UN regions: Africa, Asia, Europe, Latin America and the Caribbean (LAC), Northern America (NA), and Oceania.

b Population groups: PreSAC, preschool-age children(0.00-4.99 yrs); PW, pregnant women (no age range defined); NPW, non-pregnant women (15.00-49.99 yrs).

c 95% Confidence intervals.
Figure: 2.1 Global prevalence of anemia among non pregnant women.

Figure: 2.2 Anemia prevalence in adolescent girls (WHO 2011)
Adolescents constitute about 20% population in South - East Asian Countries. Figure 2.2 shows that in all South - East Asian Countries, except Thailand, more than a quarter of girls are anemic, though there is a great disparity within the region. Irrespective of severity of anemia, prevalence among adolescent girls ranges between 17% - 90% within the region. The National data from India, Nepal and Myanmar also show that adolescent anemia as moderate to severe public health problem. According to WHO guidelines, there are almost no countries in the region where anemia is not at least a mild public health problem in the adolescent population (WHO 2011).

2.1.2 National prevalence of anemia

Seetharam et al. (1997) conducted a study on prevalence of nutritional anemia in selected girls of Mysore city. In this study 510 girls in the age group of 16-22 years from Maharani’s science college were selected. 68% of them had a family income of Rs 2001 – 5000 per month and majority (82 %) of them had college education. A significant percentage of the girls (60%) were anemic. Among the anemic girls, 32%, 36%, and 2% of them were moderately, mildly and severely anemic respectively. Distribution of difference was similar in all the age groups. Paleness of the tongue and eyes were predominant clinical signs among the girls which indicated anemia. The mean weight of the girls (16-17 years) was 45.5 kg and height was 157 cm. The mean height and weight of these girls were lower than the NCHS standards. As per the BMI classification, all the girls of 18-22 years belonged to grade I chronic energy deficiency. Height and weight had no impact on anemic conditions. However, weight and BMI decreased as the severity of anemia increased, which were not statistically significant. Educational level of the parents and income of the parents showed no influence on occurrence of anemia. It is noteworthy to mention here that the children of educated and high income families also suffered from anemic condition. There is an urgent need for nutrition education of girls and parents to prevent anemia.

Rawat et al. (2001) conducted a study on socio demographic correlates of anemia among adolescent girls in rural areas of district Meerut (Uttar Pradesh). The
present study was undertaken to find out prevailed anemia among adolescent girls in rural Meerut and to study their socio-demographic characteristics indication to the anemia. The study was carried out in Daruala block. The sample consisted of randomly selected 504 adolescent girls (10-18 years), covering 21 girls from each of the 24 sub center villages under Daruala, PHC. Detailed information was collected about socio-demographic characteristics for anemia by oral questionnaire method, supplemented by physical examination and haemoglobin estimation. 174 (34.5%) of the 504 adolescent girls were anemic. The prevalence of mild, moderate and severe anemia among adolescent girls was 19 %, 14.1 % and 1.4 %, respectively. The proportion of mild, moderate and severe anemia was 55.2 %, 40.8 % and 4.0 % respectively.

The prevalence of anemia was significantly higher (45.2%) among adolescent girls from joint families as compared to those from nuclear families (28.3%) (p<0.001), which may be related to household food security. Anemia was higher in socio-economic (50%) and it significantly reduced with rise in socio-economic status, being minimum (27.3%) (p<0.001), this may be because of better availability of high quality food with rise in socio-economic status (SES), an inverse association between SES and anemia was observed. The prevalence of anemia in relation to father’s occupation was found to be significant (p<0.001) which may be because of availability of better quality foods to the girls of agricultural families. Adolescent girls, whose fathers were laborers (44%), were more anemic than those whose fathers working in agriculture (27.1%). A significantly higher (p<0.01) prevalence of anemia was seen in adolescent girls having illiterate (42.2%) and literate mothers (51.9%). A significantly high (p<0.02) level of anemia was observed in adolescent girls belonging to families having family size > 3 (38%) than those from families of size ≤3 (27.2%), which may be due to availability of adequate diet to all the family members in small families.

WHO (2001) published a guide for programs managers on “Iron Deficiency Anemia” in order to assess, prevent and control anemia which occurs mainly due to
iron deficiency. This document deals primarily with indicator for monitoring intervention to combat iron deficiency, including iron deficiency anemia. However, it also reviews the current methods of preventing iron deficiency in the light of recent significant scientific advances. Prevention program strategies for preventing iron deficiency through food based approaches include dietary improvement or modification and fortification, were discussed. A schedule for using iron supplements to control iron deficiency, and to treat mild to moderate IDA according to age, gender and physiological status is provided. Iron deficiency can impair cognitive performance at all stages of life, moreover, the effects of iron deficiency anemia in infancy and early childhood are not likely to be correlated by subsequent iron therapy.

India, DLHS – RCH, (2002-04) and figure 2.3 & 2.4 showed prevalence of severely and moderately anemic adolescent girls (10-19 years) by State and in India, 49% and 27 % of adolescent girls were moderately and severely anemic. The state of Chattisgarh has the highest percentage of adolescent girls who are either moderately or severely anemic (88%) followed by Haryana (86%). In the states of Andhra Pradesh, Bihar, Delhi, Gujarat, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal, the combined prevalence of either moderate or severe anemia among adolescent girls is in the range of 70-80 %. The states where this percentage is between 50-70 % included Karnataka, Tamil Nadu, Uttarakhand, Arunachal Pradesh, Tripura and Nagaland. In the rest of the states in India, the percentage of adolescent girls who are either moderately or severely anemic is less than 50 %. Among them, the low percentages in Jammu and Kashmir (26%) and Kerala (32 %) are noteworthy. High concentration of anemic adolescent girls is found in Gujarat, Maharashtra, Punjab, Haryana, Orissa and Assam. In India as whole, only 61 out of 542 district fall in the category of low prevalence of moderately anemic adolescent girls, 186 districts fall in medium prevalence and 295 districts in high prevalence categories. In more than 50% of the districts of Uttar Pradesh, Madhya Pradesh, Maharashtra, Punjab, Haryana, Orissa and Assam more than three-fourth of adolescent girls in the age group 10-19 years are either moderately or severely anemic. It is remarkable that
the states such as Punjab and Haryana, despite being economically and agriculturally more advanced than other states, show relatively high prevalence of moderate and severe anemia among adolescent girls.

**Bentley and Griffiths (2003)** conducted a study for the burden of anemia among women in India. The research investigates the prevalence and determinants of anemia among women in Andhra Pradesh from the data of The National Family Health Survey 1998/99. A total of 4032 married women aged 15-49 years from 3872 households and found 32.4 % of women had mild, 14.19% had moderate and 2.2 % had severe anemia. Protective factors include Muslim religion, reported consumption of alcohol or pulses, and high socio-economic status, particularly in urban areas. Poor urban women had the highest rates and odds of being anemic. 52% of them were underweight and 41 % of women were overweight. New program strategies are needed, particularly, those to improve the overall nutrition status of women of reproductive ages.

**Malhotra and Passi (2004)** studied the haemoglobin status of adolescent girls in rural blocks of Delhi, Rajasthan and Uttar Pradesh, and reported that the incidence of mild, moderate and severe anemia was found to be 50 %, 44.4 % and 2.8 % of the subjects and only 2.8 % of subjects had normal haemoglobin level.

**Shekhar (2005)** conducted a study on iron status of adolescent girls and its effect on physical fitness. 150 college going adolescent girls aged 17-19 years were enrolled for the study. Background information, anthropometric measurements, dietary intake and menstrual history were recorded. The mean age of girls was 18.5 years, with 95.2 % being of 17-18 years of age. The mean height was found to be 156.6 cm, and mean weight was 51.5 kg. The mean BMI of the subjects ranged from 16.8 to 20.8. Out of 150 subjects, 68 students were found to be normal, although none were observed to be severely anemic (Hb < 7 g/dl); 12.6 % and 46 % subjects were moderately and mildly anemic, respectively. Approximately 74 % girls with moderate anemic, approximately 28 % girls with mild anemia were correctly identified when pallor of conjunctiva, eyes and tongue was used to examine and assess anemia. The sensitivity of identifying girls with symptoms like
weakness, tiredness, irritability and breathlessness for moderate, mild and severe anemia was 61% and 20%; respectively. The mean age of menarche was 13 years and the menstrual cycle was regular among 75% of adolescents. Mean daily iron intake was observed to be less than 50% of the RDA, whereas the ascorbic acid intake was adequate, leading to many adolescent girls having normal hemoglobin levels in spite of iron consumption being less than RDA.

Kumar et al. (2006) conducted a study on influence of family’s vegetable cultivation on prevalence of anemia among adolescent girls. The objectives of the study were to assess whether the cultivation of vegetables in families benefits the adolescent girls in terms of vegetable consumption and maintaining normal hemoglobin levels; and whether the prevalence of anemia varies in vegetable grower and non-grower families. The study was conducted in rural areas of the Trans Ganga region in Allahabad, Uttar Pradesh, India. A total of 80 adolescent girls, 40 from vegetable grower (VG) and 40 from non-grower (NWG) families were purposively selected. A combination of general and dietary survey, anthropometric measurements, clinical assessment and laboratory test was used to obtain the required information. Data for two groups of subjects, VG and NVG were compared and statistically tested for any significant difference. The research revealed that the vegetable growers commonly cultivated leafy vegetables like soya, spinach, amaranths and onion stalks. About 15% of the families produced vegetables for their own consumption. The remaining had surplus quantities, which were either sold or fed to the animals. Preservation was not at all practiced for any leafy vegetable. In VG group 62.5% girls consumed green leafy vegetables daily and the remaining consumed 4-6 times per week. The average quantity consumed was higher in the VG groups than in their NVG counterparts.

A comparison between the two groups showed that the mean height of adolescent girls from VG families was better than the NVG ones. However, the t-test did not reveal any significant difference between the two categories (p>0.05). Weight difference of the adolescent girls was somewhat similar to difference in height, which fell below the NCHS standard value, the reference value for well-to-do Indian adolescent girl’s weight which was 40.87 kg, was not satisfactory. The
values ranged from 22.5 to 50 kg among the adolescent girls were studied. Various signs and symptoms of anemia were present among subjects belonging to both the groups. Breathlessness and tiredness were experienced by about one-fourth of the subjects in both the groups. Pale nails were observed in 6 of VG and 10 of NVG group, whereas in the latter group, pale conjunctivitis was noticed in a small proportion. The mean haemoglobin level (10.23 g/dl) in the VG groups was greater than that of NVG groups (9.74 g/dl) and varying degrees of anemia were present in higher proportion of the NVG than the VG. T-test revealed that the prevalence of anemia did not differ between the two groups. Only 8 NVG group members as compared to 19 of VG subjects had hemoglobin levels within the normal range. The findings showed that food and nutrient consumption, anthropometric status (height and weight) and hemoglobin status of adolescent girls did not differ significantly in the categories of families whether they cultivated or did not cultivate leafy vegetables.

Mehnaz et al. (2006) reported that a very high overall prevalence of iron deficiency anemia (98.87%), was found to be in urban area of Aligarh. The level of anemia was categorized as 14.8% with mild, 72 % with moderate and 13% with severity.
Figure: 2.3 Prevalence of Anemia in India and Gujarat

Source: India, DLHS – RCH, 2002-04
Sen et al. (2006) conducted a study on deleterious functional impact of anemia on young adolescent school girls. The study was planned with the objective of assessing the physical work capacity and cognition of underprivileged anemic school girls in early adolescence as compared to their non-anemic counterparts.
The study was conducted in 4 Vadodara Municipal Primary School where in 350 girls from low income families studying in standards V and VI was selected. Data on haemoglobin (n = 322), height and weight (n = 350) were collected. A random sub-sample of 60 % of the total students was taken for physical work capacity (PWC) and cognitive tests (n = 230). The cognitive functions of the girls were assessed using modified selected tests from the Gujarati version of Wechsler Intelligence Scale for Children (WISC), mean and standard deviation were calculated for PWC and cognition score. Percentage of anemic girls was calculated using WHO cut off of haemoglobin < 12 g/dl. On a smaller subset of data, anemic and non-anemic girls were compared within well nourished and under nourished groups. Under nutrition was defined as body mass index (BMI) < 5th percentile of standards.

The mean haemoglobin level of total sample of girls (n= 332) was 11.32 g/dl to 10.67 g/dl for anemic (n=217) and 12.68 g/dl for non-anemic (n=105) girls. The prevalence of anemia was very high (67%) with 32.6 % girls being mildly anemic (Hb =11.0 – 11.9 g/dl) and 34.7 % girls moderately anemic (Hb =7.1 – 10.9 g/dl). Though the mean number of steps climbed by the 59 non-anemic girls (175 steps) in 3 minutes was not significantly higher than 171 anemic girls (172 steps) but the time taken to recover to the basal pulse rate was significantly higher (p<0.001) for anemic girls, even mildly anemic girls took longer to recover to their basal pulse rate compared to non-anemic girls, the moderately anemic girls similarly showed a longer recovery time that those mildly anemic. The non-anemic girls scored higher than their anemic counterparts in cognitive tests, the difference being significant in digit span and visual memory tests. Both, mildly anemic and moderately anemic girls were fared significant poorer as regards to recovery time (p< 0.05) and digit span scores (p<0.01). Even the mildly anemic girls tended to have lower scores than non-anemic girls, and the moderately anemic girls further had lower scores than those mildly anemic girls. In the undernourished groups non-anemic girls (174 steps) performed significantly better than their counterparts (143 steps). This indicated that the adverse effects of anemia are compound due to
overall under nutrition and that being well-nourished was an important as being non-anemic for normal PWC.

**Diwaker (2007-08)** conducted a study in rural area in India and it revealed that 6,948 (69.40%) women were anemic among 10,000 rural women. The largest proportion of anemic rural women (43.52%) fell into the category of moderate anemia, while largest proportions of the urban group (35.7%) were in the mild anemia category.

**Gupta et al. (2007)** conducted a study on prevalence of anemia among female adolescents of different income ranges and studying in government and public educational institutions in District Kurukshetra (Haryana). In the present study, a sample of 160 females of early adolescents period (11-13 years) and 100 females of late adolescence period (14 – 17 years) were randomly selected from different educational institutions to see the prevalence of anemia and they suffered from anemia with hemoglobin level less than 12 g/dl of blood barring two subjects of late adolescence period who had haemoglobin more than 12 g/ dl of blood. Anemia was highly prevalent in the subjects of early adolescence as compared to late adolescence period. Maximum subjects in both early and late adolescence period were suffering from moderate (58.08 %) followed by mild anemia (33.85 %) and minimum (5.77 %) with severe anemia. Only four subjects, one from early and three from late adolescence periods were marginally anemic. Incidence of anemia was noticed in maximum subjects in low income range of both early and late adolescence period. But the severity of anemia was observed maximum in the subjects of middle and high income ranges in early adolescence period. The anemic conditions can be improved through creating nutritional awareness among the suffers and supplementing iron rich food.

**Pande et al. (2008)** conducted a study on reducing iron-deficiency anemia and changing dietary behaviors among adolescent girls in Maharashtra, India. The specific objective of the study were to increase number of daily meals from 2 to 3 or 4 in the case of adolescent girls, to encourage girls to consume iron rich food on daily basis; to encourage girls to consume vitamin C rich foods in combination with
iron-rich foods daily, and to reduce the prevalence of anemia, especially in the severe and moderate categories. The unmarried adolescent girls aged 10-19 years were selected from 10 intervention slums (1000) and 6 control slums (752) for the baseline and end line with two cross sectional samples. Ultimately, out of, 1142 girls, 811 were surveyed for information on dietary and morbidity history, anthropometric parameters, menstrual history and workload within and outside the house. Blood samples from 803 girls were taken to assess haemoglobin status. Logistic regression was used to determine the predictors of anemia, with haemoglobin status as the dependent variable. Independent variables included economic status, consumption of iron rich foods, number of meals eaten in a day, use of lemon with meals, morbidity in the past year, number of hours worked in a day and whether menses had started. The average age of the study population was 14 years and 76 % of them were currently in school and 50 % had achieved menarche.

Around 58 % of the sample was anemic (Hb < 12 g/dl), 1.3 % severely anemic (Hb < 7 gm/dl) and 40 % of them were eating two or fewer meals daily. Logistic regression of baseline data showed that anemia was significantly more likely among girls who ate two or fewer meals in a day had been sick in the past year and consumed few iron rich foods. Thus, the intervention focused on changing dietary behavior. End line comparisons showed that the intervention has influenced dietary behavior, with a significant increase in percent of girls who ate more than 3 meals a day and consumed lemon with their meals, as well as in the frequency of eating fruits in the intervention group. Between baseline and end line, blood testing showed that mean haemoglobin levels increased from 5.8 to 9.5 g/dl for severely anemic girls, and from 8.9 to 11.2 g/dl for moderately anemic girls. Participatory nutrition education can influence adolescent girl’s anemic status and dietary behavior. Key dietary behavior messages for girls include; eating more than 3 meals a day, eating with family so as to eat enough, eating green vegetables daily and eating lemon or amla with meals, iron supplementation programs need to include nutrition education programs to be effective.
Subhra Srimani *et al.* (2008) the study was a comparative as well as correlational on prevalence of anemia among rural and urban school going adolescent girls (16 to 18 years) was conducted, the main objectives of the study were to assess prevalence of anemia among adolescent girls of rural and urban community and identify the relationship of occurrence of anemia with selected factors. Non probability convenience sampling technique was used to obtain 96 samples from class X, 48 each from rural and urban schools. Varieties of developed tools as well as standard tools were utilized to collect data. Study result identified that prevalence of anemia in adolescent girls was 56%. Rural prevalence was high (81%) than urban prevalence (31%). Knowledge score about anemia in both settings were at average. Dietary data indicated that frequency intake of green leafy vegetables was remarkably less among adolescent girls. Intake of protein, iron, and folic acid was significantly deficient in respect to recommended dietary allowance (RDA) for both the settings.

Mehta (2009) reported about prevalence of anemia in the world, 1.5 to 2.0 billion people suffer from anemia, from this, 70% of women contributed to anemia prevalence in the world 45% - 50% of pregnant women of all over world suffer from anemia. In India 1.5 crore women are suffering from anemia. Every year 50 lakh women death occur due to anemia. 82% of 6-20 years of school and college girls are suffering from anemia. 93% of women and girls are suffering from anemia from lower income group in India.

Ajgonkar *et al.* (2010) conducted a study on prevalence of Iron Deficiency Anemia (IDA) among adolescent girls (11-21 years) residing in urban slum areas of Dharavi, Mumbai. The study was on iron deficiency. Anemia which is a widespread condition in adolescents of developing countries. The rapid rate of linear growth, increase in blood volume and onset of menarche during adolescence all increases the need for iron. Adolescent iron requirements are even higher in developing countries because of infectious disease and parasitic infestations that cause iron loss. Therefore an attempt has been made to report the prevalence of IDA among adolescent girls residing in urban slum areas of Dharavi, at Mumbai.
To determine the prevalence of IDA in adolescent girls (11-21 years) residing in urban slum areas of Dharavi, Mumbai. The study was carried out in the 100 adolescent girls (11-21 years) who are the beneficiaries of ICDS and Kishori project from slum areas of Dharavi, Mumbai using purposive sampling technique. Standardized questionnaire was used to determine the eating habits of the subjects. Anemia detection was done by estimation of complete blood count using mythic – 18, an automated blood cell counter. The prevalence of IDA was found to be 50 %, despite majority of the subjects (42%) being non-vegetarians. The highest frequency was found among the Hindu (24%) and Muslim (21%) community. One of the reasons for the same could be that none of the subjects had undergone deworming so far. It was also seen that consumption of micronutrient rich foods was less, thereby emphasizing the need for creating awareness of personal hygiene and providing nutrition education for the participants.

Avashia (2010) conducted a study on anemia prevalence. Anemia is more commonly prevalent among adolescents, preschool children, pregnant and lactating mothers. Anemia among adolescent have gained more importance as they are the most crucial segment of the population whose wellbeing influences the future generation as today's young girls are future mothers. Micronutrient deficiency, especially iron deficiency in adolescent girls can seriously affect their health. 8% of adolescent girls of 10-19 years of age are suffering from iron deficiency anemia. During adolescence, iron deficiency anemia not only reduces work productivity but also leads to complications of pregnancy in the later years. Targeting adolescent girls in anemia prevention programs would not only have an immediate curative effect, but may also have long term preventive effect during pregnancy and lactation. UN reemphasize that “control of nutritional anemia should be one of the global development goals to be achieved in the early years of this new millennium”. Food based approaches have higher potential for achieving and reaching and long lasting benefits for the control of iron and other micronutrient deficiency. Hence the research was undertaken to develop an iron rich health drink which was made up with locally available ingredients, evaluates its acceptability and its efficacy by supplementing the drink to selected anemic adolescents girls.
Hanan et al. (2010) conducted a study on anemia in adolescent college girls. Effect of age, nutritional status and nutrient intake was to observe overall prevalence of IDA. It was found to be 26%. The mean haemoglobin (Hb) in non-anemic girls was 13.04 ± 0.013 g/dl and in anemic girls it was 10.2±0.45 g/dl. 38% girls were underweight having body mass index (BMI > 18.5) out of which 42.07% were anemic. In terms of nutrient intake only 20% of the girls consumed energy according to recommended dietary allowance (RDA) and another similar number could meet 90% of the RDA. Only 8% of the girls met RDA for protein and another 18% could meet 90% of the RDA. 46% girls satisfied their needs for iron according to RDA and another 14% could meet 90% of the RDA.

Siddharam et al. (2011) conducted a study to estimate the prevalence of anemia among adolescent girls and to study the socio-demographic factors associated with anemia. A cross sectional survey was conducted in selected Anganwadi centers of rural area of Hassan district.314 adolescent girls (10-19 years) were included in the study. The study was conducted from February to April 2011 (3 months). Data analysis was done by using proportions and chi-square test. Prevalence of anemia was found to be 45.2%, a statically significant association was found with iron deficiency anemia, weight loss and anemia; pallor and anemia. In the present study it was seen that among the 45.2% of anemic adolescent girls 40.1% had mild anemia, 54.92% had moderate anemia and 4.92% had severe anemia. A high prevalence of anemia among adolescent girls was found, which was higher in low economic strata. It was seen that anemia affects overall nutritional status of adolescent girls.

Premlatha et al. (2012) conducted a study to estimate prevalence of iron deficiency anemia among adolescent schoolgirls in the age group 13-17 years in Chennai and to study the associated factors. A cross sectional survey was carried out among 400 school students. The prevalence of anemia was found to be 78.75% among school girls. The results of the study show that the factors such as age, literacy status of mother, types of family, community, weight, diet, frequency
of intake of green leafy vegetables and fruits, menstrual discharge and deworming are the factors contributing to the prevalence of anemia.

Savita et al. (2013) studied the impact of education intervention on nutritional knowledge of iron deficiency anemia among 207 post adolescent girls of 18-25 years of age in Bangalore. The prevalence of anemia observed that 53.14 % were found to be moderately anemic, 42.51 % were found to be mildly anemic and 2.89 % were to be found severely anemic and only 1.44 % had normal haemoglobin level. The prevalence of anemia in the study population was very high i.e.98.66%.

2.1.3 Prevalence of anemia in Gujarat

India, DLHS – RCH( 2002-04) reported that data on anemia levels were available for about 8,000 adolescent girls aged 10-19 years who constituted 60% of the total sample. Table-2.4 shows anemia level for adolescent girls aged 10-19 years by selected characteristics. In Gujarat, overall, 99 % of adolescent girls have anemia. 19 % of them were mildly anemic, 41 % of were moderately anemic and 39 % were experiencing severe anemia. No significant age difference was found in the prevalence of anemia among adolescents in Gujarat. Though there is no rural-urban difference in the prevalence of anemia, it varies substantially by its degree. While the prevalence of mild and moderate anemia was higher in urban areas, but that of severe anemia was found to high in rural areas. The prevalence of anemia does not vary much with the educational attainment of girls. The level of anemia was higher among Muslim adolescent girls (99 %). Adolescent girls from ‘other caste’ were more likely to suffer from any anemia. The adolescent girls from households with lower standard of living were slightly more likely to be anemic.

Of the 25 districts in the state, in 1 district the percentage of adolescent girls with severe or moderate anemia was in less than 50, in 7 districts their percentage is between 50 and 75, and in 17 districts their percentage was more than 75, Districts with high prevalence of anemia among adolescent girls were situated mainly in eastern and southern parts of the state. More than half (55 %) of women in Gujarat have anemia, including 30 % with mild anemia, 17 % with moderate anemia and
3% with severe anemia. 61% of women who are pregnant or women who are breast feeding are anemic. (NFHS 3- Gujarat Fact Sheet).

Verma et al. (2003) conducted a study on school going girls (n=1295) from the slum of Ahmedabad city and found that 81.8% of girls were anemic, out of which, 55.2% were mildly anemic, 0.6% were severely anemic. Anemia was found to be significantly higher among girls with the habit of post meal consumption of tea or coffee i.e. 94.4%, at p<0.01 level and whose fathers were working as semi-skilled or skilled workers i.e. 77%, at p<0.02 level. Those having a BMI of 18.5 or lower i.e. 82.4%. The prevalence of anemia was significantly lower in girls consuming green leafy vegetables, at p<0.01 level.

Table: 2.3 Anemia among adolescent girls in Gujarat.

<table>
<thead>
<tr>
<th>Background characteristics</th>
<th>% of adolescents with any anemia</th>
<th>Percentage of adolescent with Mild anemia</th>
<th>Moderate anemia</th>
<th>Severe anemia</th>
<th>Number of adolescent girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-14</td>
<td>98.5</td>
<td>19.5</td>
<td>40.9</td>
<td>38.2</td>
<td>3947</td>
</tr>
<tr>
<td>15-19</td>
<td>98.7</td>
<td>18.5</td>
<td>40.3</td>
<td>39.9</td>
<td>3883</td>
</tr>
<tr>
<td>Marital status</td>
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<td></td>
</tr>
<tr>
<td>Married</td>
<td>98.8</td>
<td>9.9</td>
<td>36.8</td>
<td>52.1</td>
<td>451</td>
</tr>
<tr>
<td>Not married</td>
<td>98.6</td>
<td>19.5</td>
<td>40.8</td>
<td>39.9</td>
<td>7369</td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>98.6</td>
<td>15.9</td>
<td>38.7</td>
<td>44.0</td>
<td>4625</td>
</tr>
<tr>
<td>Urban</td>
<td>98.7</td>
<td>23.4</td>
<td>43.4</td>
<td>31.8</td>
<td>3196</td>
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<tr>
<td>Education</td>
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<td></td>
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<td></td>
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<tr>
<td>Non- literate</td>
<td>99.1</td>
<td>13.3</td>
<td>36.7</td>
<td>49.1</td>
<td>995</td>
</tr>
<tr>
<td>0-9 years</td>
<td>98.5</td>
<td>19.2</td>
<td>40.9</td>
<td>38.4</td>
<td>5497</td>
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<tr>
<td>10 years &amp; above</td>
<td>98.4</td>
<td>22.4</td>
<td>42.1</td>
<td>33.9</td>
<td>1328</td>
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<tr>
<td>Religion</td>
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<td></td>
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<tr>
<td>Hindu</td>
<td>98.5</td>
<td>19</td>
<td>40.2</td>
<td>39.4</td>
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<td>Muslim</td>
<td>99.8</td>
<td>15.6</td>
<td>45.2</td>
<td>38.9</td>
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<tr>
<td>Christian</td>
<td>95.7</td>
<td>41.3</td>
<td>26.7</td>
<td>27.8</td>
<td>74</td>
</tr>
<tr>
<td>Jain</td>
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<td>27.8</td>
<td>47.4</td>
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<td>97</td>
</tr>
<tr>
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<tr>
<td>SC</td>
<td>98.6</td>
<td>17</td>
<td>40.3</td>
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<td>ST</td>
<td>98.7</td>
<td>15.2</td>
<td>24.2</td>
<td>59.3</td>
<td>889</td>
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<tr>
<td>OBC</td>
<td>98.2</td>
<td>16.6</td>
<td>43.6</td>
<td>38</td>
<td>3066</td>
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<tr>
<td>Other</td>
<td>98.9</td>
<td>23.5</td>
<td>42.8</td>
<td>32.6</td>
<td>2825</td>
</tr>
</tbody>
</table>
Review of Literature

<table>
<thead>
<tr>
<th>Background characteristics</th>
<th>% of adolescents with any anemia</th>
<th>Percentage of adolescent with anemia</th>
<th>Number of adolescent girls</th>
</tr>
</thead>
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<tr>
<td>Standard of living</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>99.1</td>
<td>11.8</td>
<td>2081</td>
</tr>
<tr>
<td>Medium</td>
<td>98.7</td>
<td>20.3</td>
<td>2704</td>
</tr>
<tr>
<td>High</td>
<td>98.2</td>
<td>22.7</td>
<td>3036</td>
</tr>
<tr>
<td>Total</td>
<td>98.6</td>
<td>19.0</td>
<td>7820</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mild anemia</th>
<th>Moderate anemia</th>
<th>Severe anemia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.8</td>
<td>35.3</td>
<td>52.0</td>
<td>2081</td>
</tr>
<tr>
<td>20.3</td>
<td>41.7</td>
<td>36.6</td>
<td>2704</td>
</tr>
<tr>
<td>22.7</td>
<td>43.2</td>
<td>32.3</td>
<td>3036</td>
</tr>
<tr>
<td>Total</td>
<td>19.0</td>
<td>40.6</td>
<td>7820</td>
</tr>
</tbody>
</table>

Note: Haemoglobin level between 10.0-11.9g/dl is mild anemia, 8.0-9.9 g/dl is moderate anemia and below 8.0 g/dl is severe anemia.

Acharya (2010) stated that good nutrition is a basic component of health and health is man’s natural condition. Minerals are minute amounts of metallic elements that are a vital for the healthy growth of teeth and bones. Iron is a key mineral for the synthesis of haemoglobin. The researcher had selected 20 children and 20 women for the assessment of iron deficiency. It was observed that 45% children and 35% women were found anemic. It is suggested that we should provide iron tablets and iron supplemented food and iron rich dishes to the affected respondents.

Davda et al. (2010) conducted a study on assessment of haemoglobin value in students of Home science and the study says haemoglobin is a conjugated protein synthesized inside the immature erythrocytes in the bone marrow. It consists of two components (1) Heme (Iron + protoporphyrin) gives red color to blood. The present study attempted to find the value of haemoglobin in students of Home science. 30 girls were selected Upleta city who were studying in T.Y.B.Sc. Home science. Haemoglobin was estimated by Sahil’s method. It was observed that 16% students had low, 20% students had average and 64% students had normal haemoglobin when compared to standard haemoglobin value for female.

Shah (2010) conducted a study on Tribal women, the result reported that tribal women are suffering from many health problems due to their illiteracy, ignorance, poverty, lack of health facilities and lack of health education that leads
to various diseases. Anemia is major contributor to maternal mortality in tribal areas. Most of the women were identified to have moderate to severe anemia.

(Hb less than 10% per dl) the prevalence of anemia was higher in pregnant women than that of lactating women particularly tribal area of Rajkot district of Saurashtra, Gujarat.

Shah et al. (2011) conducted a study on prevalence of anemia and nutritional status of girls of Mahila college of Mehsana city. Total 152 college girls were selected by purposive random sampling technique and pre tested questionnaire was used to collect information from girls about their personal, socio-economic and nutritional information. Body mass index (BMI) was calculated on the basis of their body weight and height. Blood haemoglobin was estimated by Cyanamethhemoglobin method. Anemia and BMI were categorized according to WHO criteria. Study shows that the prevalence of mild anemia was (34.65 %), moderate anemia (36.85%) and severe anemia (8.55%). 18.42% of girls were underweight, 20.11% were overweight and obese. Consumption of iron rich foods, fruits, protein rich foods were very less in amount as compared to their recommended dietary allowances. Prevalence of anemia was statistically significant with dietary intake. Overall study shows that prevalence of anemia was 80% and only 61% of college girls shows normal body mass index i.e., ≥18.5 – 24.9 Kg / ht. (mt²).

2.2 Etiology of anemia

Anemia in a population is caused by several factors that often exist together. The principle cause, however, is a negative balance due to inadequate dietary intake or low dietary bioavailability and iron loss. Rapid growth is always accompanied by an expansion in blood volume and thus increased iron requirements. Periods of rapid growth occur during infancy, early childhood, adolescence and pregnancy. Iron loss occurs mainly during menstruation. Iron transfer to the fetus during pregnancy and due to blood loss during child birth. It is therefore difficult for adolescent girls and women, to maintain positive iron balance during these periods.
of increased needs. Other important nutritional causes of anemia are inadequacy of 
hemopoietic nutrients mainly folic acid, vitamin C, vitamin B<sub>12</sub>, parasitic 
infections, especially hook worm and schistosomiasis also produce iron deficiency 
anemia. Malaria, chronic infections (including HIV/AIDS) and genetic factors 
thalassemias and haemoglobinopathies) may also cause anemia. However, iron 
deficiency is the main cause of anemia everywhere and in developing countries, it 
is frequently associated with other factors

(UNICEF- WHO Joint Committee on Health Policy 1995) Various factors 
causing iron deficiency anemia are summarized in Table:

Table: 2.4 Iron deficiency: Underlying and immediate causes of iron deficiency.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Underlying causes</th>
<th>Immediate causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1. Low food supply</td>
<td>Inadequate diet (inadequate intake of iron).</td>
</tr>
<tr>
<td></td>
<td>2. Erroneous feeding practices</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Low socio – economic status.</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>1. Low intake of available iron.</td>
<td>Poor absorption.</td>
</tr>
<tr>
<td></td>
<td>2. Unsuitable meal composition.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Excess of inhibitors.</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>1. Growth.</td>
<td>Increased requirements.</td>
</tr>
<tr>
<td></td>
<td>2. Pregnancy and Lactation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Chronic blood loss and parasitism.</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>1. Poor sanitation.</td>
<td>Infections.</td>
</tr>
<tr>
<td></td>
<td>2. Inadequate health services.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Venkatachalam P.S. (1968)

Trumbo (1995) examined the interactions between iron and seven other 
micronutrients and compounds, Ethylene Diamine Tetracetic Acid (EDTA), 
ascorbic acid, peptides in meat, zinc, phytates, vitamin A and copper. EDTA is a 
common food additive in developing countries that chelates iron as well as calcium 
and magnesium in the stomach and duodenum. Inclusion of EDTA in the diet does 
not affect other minerals that are known to chelates to EDTA. Phytates also reduces 
iron absorption by binding to iron. Soaking and fermenting phytates rich food such
as grains and cereals results in the release of zinc, selenium, and calcium from phytates complexes, thus by increasing intestinal iron absorption. Ascorbic acid reacts with iron in a manner similar to EDTA where the solubility of iron is increased enhancing absorption. Zinc reduces iron absorption by competing for the carrier involved in the uptake of non-heme iron. Vitamin A status affects the release of iron bound to ferritin, thus by increasing plasma iron concentrations. Both Vitamin A and copper are important for the release of iron from the liver.

2.3 Pica- Eating disorder of non nutritional substances

Pica is characterized by an appetite for substances that are largely non-nutritive, such as paper, clay, metal, chalk, soil, glass, or sand. There are different variations of pica, as it can be from a cultural tradition, acquired taste, or a neurological mechanism such as an iron deficiency or a chemical imbalance. It can lead to intoxication in children, which can result in impairment in both physical and mental development. In addition, it can also lead to surgical emergencies due to an intestinal obstruction as well as more subtle symptoms such as nutritional deficiencies and parasitosis. Pica has been linked to mental disorders and they often have psychotic co-morbidity. Stressors such as maternal deprivations, family issues, parental neglect, pregnancy, poverty, and a disorganized family structure are strongly linked to pica. Pica is more commonly seen in women and children, and in areas of low socio economic status. Particularly it is seen in pregnant women, small children, and those with developmental disabilities such as autism. Children eating painted plaster containing lead may suffer brain damage from lead poisoning. There is a similar risk from eating soil near roads that existed before tetra ethyl lead in petrol was phased out (in some countries) or before people stopped using contaminated oil (containing toxic PCBs or dioxin) to settle dust. In addition to poisoning, there is also a much greater risk of gastrointestinal obstruction or tearing in the stomach. Another risk of eating soil is the ingestion of animal feces and accompanying parasites.
Epidemiology: The prevalence of pica is difficult to establish because of differences in definition and the reluctance of patients to admit to abnormal cravings and ingestion. Thus leading to the prevalence recordings of pica being in the range of 8% and 65% depending on the study. A study published in 1994 found that 8.1% of pregnant African–American women in the United States self-reported pagophagia, the ingestion of large quantities of ice and freezer frost. A study conducted in 1991 found a prevalence of pica in 8.8% of pregnant women in Saudi Arabia. Rates of pica among pregnant women in developing countries, however, can be much higher, with estimates of 63.7% and 74.0% reported for two different African populations. This is due to different cultural norms as well as greater levels of malnutrition. Two studies of intellectual disability in adults living in institution found that 21.8% and 25.8% of these groups suffered from pica. Prevalence rates for children with and without developmental disabilities are unknown.

History: The term pica originates in the Latin word for magpie, a bird that is famed for its unusual eating behaviors, where it is known to eat almost anything. In 13 century Latin word, pica was referenced by the Greeks and Romans; however, it was not addressed in medical texts until 1563. The Southern United States in the 1800s, geophagia was a common practice among the slave population. Geophagia is a form of pica in which the person consumes earthly substances such as clay, and is particularly prevalent to augment a mineral-deficient diet. Search on eating disorder from 16th century to the 20th century suggests that during that time in history, pica was regarded more as a symptom of other disorders rather than its own specific disorder. Even today, what could be classified as pica behavior is a normative practice in some cultures as part of their beliefs, healing methods, or religious ceremonies (Wikipedia).

2.4 Nutritional Status

Vasanthi et al. (1993) assessed iron nutritional status of adolescent girls from rural area and urban slum by measuring serum ferritin levels. Overall, anemia was
observed in 25% of girls irrespective of their urban or rural residence. A higher prevalence of rural girls (37.5%) especially below the age of 12 years showed evidence of anemia. The prevalence was similar in both urban and rural girls who attained menarche. With increasing age, urban girls who had attained menarche showed an increase in the prevalence of anemia. Overall, iron deficiency was of much higher order in the rural girls irrespective of the menarcheal status.

Suba et al. (1997) conducted a study on the nutritional status of selected adolescent girls of Coimbatore slums of 16-18 years of age. A total number of 1000 adolescents were selected from ten slums of Coimbatore city. Socioeconomic background and dietary habits of the subjects were collected by administering a questionnaire. Anthropometric measurements such as height, weight, clinical examination and haemoglobin estimation were done for all the selected subjects. A three-day food consumption survey was carried out on a subsample of 50 subjects. The major findings of the study were, among the 1000 girls, 9.2% of them were married, the mean age of menarche was 13.62 ± 1.43. Anthropometric measurements revealed that the percentage deficit of weight was from 18.5 ± 2.3 up to 20.2 ± 2.1%. The percentage height deficit of height from that of standard value was found to be 4.9 ± 1.3, 4.0 ± 1.2 and 3.2 ± 2.3 for 16, 17 and 18 years respectively. Clinical examination revealed that higher prevalence of anemia had spongy bleeding gums. The mean haemoglobin levels of adolescents in age 16–18 years were found to be 10 ± 2.3 which was less than WHO standards. The food consumption survey showed inadequate intake in amounts of all the nutrients. Thus, it may be concluded that the low socio-economic environment and poor sanitation in slum areas are the main causative factors for the poor anthropometric and biochemical indicators of nutritional status.

Chaudhary et al. (2003) conducted a study on nutritional status of adolescent girls in rural area of Varanasi. The cross-sectional community-based study covering 270 adolescent girls were enrolled for the study in Chicagoan block selected by simple random sampling. Data was collected through interviews and examination schedules anthropometric measurements of weight, height and mid arm circumference (MAC) recording and hemoglobin estimation. Data were
analyzed with the help of the SPSS package. Nutritional status of study subjects was assessed by using various parameters viz. weight for age, height for age, weight for height, MAC for age and BMI at different age points were compared with the corresponding reference values.

Average haemoglobin of adolescent girls was 12.44 ± 1.29 g/dl. As many as 30.74 % study subjects were anemic (Hb < 12 g/dl). It was found that average haemoglobin of menstruating girls (12.65 ± 1.3 g/dl). Mean haemoglobin of adolescent girls using footwear, during defecation (12.6 ± 1.5 g/dl ) was significantly (p< 0.001) higher than of subjects without footwear (0.2 ± 1.4 g/dl ). Extent of anemia (Hb < 12 g/dl) in this group (20 %) was significantly less (p<0.000) in subjects not using footwear (43.30 %).A considerable proportion of adolescent girls had critical nutritional deficiency diseases. Two-third of study subjects were undernourished (BMI < 18.5 kg/m²) nearly one-third experiencing chronic energy deficiency grade-III (BMI < 16 kg/m²). However, with varying parameters, the extent of under nutrition in adolescent girls also varied. Nearly one-third girls were anemic (Hb < 12 g/dl); anemia was significantly more in non-menstruating girls and subjects not using footwear during defecation. Thus, there is a need to promote sound eating and personal hygiene-related habits in rural adolescent girls, besides improving intra-family food distribution and economic empowerment of rural households.

Deshmukh et al. (2006) conducted a study on nutritional status of adolescents in rural Wardha. (Maharashtra). The cross sectional study was carried out in two public health centre area of Wardha district with two stage sampling method. In the first stage, cluster sampling method was used to identify 30 clusters in each Rural Health Training Centre (RHTC) area separately. All adolescents in the household thus selected were included in the study. The mean body mass index (BMI) for age was used for classifying the nutritional status with CDC 2000 reference. Out of 764 adolescents 420 (54.9%) were boys and 344 (45.1%) were girls. Majority (53.8%) of the adolescents were underweight, only 2.2 % were overweight. The mean BMI was significantly higher among boys (16.38 ± 3.09) as
The prevalence of thinness was significantly higher in early adolescence (57.0%) than in late adolescence (48.5%). Moreover, the prevalence of thinness was significantly more (169.7%) in girls than boys (40.7%). The significant higher prevalence of thinness was observed among adolescents from lower family income group (63.2%) than the higher (38.1%) family income group. The prevalence of thinness was significantly (p< 0.05) higher (60.3%) in those having education less than 8th standard than those educated at least up to the 8th standard (49.6%). The anthropometric assessment at the community level is to provide an estimate of prevalence and severity of malnutrition. The prevalence of thinness (<5th percentile of BMI for age) was observed to be 53.8%, chronic energy deficiency (BMI < 18.5) 75.3% and wasting (< -2 Z-value of weight for height) was observed to be only 20.8%.

WHO report (2011) reveals that anemia prevalence in adolescent girls is very high ranging from 50% to > 90%. In 2006, the overall prevalence of anemia has been reported to be extremely high at 90.1% in adolescent girls of 11-18 years of age, from 16 districts in 4 regions of India. The study also confirms that 85% of pregnant women were anemic. The earlier study from Western India reports that in the low income group 80-90% had haemoglobin less than 12%. In a study of adolescent girls (10-19 years) in urban slums of Southern India, Andhra Pradesh, anemia prevalence is reported to be 67.9% where moderate anemia 37.05%, mild anemia 21.42% and 9.4 severe anemia was seen, while another study from Ranga Reddy district of Andhra Pradesh reported anemia prevalence in girls 13-15 years to be 83%. Where as under nutrition is reported (stunting) in one – third of adolescent population, prevalence of anemia is almost universal. A similar high prevalence of anemia in rural Rajasthan between 73.3% and 85.4% had been reported. About 62% of urban adolescent girls from the lower socio economic group are estimated to be anemic. Anemia in adolescent girls is now recognized to be a public health problem along with anemia in other population groups such as young children and pregnant women.
2.4 Intervention strategies for eliminating IDA

The growth spurt during early adolescence and early adulthood mounts pressure on the overall nutritional requirements of girls and micronutrients too are, therefore, required in higher proportion. The increase in height and the related skeletal growth and increase in blood volume and menarche raise the requirements for dietary calcium and iron among adolescent girls. The major micronutrients of concern in adolescent growth and development are iron, calcium and iodine. Anemia has been reported to be a major micronutrient deficiency among adolescent girls across the country through several studies. The prevalence of anemia was reported to be above 80% in various states of India. Weekly supplementation of iron was found to be as effective as daily supplement of iron. Non-anemic girls had higher scores in cognitive skills tests than the anemic girls. Data has shown an inverse relationship between anemia and the socio-economic status of the family. Anemia among adolescent girls was found to have an association with the literacy status of the mother, occupation of the father and structure of the family (joint or nuclear) and these factors need to be confirmed through multi-factorial studies in different parts of the country in order to develop appropriate intervention strategies. One such intervention through school system for rural adolescent girls was successful in generating awareness about symptoms, prevention and control of anemia. Studies have shown a positive impact of iron supplement, leaf concentrate administration and cooking in cast iron utensils on the iron status of adolescent girls. Following are the major key ways to eliminate iron deficiency anemia among girls.

2.4.1 Supplementation.
2.4.2 Fortification
2.4.3 Dietary diversification
2.4.4 Nutrition education
2.4.5 Bio availability of iron
2.4.6 Effect of Garden cress seeds supplementation
2.4.1 Supplementation

Supplementation is a form of direct intervention to solve the problem of iron deficiency anemia. It is the distribution of hematinics (iron and folate) in tablet or other suitable form. There are two types of supplementation with tablets viz.

(1) Therapeutic supplementation where prevalence of anemia is high and must be cured in a short time and (2) Prophylactic supplementation where prevalence of anemia is low requiring smaller doses of iron for its prevention (WHO 1972, INACG, 1977, Baker and DeMayer, 1979). In many developing countries iron supplementation through tablets to a large group is difficult because of a poorly organized health delivery system, under such circumstances fortification may be a more acceptable program to improve iron intake by population. To set up an iron fortification program, a suitable vehicle to carry iron must be identified and the source and amount be added should be determined.

Baxi M. (1991) assessed the awareness regarding anemia on haemoglobin level and growth in girls and found no significant impact of intervention was seen on weight and height of the experimental subjects. However, the percentage prevalence of anemia decreased significantly after the intervention. Prevalence of severe anemia (Hb < 8g/dl) decreased from 16 % to 3 % and subjects having (Hb <11 g/dl ) from 13 % to 3 % . The impact was more marked in the older girls (16 – 18 years) in whom the prevalence of severe anemia decreased from 29 % to 4 %. The mean haemoglobin level and the mean change in haemoglobin level increased with increased consumption of iron tablets compared to baseline (2 %). 59 % of subjects were aware about anemia after intervention. Awareness of the symptoms of anemia and importance of diet for the prevention of anemia were observed.

Budhwaker S. (1996) assessed the prevalence of anemia in upper income group women of ages 19 -25 years. The results indicate that a significant rise of 2.2 g/dl was noticed in the haemoglobin level of fruit supplemented group at the
end of month period, while the control group showed no significant increase in haemoglobin of 0.3 g /dl. There was however, no significant change in the iron store of the fruit supplemented group as indicated by the serum ferritin levels which remained the same at baseline and final data. From this, it was postulated that on correction of anemia, haemoglobin levels received a priority and thus all the iron replenish haemoglobin levels. percentage iron absorption was calculated using rise in the haemoglobin levels and total iron intake during the supplementation period.

Beaton and McCabe (1999) analyzed the efficacy of intermittent iron supplementation in the control of iron deficiency anemia in developing countries. It is based on the analysis of results of 22 completed trials of iron supplementation. Out of 22, 14 trials including 5100 individuals contain completed data sets. The results in individual projects are grouped into three categories: pregnant women, school children and adolescents and preschool children. Overall, it was found that both daily and weekly iron supplements are efficacious. However, weekly iron supplementation is likely to be less effective than daily administration except in situation where supervision is feasible with weekly regimens and not with daily supplementation. Moreover, weekly supplementation was found to be disadvantageous during pregnancy and in situation where the base line prevalence of anemia is very high.

IIHFW (2000) conducted a study, on prevention and control of anemia in rural adolescent girls through school system, Andhra Pradesh. The study was undertaken with the objectives of assessing the feasibility and acceptability of supervised weekly supplementation of iron folic acid to school going adolescent girls (10-15 years) to prevent and control anemia, improving the knowledge attitude and understanding of adolescent girls regarding ill effects of anemia and usefulness of weekly iron folic acid supplement through appropriate informational and educational counseling interventions, assessing the impact of the program in reducing the prevalence of anemia using haemoglobin as an indicator. All (n=1811) adolescent girls between 10 to 15 years of age, studying in 6th to 10th standards in 16 high schools located in two randomly selected mandals, viz.
Hathunura and Kondapur of Medak district were enlisted. A combination of anthropometry, biochemical assessment and interviews were used for assessing the nutritional anemia status and awareness about anemia among subjects. Data pertaining to knowledge, attitude and practices, nutritional status (height and weight) and blood samples for estimation of blood haemoglobin levels were collected. The mean age of students was 12.4 ± 1.44 years. Signs and symptoms of anemia like pallor (eyes, tongue and nails), fatigue, breathlessness, poor appetite and lack of concentration in studies were reported by 12.5 %, 14 %, 9.2 %, 26.5 % and 86 % of girls respectively, respondents who were aware of anemia (7.4 %) and the national program to control it (4.6 %). Consumption of iron rich foods like ragi, greens, meat and vitamin C rich foods like, sprouted grams on the previous day was reported by 36.3 %, 20.1 % and 7.3 % of subjects respectively. Iron deficiency was found in 81 % of respondents, mild, moderate and severe grades of anemia were observed in 63.2 %, 12.5 % and 5.3 % of respondents respectively. Though the pattern of growth of the girls were similar to that kind of NCHS standards, the heights and weights of study subjects at any given point of age were far below the NCHS standards and the deficit increased with age .Side effects like abdominal pain, nausea, vomiting, diarrhea were reported in 5.15 % of girls at the beginning of project and remained 3 % at midterm survey evaluation. In majority of cases, such effects were reported when supplementation was taken on empty stomach or during mild sickness without sufficient intake of water. About 62 % of subjects did not skip even a single iron folic acid tablet, indicating good compliance. Mean blood haemoglobin level at the baseline survey was 10.6 ± 1.1 g/dl which increased to 11.6 ± 1.0 g/dl during midterm survey. Haemoglobin level improved in 45.6 % while it remained static in 49.4 % and declined in only 5 % of subjects. Thus, it was evident from the results of midterm survey that iron folic acid supplementation to school going girls, under teacher’s supervision, for proceeding six months together with informational and educational counseling, intervention resulted in a significant increase in haemoglobin levels, indicating the feasibility of this approach.

Agarwal et al. (2003) conducted a study on anemia prophylaxis in adolescent school girls by weekly, bi-weekly or daily iron folate supplementation.
The study was planned to examine the benefits of anemia prophylaxis in adolescent school girls by weekly or daily iron folate supplementation. The study was carried out in four government senior secondary schools of North-East Delhi which cater to the middle socio-economic group, the total number of girls in the age group (10-17 years) was 2,210 of which 2,088 subjects (with haemoglobin > 7.9 g/dl) were taken, the study groups were control (Group-I), daily administered (Group-II) and weekly administered (Group-III) groups. The haemoglobin was estimated, initially, at 115 days and at 230 ± 5 days in all the three study groups. Plasma ferritin and C-reactive protein (CRP) were estimated in every tenth girl of the study groups. Sexual maturity rating was done using Tanner’s criteria and the time of menarche and regularity of menstrual periods was noted. Statistical analysis was done using ANOVA, MANOVA (Multi Analysis of Variance), Z -test and chi-square test.

Initially 0.3%, 0.6%, and 0.5 % girls had hemoglobin level of 7-8 g/dl in group I, II, III respectively. After 115 days of intervention, the corresponding values were 0.9%, 0.4 % and 0.3 % respectively. When no supplementation was given (control group), the prevalence of anemia increased by 3.2 % at 115 days, whereas in groups II and III, it declined significantly by 12.5 % and 7.7 %, respectively. The difference between groups II and III was significant (<p < 0.001). Control group showed insignificant decline in the average haemoglobin level at 115 days but mean haemoglobin at 230 days was significantly higher than the value at 115 days (p<0.05). Group – II showed the maximum rise (0.5 g/dl) at 115 days (p<0.01). While weekly administered (Group III) did not showed significant change, similar to the daily group at 230 days (p<0.05). Girls with haemoglobin ≥ 12 g/dl were also benefited by daily supplementation as 35 % of them showed rise in haemoglobin, compared to 26.1% in the weekly supplemented group at 115 days (Z=2.62; p>0.05). MANOVA showed a significant increase in haemoglobin level at 115 days by 0.9 g/dl and 0.4 g/dl in daily and weekly intervention groups, respectively. However, the controls showed fall in haemoglobin by 0.1 g/dl. At 230 days, the weekly group showed haemoglobin
Plasma ferritin levels significantly increased in girls from all groups at 230 days, as compared to their initial values. The rise in haemoglobin was not related to ferritin levels. Of the 1,187 girls who had attained menarche, 48.4% had baseline haemoglobin <12.0 g/dl. In 850 pre-menarche girls, the prevalence was 46.6%. Further, the prevalence of anemia was 47.8%, 46.8%, 45.3%, 52.2% and 42.8% in breast development stages 1 to 5, respectively.

Shobha et al. (2003) conducted a study on efficacy of twice weekly iron supplementation in anemic adolescent girls. The study examined the comparative effectiveness of a twice a week supplementation program to a daily supplementation program in enhancing the haemoglobin levels of adolescent girls with different grades of anemia and in reducing its side effects. A sample of 244 girls aged 13-15 years from Andhra Pradesh social welfare Residential School for girls in Ranga Reddy District was studied. The haemoglobin was estimated to classify girls as normal, mildly, moderately or severely anemic, as per WHO standards and were further randomly divided into sub groups to follow a daily or a twice weekly supplementation regimen for the period of 84 days. The subjects were dewormed with a single dose of 400 mg albendazole and haemoglobin was estimated at the beginning and at the end of the 3rd, 6th, 9th and 12th weeks. Group means and standard deviations were calculated and student ‘t’ test and paired ‘t’ test were carried out to test the significance of difference between different groups, as well as within the groups at different periods of supplementation. 83% adolescent girls were anemic. The haemoglobin level increased steadily in all supplemented subjects as the period of supplementation increased. By the end of 21 days of supplementation, all categories of both group showed significant improvement in the base line haemoglobin level. In the mildly anemic girls, the daily groups had significantly higher haemoglobin level than the weekly group. The same trend was observed by the 41st day of supplementation. By the 63rd day the subjects reached normal levels of haemoglobin, while weekly supplemented adolescent girls had near normal haemoglobin levels. At the end of the study period (84 days), all mildly and moderately anemic subjects given either daily or weekly
twice supplementation became normal (12g/dl). Moreover, majority of the severely anemic subjects also reached near normal levels. Severely anemic subjects showed maximum overall increment (58.78 % in daily and 52.64 % in weekly groups), followed by moderately (33.44% in daily and 29.69 % in weekly groups) and mildly anemic subjects (23.22 % in daily and 18.95 % in weekly groups). Thus, it was observed that lower the initial haemoglobin level, the greater the increase on supplementation while 57.84 % of the daily supplemented subjects suffered unpleasant side effects. This could probably be due to the avoidance of iron overload in the stomach of the subjects due to intermittent supplementation. Thus, the study concluded that supervised administration of weekly twice supplementation of iron to anemic subjects was found to as advantageous as daily supplementation, as far as raising the haemoglobin levels were concerned. Even the severely anemic adolescent girls had near normal haemoglobin status after the 84 day supplementation program. It has an edge over the traditional supplementation method with regard to occurrence of unpleasant side effects like nausea and epigastric pain, which could perhaps lead to better compliance among subjects to iron supplementation.

Kotecha et al. (2002) conducted a study on adolescent girls anemia reduction programs – impact evaluation (mid-term) of Vadodara district. The objectives of the survey were to measure the anemia prevalence and haemoglobin level of the school girls and measure the change due to intervention, to study the utilization of informational and educational counseling material and to study the consumption of iron rich and Vitamin C rich foods, and to evaluate the supplementation compliance of the school girls and out of school girls using existing school based records and self-reporting by the girls.

A stratified random sample (baseline survey) of 2,860 adolescent girls aged 12-19 years from schools a Vadodara district were selected. The sample consisted of rural, urban and tribal girls. Intervention trial was adopted as the same population was studied during the mid-term of anemia reduction program. Both biochemical tests and verbal enquiry were employed to collect the data.
Haemoglobin estimation was done by ABACUS cell counter and serum ferritin was assessed using immolate. Mean, median and percentages were calculated. Anemia prevalence (Hb<120 g/dl) was recorded at 53.2 %, as compared to baseline anemia prevalence of 74.7 %. There was a reduction of 20.5 % in anemia prevalence after the initiation of the programs. The reduction achieved was maximum in rural areas followed by urban areas, with both showing a net reduction of anemia 23 %, while the tribal areas showed a reduction of anemia by about 16 %. Mean rise of haemoglobin was seen to the extent of 6.4 g/dl, with regional differences and maximum rise was seen in rural areas followed by urban areas and relatively, the least rise was seen in tribal area. Severe anemia prevalence was reduced from 1.6 % at baseline to 0.5 % suggesting a reduction of 68 % in severe anemia from the baseline value. Similar reduction value for moderate and mild anemia was 51 % and 22 %, respectively.

A total of 804 samples were studied for serum ferritin and a proportion of girls having serum ferritin less than 12 mg/ml, indicative of poor iron storage, declined from 49.7% to 39.7 % and was consistent in all the areas. The mean value of ferritin increased by 5mg/ml across all areas. Overall, the proportion of girls below 12mg/ml serum ferritin level decreased, along with an improvement in the medians after intervention. The frequency of consumption of iron rich food was not very high except jaggery, which was consumed daily by one fourth of the girls as compared to other iron-rich foods. Frequency of consumption of Vitamin C rich foods was better than that of iron rich foods. Overall, 32.7 % of the girls consumed vitamin C rich fruits along with snacks or food. The evaluation revealed that the coverage of school girls to the extent of 90 % has already been achieved under the programs. The intervention was more successful among adolescent girls in rural areas than in tribal areas though even in the tribal areas the reduction in prevalence of anemia was substantial. Thus, there is a need for modification of intervention strategy and methodology for tribal areas, as per the local socio-cultural context. Even though consumption of Vitamin C rich foods improved among adolescent girls, yet greater effort would be required to promote consumption of iron rich foods for long term gains in iron status of the girls.
Mathur et al. (2005) conducted a study on a comparative study of impact of leaf concentrate and iron and folic acid supplementation on blood profile of anemic adolescent girls. Despite impressive gains in the field of health and nutrition, significant proportion of your people in developing countries suffers from nutritional anemia. The effect of earlier nutritional status is visible in the adolescent age particularly in girls. Adolescence is a time of major physical, cognitive and psychological growth and development. Due to various reasons like irregular supply chain, poor compliance, the National Anemia prophylaxis programs has not made an appreciable stand in prevention of anemia. Hence it prompts us to look at other alternative use of leaf concentrate (LC), which is a good source of micronutrients, is one such alternative.

The overall objective of the present study was to compare the effects of leaf concentrate and iron and folic acid tablet supplementation on blood profile of adolescent girls. The present study was conducted on adolescent girls aged 14 to 18 years residing in Shastri Nagar, Kacchi Basti, an urban slum area in Jaipur city. A total of 120 unmarried anemic girls willing for the intervention trial were divided into two experimental groups, I (IFA supplementation) and II (LC supplementation). One IFA tablet (60 mg iron and 500 mg folic acid) was given to group I every day and 10 gm of leaf concentrate powder (8 mg iron and 0.03 mg folic acid) was used as herbal medicine for the second experimental group for 135 days. After excluding dropouts, the results of 90 subjects (40 subjects in IFA group and 50 subjects in LC group) were tabulated and compared. A statistically significant improvement had taken place in hemoglobin levels, as well as other blood parameters i.e., TRBC, PCV, MCV, MCH, MCHC, serum iron, serum ferritin of the subjects in both the groups.

There was about 15 % increase in haemoglobin level of subjects in both the groups. This data was even tested for larger sample size and it indicated that if LC was used as a supplement for larger population size then the result will prove to be more promising as compared to IFA. The iron content of an IFA tablet is 60 mg, although 10gm of LC powder supplied only 8 mg of elemental iron which is not at
all comparable. In spite of this fact, the results of both the groups were comparable, with no statistically significant difference between the two groups. This can be attributed to perhaps better absorption of LC. Microscopic examination of the slides at initial, as well as final stage was also studied. Initially, the slides showed anisocytosis, poikilocytosis, severe hypochromic macrocytes, ovalocytes and macrocyte cells, these showed a shift towards normocytic, normochromic and few macrocytes and mild hypochromic cells in both the groups after supplementation. The results of the study are promising for LC, which gave similar and comparable results on the iron status of the subjects, both the supplements showed similar improvements, in spite of the small doze of LC given to the subjects, the other factors like presence of other micronutrients, e.g., copper and zinc must have helped in bringing significant change in haemoglobin levels, as well as other blood parameters of the subjects.

The LC powder has grassy flavor and subjects initially have problems in consuming 10gm of powder at a time. Due to close monitoring and rapport with the subjects, during the present trial, they were advised to consume this 10gm LC powder by taking a spoonful; 2-3 times in a day. It is not that 10 gm dose of LC powder is very problematic to consume; it can be taken orally with glass of water or lemon juice or buttermilk or mixed with chapatti dough, yoghurt or lentils. Perhaps a lower dose of 5 gm LC powder can be introduced on long-terms basis into the existing supplementary feeding programs and Mid Day Meal (MDM) programs so that the vulnerable groups of people can get some additional amounts of micronutrient in their diets besides their usual intake.

Deewan A. (2007) conducted a study on impact of iron, folic acid and vitamin C supplementation on the prevalence of iron deficiency anemia in non-pregnant woman of Shimla. The study was conducted on randomly selected 180 non-pregnant females of the age group of 15-65 years. They were interviewed using a pretested performa. Physical examination, haemoglobin estimation and standard blood smear analysis were also done. The experimental group was divided into two sub-groups 1 and 0. Sub-group 1 was supplemented with iron, folic acid
and vitamin C. No supplements were given to the control group. The haemoglobin measurements were done at the start of the study, at 30 days, 150 days after supplementation. There was considerable improvement in the haemoglobin status of the anemic females on supplementation with iron and folate alone but more with vitamin C. Emphasis should be made on the need to improve the diet through increased intake of fruits and vegetables rich in vitamin C. Method of cooking, fermentation and germination can the increase the availability of free iron.

Sehjpal and Gupta (2007) conducted a study on the impact of lotus stem supplementation on the haemoglobin status of the college students (17-19 years). This study was done on 62 students and their dietary data was gathered (24 hour dietary recall). Initially, indicating that a large majority of the girls have diets deficient in energy, protein and iron but sufficient in vitamin C. During supplementation phase (8 weeks), the food supplements i.e. providing lotus stem biscuits to the experimental group and plain biscuits to the control group. Height, weight and haemoglobin levels were assessed both in the pre supplementation and post supplementation phase. Data indicate a significant impact of supplementation on various parameters. Especially Haemoglobin levels of the experimental group which increased from 11.20 g/dl ± 0.95 to 13.13 g/dl ± 1.25 and also seen for the control group which could be attributable to plain biscuits given to them, but the increase in the case of experimental group was many fold without the impact on height. Thus, food supplementation can be looked upon as effective long term measure to control and prevent iron deficiency anemia.

Bansal et al. (2007) conducted a study on nutritional status and the effect of leaf concentrate supplementation on iron status of women (25 –45 years) residing in Jaipur city. The present study was designed with the objective to assess the nutritional status and the effect of Lucerne Leaf Concentrate (LLC) supplementation on iron status of women (25 – 45 years) with three and more than three pregnancies and residing in slums of Jaipur city. At pre intervention, the nutritional status of 44 women was assessed through anthropometric measurements, dietary intake data, complete blood count and serum iron. The diets of thirteen
anemic women (25 – 45 years) were supplemented with 15 g LLC on alternate days over a period of 12 weeks. At post intervention, the iron status was assessed through determination of complete blood count and serum iron. On the bases of body mass index, 45.5 % of the women (n = 44) suffered from chronic energy deficiency. The mean intake of all the nutrients was lower than the RDAs. The mean iron intake of the women was 43 -53 % of the RDAs. As a consequence of LC supplementation, it was observed that women (n = 13) had a significant weight gain of 1.55 kg. Haemoglobin levels improved significantly by 10.5 % (10.5 to 11.82 g/dl) from pre to post intervention. Results highlighted increases in haematocrit and total iron binding capacity levels as well. A highly significant increase in serum iron levels was also observed on intervention. Therefore, it was concluded that LLC supplementation led to an improvement in the nutritional and iron status of women.

Aggarwal et al. (2007) conducted a study on effect of frequency and dosage of iron folic acid supplementation on blood haemoglobin status of anemic adolescent girls in Delhi. The subjects were drawn from an NDMC school in Green Park. Blood haemoglobin was tested for all the girls (140) in age group (13 to15 years) and those with haemoglobin less than 12g/dl i.e. anemic (N =89) were divided by random sampling into two groups. Group I received the supplement thrice a week while group II received it once every week for twelve weeks. Haemoglobin levels were assessed by the cyanmethaemoglobin method before and after supplementation. Data indicated a significant impact of iron folic acid supplementation on the blood haemoglobin levels in both the groups. However, the mean increase in haemoglobin levels was not significantly different (1.42g/dl in Group I and 1.33g/dl in Group II). A significant improvement in haemoglobin levels was achieved even with a lower frequency dosage of once a week. Further, weekly administration of the supplement caused lesser intestinal discomfort as compared to thrice a week supplementation. Thus, a lower frequency must be considered for benefits of lesser cost and side effects as well as easier monitoring since its effect in improving haemoglobin status is not significantly different from that of a higher dosage.
Vyas et al. (2007) conducted a study on impact of leaf concentration and iron folic acid supplementation on blood profile of anemic adolescent girls. The study aims at determining the incidence of nutritional anemia among adolescent girls and the effect of giving therapeutic dose of LC and IFA tablets on the blood haemoglobin and complete iron status of adolescent girls. Adolescent girls between 14-18 years from Jaipur city were selected. For screening Haemoglobin assessment was done by cyanmethamoglobin method. Anemic adolescent girls were then selected and divided into two experimental groups: Group I (IFA supplementation), Group II (LC supplementation). Initial blood profile was performed which included tests for all the blood parameters and indices. Intervention period was 135 days. Subjects were dewormed prior to intervention by Albendazole tablets (Zental tablets containing 400 mg Albendazole). Group I was supplemented with one big tablet of iron and folic acid (50mg elemental iron and 500 microgram of folic acid).Group II was supplemented with 10g of LC powder (8 mg iron and 0.03mg of folic acid). The prevalence of anemia among the population studied was about 66.25 %. The results even highlighted that there was significant improvement in all the blood parameters (i.e. TRBC, PCV, MCV, MCH, MCHC, serum iron and serum ferritin). There was 15 % increment in haemoglobin levels of the subjects. This data was even tested for larger population size and it indicated that if LC was used as a supplement for larger population then the results will prove to be more promising as compared to IFA tablets. The results of the study are promising for LC. In spite of the small dose of LC giving to the subjects, the other factor like presence of micro nutrients like copper and zinc must have helped in bringing significant change as they play a specific role in haemoglobin regeneration. Although LC powder has grassy flavors but it could be taken orally with glass of water or lemon juice or buttermilk or mixed with chapattis dough and also can be consumed like herbal medicine.

Kotecha et al. (2009) conducted a study in June 2000. Adolescent anemia control program was initiated as a pilot program in Vadodara district of Gujarat covering over 69,000 girls in over 426 schools. Strategy was to provide once weekly fixed day (Wednesday) supervised iron folic acid (IFA) supplements to all
adolescent girls of grade 8-12. Currently, program covers 10 lakh school girls and 2.6 lakh out of school girls with a compliance rate of over 90% as reported by education department. This study was undertaken to institutionalize once a week IFA supplementation in the schools for adolescent girls with built in compliance monitoring in one district and scale up the program from its learning to all the districts as feasible.

Baseline survey for three areas of Vadodara district, tribal, rural and urban from 10 schools each was conducted to collect data for anemia prevalence. Education inspectors were assigned responsibility to supervise and motivate teachers to try out innovative ideas to promote the programs. Simultaneously anganwadi workers of urban Vadodara were motivated to initiate IFA supplementation for out of school girls on similar strategy. After approximately 17 months of intervention, impact study was conducted in the same 30 schools in November 2001 to obtain levels of anemia and some of the paired data from the students who were part of the baseline study also included knowledge and practices of the adolescent girls with reference to their dietary habits and package of intention included nutrition education through schools by providing information and education material prepared by the government.

Baseline study had shown around 75% anemia prevalence, which was similar in all the three areas. Level of serum ferritin was also low. Impact evaluation showed reduction in anemia prevalence by 21.5% that is, from 74.7% to 53.2%. (p<0.05) further improvement in Hb was recorded among 80% girls. Pre and post intervention also showed improvement in serum ferritin value.

Bhanushali et al. (2011) conducted an intervention study among 104 unmarried adolescent girls with an objective to study the effect of change in dietary behaviors and iron supplementation for reduction of iron deficiency anemia. The relevant information was collected with anthropometric measurements and haemoglobin estimation, socio-economic status was collected using pre-tested questionnaires. The girls were administered iron folate and calcium tablets on alternate days for three months. Results showed there was increment 19.55%
Review of Literature

Haemoglobin in the group of girls receiving IFA supplements where as haemoglobin decreased slightly in girls of the control group. A significant weight gain of 2.66 kg was seen in the intervention group, here as girls in the control group showed little weight gain. In conclusion, considering the bio feasibility and effectiveness of the intervention, adolescent girls of the control group for prevention of anemia and IFA supplementation in this population.

2.4.2 Fortification of foods

A number of vehicles have been proposed for iron fortification on a large scale, cereals, sugar or condiments like fish sauce (World Health Organization, 1972, INACG, 1977). Several iron sources have been employed in fortification.

Cereals and salt:

Several countries (e.g. Sweden, UK and USA) have programs in operation for the fortification of wheat flour with ferrous sulfate, reduced iron or carbonyl iron (Council on Foods and Nutrition, 1941 and INACG, 1977). In, India where the stable food varies with each ethnic group, salt has been used as a vehicle for iron fortification as it is universally consumed and centrally processed (Narsinga Rao and Vijaya Sarathy, 1975). Although fortification of salt with iron at level of 5mg/g has been shown to produce a significant rise in haemoglobin levels of school children (Food and Nutrition Board and UNICEF, 1981) the amount that can be derived from fortified salt (about 10-15 mg/day based on average salt consumption of 10-15 mg) is adequate for the increased demands during pregnancy. Therefore, it can only be used as complementary measures for combating the problem of iron deficiency anemia in pregnant women. In Thailand fortification of fish sauce has shown great promise in improving the iron status of the general population (Garby and Areekul, 1974).

years in whom haemoglobin was measured. The prevalence of anemia was 35.5% in fertile aged women and 39.1% in pregnant women.

Table salt can be fortified with iodine and iron without interaction and without loss of potency (Boulet, 1997). According to Levente Diosady, professor of food engineering at the university of Toronto, the amounts of the micronutrients available to the human body have been significantly reduced when the two interacted. In the new technology, the iodine is covered with a dextrin (a water soluble starch) capsule that serves as a physical barrier to the iron. The efficiency of absorption of the two micronutrients in the new double fortified salt in the human body is being tested at the hospital for sick children in Toronto. Iron deficiency, the most common nutritional in the world (particularly among women, infants and children) is associated with anemia, fatigue, learning problems, pregnancy complications, premature births and maternal mortality.

Miller and Saade (1997) report that staple foods can be fortified with micronutrients in a cost – effective way. The consequences of deficiencies include low birth weight due to lack of iron, iodine and vitamin A with mental retardation, night blindness, lower intelligence quotient, low school program less energy and strength, and decreased productivity. Correction of micronutrient deficiencies can result in greater child survival and reduce maternal deaths. Saade (1997) campaigned for fortification of corn flour with micronutrients.

Draper (1998) quotes that in developing countries, street foods are widely consumed by millions of people. These foods provide an affordable source of nutrients to various sectors of population, including the urban poor. Street foods include commercially produced snacks that are retailed by street food vendors as well as food items made by vendors. As micronutrient deficiencies are major public health concerns in these countries, fortification should be considered to prevent and control micronutrient malnutrition. Fortification with micronutrients could improve the nutrient profile of these foods and serve as a means of introducing micronutrients rich foods to consumers. Street foods present two fortification opportunities: 1) ingredient based fortification of universal ingredients like flour or
sugar, 2) food based fortification of specific processed foods or drinks, particularly with vitamin A and C as well as with iron and iodine. A fortification program will be most successful if it concentrates on foods that are sold through a target group and delivers the appropriate micronutrient for that population.

Ricardo et al. (2002) concluded that iron fortification is a methodology utilized worldwide to address iron deficiency. Fortification of foods with iron has been a commonly used strategy to combat iron fortification through the world. Iron fortification of staple foods: wheat, maize, rice and cereal flours are currently the most common vehicles for iron fortification to reach the general population. (UNICEF, 1999). Fortification of rice requires additional research before it can be considered ready for program implementation. Implementation of complimentary food fortification or preventive supplementation is important to meet their daily iron requirements. Ferrous sulfate and fumarate are suitable for refined wheat flour with low levels of iron inhibitors. Elemental iron despite being very compatible with most food matrixes is very poorly absorbed and, thus, is not useful even at high levels of fortification. The exception is electrolytic iron, which has better absorption and is widely used in commercial infant cereals. Finally, effectiveness requires that the fortified food is consumed by the target population, is low in cost and has good organoleptic properties. Failure of fortification efforts to prevent iron deficiency can be explained in most cases by lack of compliance with these criteria. 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 step.

Complimentary foods

The contribution of iron from fortified complementary foods has great potential because it may provide the major source of iron at a critical time in infant growth and brain development. There are two major technical constraints when cereals are selected as vehicles: high levels of phytic acid and the extreme sensitivity of unsaturated fat to oxidation during storage in the presence of highly
reactive forms of iron (ferrous sulfate or fumarate). One option for increasing nonabsorption is to hydrolyze the phytic acid in cereals, but nearly all of it needs to be removed (Hurell et al. 1999). Activating natural phytases from legumes and some cereals (rye, buckwheat, and wheat) helps to hydrolyze phytic acid. In the future, it may be possible to develop crops with low phytic acid through plant breeding to prevent fat oxidation and preserve organoleptic problems. Infant cereals are usually fortified with elemental iron powders, which are not very reactive, but this form of iron has extremely poor bioavailability and should not be used in complementary foods. A new form of elemental iron (atomized iron) appears promising and is already being used. However, it should be evaluated for efficacy before recommending its continued use (Yang et al. 2001). The presence of inhibitors and enhancers should be critically assessed to ensure bioavailability. EDTA and ascorbate act as enhancers and have additive effects. Bioavailability studies are crucial in the selection of fortificant for specific complementary foods but do not ensure effectiveness of the fortified food product. Choice of iron fortificant should be based on compatibility and bioavailability within the specific food matrix. Ferrous sulfate, fumarate and electrolytic iron are the better choices, provided that the food matrix, packaging and storage conditions are compatible for shelf life.

Condiments and Sauces

Condiments and sauces have several advantages as vehicles for iron fortification. They are traditionally part of the daily diet in most countries, widely consumed, reach vulnerable populations, can be added to multiple foods and can be combined with fortified staple foods. Iron fortification of condiments can have a significant contribution where central processing of staple foods is absent. However, successful experiences of fortified condiments have never gone beyond the pilot level: curry powder fortified with NaFeEDTA (Ballot et al. 1989), sugar with NaFeEDTA (Viteri et al. 1995) salt fortified with ferric orthophosphate, ferrous fumarate, sulfate, or bisglycine chelate (Foy, 1976) soy sauce and fish sauce fortified with NaFeEDTA (Yang et al. 2001 & Thuy et al. 2001) and seasoning in
noodles with ferrous sulfate. Recent investigations have shown that fortification of salt with iron could be very useful and possible even when combined with iodine.

For the most part, countries in the America are already fortifying with iron wheat flour, maize flour or both. Although the conditions for successful iron fortification programs are at hand, specific problems still exist. First, arbitrary criteria have often been adopted to select iron compounds. Second, fortification programs lack quality assurance systems, and countries have not implemented monitoring and surveillance systems. Third, legislation has not been adjusted in accordance with needed changes to mandate fortification with specific sources, to prevent contraband and to ensure monitoring and quality control. Because of the widespread use of elemental iron powders (reduced and atomized iron) with uncertain bioavailability, these programs are likely to have limited impact. In light of the current situation, a Pan American Health Organization/United States Agency for International Development/International Life Sciences Institute expert group (PAHO, 2001) recently proposed the following recommendations for iron fortification in the American region.

- Wheat flour: fortificant, ferrous sulfate or fumarate or electrolytic iron at twice the amount at level, 45 ppm, but in countries where consumption of wheat products per capita is > 100 g/day, lower levels may be considered.
- Maize flour: fortificant, NaFeEDTA, ferrous fumarate at level, at least 5 mg/day of additional iron, but no < 25 ppm (above current level available).
- Complementary foods and school programs: fortificant, ferrous sulfate + ascorbic acid or ferrous fumarate + ascorbic acid at level: based on specific requirements for age.

Pahwa et al. (2007) conducted a study and assessed the impact of double fortified salt (DFS) on iron and iodine status of adolescent girls (17-19 years). A sample size of 61 was randomly divided into experimental group (n = 31) which was given DFS and control group (n = 30) which was given iodized salt for a period of 11 weeks. Eight subjects from the experimental group were dropped
because of non compliance to the use of DFS. Therefore, the study was completed by a total of 54 subjects. Baseline information like age, family size, amount of salt consumed etc. was collected. Anthropometric measurements like height, weight, mid upper arm circumference, body fat percentage, waist and hip circumference were taken and waist hip ratio and BMI was calculated at both pre and post supplementation phase. 24 hour dietary recall was done for calculating the nutrient intakes. Biochemical estimations for haemoglobin and urinary iodine excretion were carried out. The monthly salt consumption by the subject ranged from 1.0 – 2.2 kg. The diets of majority of the subjects were found to be deficient in energy, protein, iron, thiamine, riboflavin, vitamin A and niacin. However, they met the RDAs for calcium, folic acid and ascorbic acid. No significant changes were seen in the anthropometric measurements after supplementation. A significant increase in the haemoglobin level of both the groups was seen but the percentage increase was higher in experimental group.

2.4.3 Bio availability of dietary iron

Bio availability of a nutrient particularly with reference to a trace mineral is defined as the proportion of a nutrient in food which is absorbed, transport to its site of action and converted to its biologically active form (O’Dell, 1984). Iron availability depends on iron exchange reactions in which ligands of digestive tract act as donors and mucosal iron receptor protein as the acceptor. The rate and extent of this reaction depends on the number and activity of mucosal iron receptor site determined physiologically by iron status of individual and chemical state of iron in the digestive mixture (Chidambaram et al., 1989).

Table: 2.5 Mean total intake of iron and the bio available iron (mg) in the vulnerable groups in India.*

<table>
<thead>
<tr>
<th>Group</th>
<th>Total Dietary intake of iron (mg/day)</th>
<th>Intake of bio available iron (mg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant Women</td>
<td>25-30</td>
<td>0.5 -1.5</td>
</tr>
<tr>
<td>Preschoolers</td>
<td>15</td>
<td>0.3 -0.75</td>
</tr>
<tr>
<td>Schoolers</td>
<td>20</td>
<td>0.4 -1.0</td>
</tr>
<tr>
<td>Adult Male</td>
<td>30</td>
<td>0.6 -1.5</td>
</tr>
<tr>
<td>Adult Female</td>
<td>25-30</td>
<td>0.5 -1.5</td>
</tr>
</tbody>
</table>

Table: 2.6 Bio availability of iron from typical Indian meal

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Meal</th>
<th>% of Bio availability</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wheat chapattis, Potato, Vegetable and Tea</td>
<td>1.8</td>
<td>Narsinga Rao, 1983</td>
</tr>
<tr>
<td>2</td>
<td>Rice, Dal, Potato, Vegetable and Milk</td>
<td>4.5</td>
<td>Narsinga Rao, 1983</td>
</tr>
<tr>
<td>3</td>
<td>Ragi balls, Potato, Vegetable and Tea</td>
<td>0.9</td>
<td>Narsinga Rao, 1983</td>
</tr>
<tr>
<td>4</td>
<td>Sorghum, Potato, Vegetable and Tea</td>
<td>0.8</td>
<td>Narsinga Rao, 1983</td>
</tr>
<tr>
<td>5</td>
<td>Wheat Bhakris</td>
<td>3.7</td>
<td>Christian and Sheshadri, 1989</td>
</tr>
<tr>
<td>6</td>
<td>Wheat Bhakris + one cup of Tea.</td>
<td>2.5</td>
<td>Christian and Sheshadri, 1989</td>
</tr>
</tbody>
</table>


Savitha et al., (2011) designed to study the in-vitro bioavailability of various forms of iron compounds and to analyze the iron dialysability from the juices developed using the highly bioavailable form of iron. The in–vitro method involving gastro intestinal digestion and diffusion of iron through a semi-permeable membrane was used in the study. The dialyzed iron was using u-v spectrophotometer. The iron bioavailability of various forms of iron such as anhydrous ferrous sulphate, ferrous sulphate hydrate, ferrous fumarate, ferrous sulphate ammonium sulphate, ferric fumarate, ferric pyrophosphate, ferric chloride, sodium ferrous EDTA and elemental iron ranged from 0.2 to 4.1 per cent. Iron bioavailability was doubled in fortified lime juice, which could be due to the ascorbic acid content which is an enhancer of iron absorption. The lime juice contained 6.3 mg% of ascorbic acid. Thus fruit beverages with ferrous sulfate as a fortificant can be recommended for the anemic youth to improve their iron status.
2.4.4 Improving bioavailability of dietary iron

Accumulating evidence has suggested that a number of enhancers and inhibitors interact to determine the net bioavailability of iron from a given meal (Monsen, 1988). Manipulation of their dietary constituents would be necessary to bring about an improvement in the iron availability by (1) a reduction in the amount of inhibitors of iron absorption such as tea, coffee, wheat bran, phytic acid fibers, eggs, calcium, phosphate salts, and (2) an increase in the amount of enhancers of iron such as ascorbic acid, animal tissues like meat and flesh foods.

The germination of some cereals and legumes for 24-48 hours is associated with the appearance of 10-70 mg of ascorbic acid per 100 g and 8-25 % reduction in the tannic acid concentration and a 25-35 % decrease in the phytic acid concentration. The bioavailability of iron from such germinated grains, as determined invitro, increases almost two fold. The malting of millets has been shown to result in iron bioavailability (Kumar et al., 1978). The two factors greatly enhance iron absorption are vitamin C and meat.

Accumulating evidence has suggested that a number of enhancers and inhibitors interact to determine the net bioavailability of iron from a given meal (Monsen et al., 1988). Manipulation of their dietary constituents would be necessary to bring about an improvement in the iron availability. This would be brought about by 1) a reduction in the amount of inhibitors of iron absorption and 2) an increase in the amount of enhancers of iron.

A reduction in the quantity of inhibitors such as tannic acid, phytic acid, oxalates, calcium, phosphorus and fiber can be achieved through common household processing methods such as (a) germination(b) malting(c) fermentation(d) de hulling (e) soaking (Pawar and Parlikar 1990).

Nalwade et al. (1997) conducted a study on bioavailability of iron and calcium content of uncommon leafy vegetables. This investigation was undertaken to assess the bioavailability of iron and calcium content of selected uncommon leafy vegetables. Fourteen uncommon leafy vegetables namely Beet greens (Beta
Review of Literature

vulgaris), Cheel (Amaranthus sp.), Chopda math (Amaranthus vividis), Ghol (Portulacao leracea ), Kante math (Amaranthus spinosus), Kunjeer (Digera orveniss), Pakla (Merremiya emerginta), Paatar (Sonchus arvensis), Rajgira leaves (Amaranthus paniculatus), Drumstick leaves (Moringa oleifera), Sarate (Tribulusntessestris), Tandulga (Amaranthus polygramous), Tarwata (Cassia tora), and Vavdinga pan (Embelica ribes) were selected from local market of Parbhani city and rural area of Maharashtra region of Maharashtra state. The total iron content of the uncommon leafy vegetables were found to be varying from 19.87 – 1.68 mg/100g, Kante math (19.87mg %) recorded the highest value of iron content as compared to other leafy vegetables followed by Rajgira leaves (17.91 %), Polka (17.72 mg %) and Chopda math (17.26 mg %). On the other hand, Rajgira leaves was found to have maximum (6.16 mg %) content of available iron content (1.08 mg %). In case of bioavailability of the iron Tandulga (62.47 mg %) recorded the highest bioavailability of iron, where as Ghol recorded the lowest (4.99 mg %). The calcium content of selected uncommon leafy vegetables ranged between 512 and 690 mg /100g. The maximum calcium content was found in Rajgira leaves (512 mg %), followed by drumstick leaves (423 mg %), Beet greens (322 mg %) and Chopda math (312 mg %). Hence Kante math , Rajgira leaves and Tandulga can be considered as good and cheap sources iron and calcium, therefore, it can be recommended for consumption in the diet of the people to reduce the prevalence of anemia in the community.

Yadav et al. (1997) conducted in vitro study on the effect of certain household processing methods on the bioavailability of iron from the selected preparations. The present study attempted to investigate the total iron content and in vitro iron availability of certain products and their modified forms, which had undergone household processing like soaking, fermentation and germination. Three variations each of Idli (instant, soaking, fermentation), Soy chat (boiling, soaking, germination), Handwa (cooking in iron utensil, in steel pan, iron utensil with soaked and ground soya bean) and biscuit (normal, roasted soya flour, defatted soy flour) were prepared. Nutrient analysis revealed that soyabean containing products had comparatively higher total iron content. In vitro iron bioavailability was better
in fermented and germinated products, maximum increase of $10.0 \pm 0.016$ soluble iron and $11.8 \pm 0.001$ insoluble iron in idli sample (fermentation). Cooking in iron pan increased the total iron content but its bioavailability was not quite high. Products having soyabean also had relatively high calcium processing brought about a decline in phytate phosphorus content. All the products enjoyed high acceptability, which was judged by semi trained panel. Thus the results reinforce that simple household processing techniques are beneficial in improving iron bioavailability. There is a need to emphasize this fact so that it can be incorporated in the designs to combat anemia of iron deficiency.

2.4.5 Nutrition Education

Upadhyay et al. (2002) observed the impact of single vs. combination of media on nutrition knowledge and haemoglobin status. After a period of 60 days a significant rise in post exposure knowledge scores of both the groups was observed. Between the groups multimedia group scored significantly higher than print media group. Mean haemoglobin concentration were found to be higher though non-significant. Similarly in the present study the subjects were exposed to short lectures, and other visual aids such as folder, flash cards, posters and display of raw foods which showed a significant rise in post exposure knowledge scores.

Meenakshi and Vyas (2003) used a questionnaire to assess the nutritional knowledge of adolescent girls which contained 100 questions with multiple choices. A pre-test and post test study was conducted within the interval of seven days on the same questionnaire. The results indicated about 30 % gain in knowledge by comparing the scores of pre – test and post test, as against to a high score (>23) by the subjects in the post tests in the present study.

Dutta et al. (2004) revealed that 60 % of the girls (17-19 years) had correct knowledge about signs of anemia and cheapest source of iron, 72 % of them knew the dietary cause of the disease. Their knowledge regarding the prevalence of anemia among Indian women and the normal haemoglobin level of them, however, was poor as only 26 % and 37 % of the girls could correctly answer in this respect.
**Review of Literature**

Patel (2009) conducted a study and the result revealed that nutrition deficiency diseases are widely prevalent in rural community due to poor awareness regarding nutrition. Because of poor knowledge regarding nutrition, their family suffers from deficiency diseases. Two villages Kamli and Sinhi of Unjha taluka were selected by purposive random sampling method. 100 rural women of 20-50 years age group were selected (50:50) or equally from two villages randomly. The intervention program was conducted by poster exhibition and lecture. Data revealed that an awareness regarding nutritional requirement had increased after intervention program. Highest difference was observed in knowledge about vitamin requirement (50%). The respondents had highest unawareness about calorie and lowest awareness regarding vitamins requirements before an intervention program.

Savita et al. (2013) conducted a study on impact of education intervention on nutritional knowledge of iron deficiency among post adolescent girls and stated that approximately, 70% of adolescents in India suffer from anemia, making it one of the most important public health issues. Public intervention programs are essential to combat iron deficiency. Nutrition knowledge and nutrition education is also considered a long term approach to combat iron deficiency anemia. A total 207 girls in the age group of 18 to 25 years were screened for the haemoglobin status and knowledge assessed among the volunteer subjects (156 girls) using the tool developed for the purpose. Nutrition knowledge intervention was carried out through a short lectures using the visual aids (flash cards, posters and display of raw foods such as rich sources, enhancers and inhibitors of iron absorption) followed by discussion. A folder was developed consisting brief information regarding iron, anemia, sources, enhancers, inhibitors, consequences of anemia and fortification. The knowledge assessment tool was tested thrice during the study period- initially before the education, soon after the nutrition education and one month later and the subjects were classified on the scores obtained. The classification was made as low, medium and high based on mean +1/2SD. 30 % of subjects scored low (<17) ,42.31 % scored medium (17-23) and 27.56 % scored high (>23) before education. Assessment of the knowledge immediately after the education program revealed that 97.44 % of subjects scored high (>23) where as
2.56 % scored medium (17-23) and one month later, the knowledge level revealed that 95.51 % scored high (> 23) and 4.49 % scored medium (17-23) reflecting that the retention of knowledge is quite satisfactory during follow up assessment. The percentage of correct response ranged from 39-69 % previously followed by 71% to 96 % at immediately after education intervention and 70 % to 91 % at one month after education intervention. The response improved after education intervention that could help to combat micronutrient malnutrition.

2.4.6 Effect of Garden cress seeds supplementation

Since Garden cress seeds belong to the brassica family, they contain compounds known as glucosinolate. Certain glucosinolates and, more importantly, their break down products, isothiocyanates, have been linked to a reduction in the prevalence of certain types of cancer. Studies have been performed with regard to various properties of GCS. The amount of data may be sparse but all trials to indicate the potential benefits that the seeds hold. The seeds have been considered for their anticancer (Hare et al, 2005, Fekuda et al, 2002), anti hypertensive (Meghrani et al, 2005), hypoglycemic (Kddouks et al, 2005, Eddouks & Meghrani, 2000), fracture healing properties (Atasan,1998) etc.

**Sharma and Garg (2002)** conducted study among anemic women, significant rise in Hb status was noted 0.99 g/dl with supplementation of chikki made with GCS and Niger seeds at the level of 60g/day. Few more studies was conducted on GCS are as under:

<table>
<thead>
<tr>
<th>Author</th>
<th>Dose</th>
<th>Intervention Period</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iyer U &amp; Ratnani V, 2009</td>
<td>5 g</td>
<td>20 days</td>
<td>0.44 g/dl rise in Hb level</td>
</tr>
<tr>
<td>Iyer U &amp; Pandit N, 2009</td>
<td>3 g</td>
<td>28 days</td>
<td>Nonsignificant reduction Hb value</td>
</tr>
<tr>
<td>Iyer U &amp; Dave S,2009</td>
<td>5 g</td>
<td>28 days</td>
<td>0.2 g/dl rise in Hb Level</td>
</tr>
</tbody>
</table>

**Meghani & Nair (2011)** conducted a study among pregnant women of tribal set up and found mean increase in Hb level was 1.32g/dl after 2 month supplementation
of GCS and there was improvement observed at 15.52% in the population and it was also observed that between experimental and control group the post analysis of haemoglobin level showed the difference of 1.17g/dl.

**Figure: 2.5 Uses of Garden cress seeds**

**Conclusion**

Above marked studies showed that the efforts were put in the right direction which included the global burden of anemia, causes of anemia, etiology, seriousness of anemia and intervention strategies to combat anemia viz. supplementation, fortification and improving bioavailability of iron in the diet. Nutrition education and supplementation of indigenous food like Garden cress seeds helps in prevention of anemia. Supplementation of locally available foods helps reduce the prevalence of anemia at lower cost and useful to the community for combating anemia.