REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The review of literature pertaining to the present study entitled **"Impact of Nutritious Supplement on Selected Anaemic Adolescents in Coimbatore City, Tamil Nadu "** is reviewed under the following headings.

A. Adolescents Life Style Pattern, Food Consumption and Nutrient Intake – Empirical Evidence

B. Prevalence, Causes and Consequences of Iron Deficiency Anaemia

C. Supplementation – An Approach to Combat Nutritional Deficiency Diseases

D. Nutrition and Health Education – A Mile Stone Approach to Overcome Nutritional Problems

A. Adolescents Life Style Pattern, Food Consumption and Nutrient Intake – An Empirical Evidence

One of the common life style factors that is commonly seen in adolescents is eating away from home this statement was also strongly supported by (Story, 2002) studies. Dietary pattern is the most important aspects in the nutritional profile of adolescents. According to Mahan (1996) biological, psychological, cognitive and socio-developmental changes have dynamic effects on the eating behaviour of adolescents. Whitney (1997) states that this period is also known as s a rebellion period, extending to foods. Teens decide for themselves what to eat and possess worst eating habits.

Biologically adolescents phase needs larger amount of protective nutrients as proteins, vitamins and minerals per unit of energy consumed than pre pubertal children and adults Dwyer (1992). According to Dubey (1994) emotional stress may adversely affect calcium retention in the body resulting in a decrease in bone density which may be a predisposing factor for osteoporosis.

Adolescents believe that skip meals could control weight. Use of tobacco, alcohol, marijuana and other drugs is a major problem among adolescents (Kathleen and Sylvia, 1994). Mosses et al., (1999) state that anorexia nervosa and anorexia bulimia are the two common eating disorders found among adolescents. Richard and Facchem (2001) warn that these disorders cause disturbance in eating behavior of adolescents which may affect their physical and psychological health.

Steinberg (1994) points out that the peer groups influence the adolescent norms in all factors including food habits. Peers become a pivotal force exerting more influence over behavior than parents and eating is an important form *of* recreation and socialization

among friends. Whitney (1997) puts forth that with a multitude of after school, social and job activities, adolescents almost inevitably fall into irregular eating habits. Robinson et al., (1996) expressed the view that food faddism among young adolescents, critically affect their anthropometric measurements.

Reason for the shift in eating pattern as children move into adolescent are likely because of life style changes (Shry and Newmark, 2001). Gone are the days, when family dinning table used to be the only source of daily food (Due, 2003).

Shovelin et al., (2001) current surveys shows that families dine out frequently. Warde and Martens (2001) also reported that eating out is seen to have practical and symbolic importance.

Eating pattern established during adolescents shape diet pattern later in life. Compared with young children, adolescent have more control over their eating habits and more access to food outside home experiment, more with food choices, deviates more from a 3 meals a day and are more likely to eat snacks (Duyer et al., 2001).

Teens identify the biggest barrier to healthful eating as they often perceive themselves as too busy to worry about food, nutrition, meal planning and eating right (Bonnie, 2002).

Today, the death of the family meal has coincided with the explosion of fast food restaurants and smart marketing of junk foods to children. Fun foods like fries, burgers and colas are now a daily staple among youngsters leading to high salt and sugar consumption (The New Sunday Express, 2004).

Television gets a bad rap, getting blamed for every thing from violence to obesity (Sophia, 2003). It is hard not to hold television responsible for faulty eating habits of children. Many young girls voluntarily opt for sliming diets and drugs leading at times to pathological thinness because of the concept "Slim is good" (Due, 2001).

Concerns about the quality of adolescent's diet are numerous, because of rapid growth and development total nutrient needs are higher in adolescents than any other time in the life cycle (Neumark et al., 2001).

Despite the percentage of healthy eating adolescent studies have consistently shown that adolescent as group have poor eating habits that do not meet current dietary recommendations (Shry et al., 2001).

Adolescents consume excessive amount of fat (particularly saturated fat), sugar, salt and inadequate amount of fruits, vegetables, whole grains. In addition, these dietary patterns are often coupled with inadequate physical activity. These energy imbalance leads to development of chronic diseases (Jennifer, 1999).

Teenagers consumed fast foods more preferably because the fast foods are easily available, time saving and tasty; although teenagers are aware about the advantages and disadvantages of the consumption of fast foods (Kumudini et al., 2003).

These appears to reflect a basic shift in the eating preferences, induced mainly by shifts in income, prices, food availability, modern food industry and mass media (Popkin, 2001). One of the hypothesized reasons for the decrease in milk consumption in the past few decades is the simultaneous increases in the consumption especially of carbonated soft drinks (Miller et al., 2000). Now the adolescents life is with style; thirst often becomes "a need for a coke or Pepsi" (James, 2002).

The substitution of soda for milk has been recently high and linked with bone fracture among teenagers (Wyshate et al., 2000). Intake of soft drinks as a proportion of total beverage increased fold with corresponding decreases in intake of milk and fruit juices. Vegetables and fruits intake has also decreased drastically (Lytle, 2000).

Decline in dietary quality and considerable changes occur in food group from childhood to adolescents. Intake of fruits, vegetables, milk and fruit juices decreases and intake of soft drinks increases during this time. Overall there is decrease in diet during the age transition (Bogalusa ,2004). Adolescents consume low levels of fibre and high levels of saturated fat, total fat and sodium may be related to the low intake of fruits and vegetables by adolescents (Lytle et al., 2002).

Twenty eight percent of adolescent boys and 36 percent of adolescent girls in America reported that inadequate intake fruits and vegetables (Dianne et al.,1998). Adolescent girls are more likely than adolescent boys to have lower intake of daily foods and fewer serving of fruits and vegetables (Morten, 1998).

The consumption of fast foods for meals or snacks is especially popular among adolescents in which most of the food items provide more than 50 percent of their energy from fat (Bonnie, 2002). Reduced consumption of vegetables, other high fibre foods and increased consumption of meat, dairy and sugar would be expected to increases dietary energy density which may promote increased energy intake and can lead to weight gain (Swarya, 2003).

Chigh and Puri (2001) found out the consumption of fast foods among adolescent girls in Jalandhar and Ludhiana was 73 percent and 78 percent respectively. These fast foods were consumed between meals and reduce appetite, so these adolescent girls are more prone to nutritional problems. Yannakoulia et al., (2004) study suggests that eating habits of adolescents in Greek schools are changing from more traditional to more westernized diets.

Dietary intake of adolescent also showed that 20 to 50 percent deficit of several nutrients including protein. However inadequacy is greater while deficiencies of fat, energy, calcium, zinc are lower. This may be due to more intake of cereals by the adolescents (Rao, 2002).Alexandra et al., (2002) states that there is a significant increase in fruit consumption often the transition from high school to college.

B. Prevalence, Causes and Consequences of Iron Deficiency Anaemia

PREVALENCE

Anaemia is the most wide spread and much neglected problem. Iron deficiency anaemia (IDA) is the most common single nutrient deficiency in the world. Globally at least one billion people have iron deficient (UN, 1992). Asia has the highest prevalence of anaemia in the world affecting a vast number of infant and children (WHO, 1998). For many decades, iron deficiency has been the primary driver of public policies concerned with iron nutrition (FAO / WHO, 2002)

Approximately two billion people worldwide and roughly one-third of the human races are affected by iron deficiency (Mary, 1999). According to WHO (1992) anaemia is a major global problem, affecting 20 to 70 percent of the population in various countries. WHO (1995) also reported that the prevalence of anaemia in developing countries is 46 to 51 percent among children and 20 to 40 per cent among school going children.

In the South East Asia about 50 percent of the population are affected by IDA followed by Africa (16%), Eastern Mediterranean (15 %), America (8 %) and Europe (2 %) (WHO, 2002).Prevalence of anaemia was 27 percent in developing countries, six percent in industrialized countries. Results showed that in Africa, Oceania, Latin America and Caribbean the prevalence rate was higher among adolescents (Underwood, 2003).

The ICRW / USAID studies also showed that anaemia in adolescents was quite high in Nepal (42%), India (55%), Cameroon (33%), Jamaica (16%), Guatemalan (48%) and low in Ecuador (17%) (WHO, 2005). According to Gomber (2003) prevalence of anaemia among 5 to14 years old urban and rural children were found to be 67 to 77 percent in North America.

Iron Deficiency Anaemia is more prevalent in the developing countries than in the industrialized ones. Vasanthi et al., (1994) observed that nearly 25 to 50 per cent girls become anaemic by the time they reach menarche.

Nutritional Anaemia is one of India's major public health problem. Prevalence is high in all vulnerable group, children, adolescent, pregnant and lactating women and in almost all states of the country (Agrwal, 2000).

According to Vir (1998) more than 50 percent of adolescent girls are anaemic in India. Around half of those with anaemia are suffering from iron deficiency anaemia. About 269 million Indians are estimated to suffer from anaemia. Dubey (1994) stated that in a large scale study by ICMR, showed that 53 per cent of children were found to be anaemic. The report of task force on micronutrient reports that the prevalence of nutritional anaemia varied between 14 to 90 percent in school children in India (Seshadri, 1996).

All India level data available from NFHS – 2 (2000) indicated the overall prevalence of Anaemia in children (5-11 years) as 73 per cent. But in 1980s, 80 percent were affected and the rate was declined to 63 per cent during the period 1991 onwards. Vasanthi et al., (1992) assessed the iron nutritional status among 312 rural school girls of

Delhi. The prevalence of anaemia was 28 percent in girls who had attained menarche and 22 percent in girls who had not attained menarche. Another study by Dua (2003) showed that 44 percent adolescent girls in Government schools in Delhi were anaemic and mean haemoglobin level was found to be 10-11 g/dl.

Kundu (2003) study revealed that 57 percent adolescent girls from urban slums had less than 12g/dl and only 1.2 percent of girls were severely anaemic. Chandrasekar et al., (1983) conducted a survey among school going children between the age group of 6 to 12 years in the urban areas of Coimbatore district, Tamilnadu, the prevalence rate of anaemia was found to be 65 percent. In a study conducted by Ganga (1997) the prevalence of anaemia in Nagai district of Tamilnadu state was found to be 43 percent among school children of both sexes.Very sever iron deficiency Anaemia in children has been associated with increased mortality and susceptibility to infection (Oppenheimer, 1989).

CAUSES

According to Kela et al., (2003) poor dietary iron intake or excessive loss of iron from the body leads to iron deficiency Anaemia. Iron deficiency Anaemia can affect children at any age and is most commonly seen in school children and adolescents.

According to Kanani (1995) IDA is due to poor bioavailability of iron from typical cereal based diets. Sethuraman (1998) pointed out that low bioavailability of diets consisting of cereals, roots and tubers with negligible quantities of meat, fish or ascorbic acid contribute to IDA.

Webb (1997) reported that the proportion of dietary iron absorbed varied with the iron status of individuals and the form in which dietary iron was present. Sachdev and Choudhry (1994) proved that in iron deficient person, the absorption of haem iron is about 35 percent and non-haem iron is 25 percent when enhancers are abundant. The balance between enhancers and inhibitors determined the bioavailability of non-haem iron in the meal (Lynch, 1997).

Hunt and Rougehead (1998) reported low iron absorption among women consuming lacto vegetarian diet and their serum ferritin and faecal ferritin values were low compared to those consuming non vegetarian diets. The relative absorption of haem iron is 11 to 22 percent which is greater than that of non-haem iron which is only one to seven per cent (Patterson and Brown, 1998). Oski (2003) reported that haem iron effectively enhances the absorption of non-haem iron from the same meal.

A study by Sing et al., (1995) on the iron status of adolescent Chinese vegetarians and non vegetarians revealed that the occurrence of IDA was more in vegetarians. According to Aziz et al., (1999) drinking tea and cola that contain *polyphenols* render available iron unabsorbable, based on a study conducted among adolescent girls of Riyadh.

Many adolescents over indulge in junk foods which constituted merge iron content (Devadas et al., 1990). Adolescents who start a poorly planned vegetarian diet and young slimmers may be at more risk of iron deficiency (Vir, 1998). The amount of cereals consumed by adolescents in villages of South India was much above the RDA level which satisfied their hunger but did not provide adequate iron in the diet (Jainita, 1998).

The primary determinants of iron deficiency anaemia include dietary factors namely low intake and poor availability of dietary iron and low dietary intake of vitamins such as C, A and B-complex (Vir, 1998). The other factors include diseases like malaria, intestinal parasites, HIV / AIDS and genetic haemoglobinopathies, which in turn increase the metabolic needs of iron (Yeung, 1998). The factors contributing to iron deficiency have been categorized as dietary factors, host factors and other factors relating to blood loss.

Surveys conducted have revealed that the diets consumed by the majority of vulnerable groups of population were inadequate in quality and quantity (Dak, 1997).

Body iron content at birth is 80mg/kg and there is virtually no reserved iron between six months and two years (ICMR, 1998). According to Stekel (1994) the absorbed iron among children of 6 to 24 months was estimated to be 0.7 to 0.9mg/day.

Low iron stores throughout childhood may contribute to a delayed age of menarche and impaired immune response (Brabin and Brabin, 1992). The additional requirement during adolescents attributed to growth spurt, expansion of blood volume and increase in haemoglobin concentration is 12g/kg for boys and 8g/kg for girls. An additional 8g/kg of iron is recommended to compensate menstrual blood loss in girls (WHO, 1998). Ahmad et al., (1993) reported that men store approximately 1.0 to 1.4g of body iron while women store 0.2 to 0.4g and children store even less. Pregnancy imposes the largest demand for iron as 1200mg per pregnancy.

Negative iron balance like menorrhagia is noticed in multiple pregnancies due to excessive blood loss, inadequate dietary intake and other reasons (Manju, 1990). A study by Gnanamani et al.,(1998) among slum dwelling school children in Visakhapattnam revealed a prevalence of 82 percent of soil born intestinal helminthiasis with 88 per cent of the children being anaemic. Yip (1996) emphasized that changes in attitude, smoking habits, vitamin A deficiency and inflammation influence haemoglobin levels.

Sharma (1996) observed that preschoolers suffering from morbidities of five days or longer had significantly lower haemoglobin levels (9.5g/dl) compared to those who did not suffer any morbidity during the past one month (10.5g/dl). According to Khan et al., (1990) respiratory infections, diarrhea and worm infestation lead to iron deficiency. Sethuraman (1998) reported a trend towards lower haemoglobin levels due to chronic inflammatory conditions and severe bacterial processes among children.

Bouveir et al., (2000) found that malaria to be a cause of Anaemia. Stoltzfuse et al., (1997) estimated that hookworms contributed to 25 percent of all anaemia. Pawalowski et al., (1991) showed hookworm *Aneylosctom duodinale* and *Nector* *americanus* to be the most deleterious followed by whipworm *Trichuris trichurina,* both of which cause blood losses of 2 to100ml per day depending on the severity of infestation.

Sullivan et al., (1998) identified that 22 percent of the anaemic cases to be drug related. Cataldo and Nyenhius (1999) observed decreased iron stores among patients consuming antacids like calcium carbonate, aluminum hydroxide severity of infestation.

Bhargava et al., (1991) reported that mild to moderate iron deficiency in mothers contributed to lower fetal iron, severe iron deficiency anaemia and low birth weight babies. Kurz and Johnson (1998) opined that an iron deficit diet would result in negative consequences during postnatal period.

Studies by Ramana et al.,(1997) estimated during the year 1996 annual productivity loss due to protein energy malnutrition and iron deficiency anaemia in India was 10 to 28 billion US dollars of which contributed to nearly 90 per cent of the total loss. Anderson et al., (1994) showed that iron deficiency anaemia affected work capacity, physical performance and exercise tolerance.

Iron deficiency is associated with impairment of severe immune functions such as skin responses to antigen and allergens, mutagenic response of human peripheral blood lymphocytes and bacterial capacity of phagocyte cells (Kuvibidila et al., 1990). A study conducted by Dubey (1994) among children aged 12 to 14 years indicated that the cell mediated immune response and the bactericidal capacity of leucocytes were significantly depressed in those with haemoglobin concentrations less than 10g/dl.

An impaired capacity to maintain body temperature in a cold environment was a characteristic feature of iron deficiency observed among adolescents of 13 to 15 years (Beard and Borel, 1998). Animal and human studies by Dubey (1994) showed that anaemic subjects more readily became hypothermic and had depressed thyroid function. Iron deficiency was found to promote secondary folate deficiency (Clark et al., 1992).

Yeung (1998) found that the prevalence of lead poisoning was 3 to 4 times higher among young children with iron deficiency.

Dubey (1994) reported that the enzyme monoamino oxidase (MAO) is decreased in iron deficiency; therefore there is a reduced synthesis of neurotransmitters such as dopamine, non-epinephrine and seratonin leading to neurological impairment. Moderate iron deficiency also contributed to cancer development (Spear and Sherman, 1992).

Blood loss is another important cause of iron deficiency anaemia. A study by Dallman et al., (1993) on adults with iron deficiency anaemia revealed that 62 percent had clinical evidence of gastro intestinal bleeding due to lesions, ulcers and tumors. Halliday (1998) demonstrated that women who had donated blood in the past six months were 2.5 times more likely to possess low iron stores. Blood donation according to Milman and Kirchoff (1991) and Fogelholm et al., (1995), is a known risk factor for iron deficiency. The use of intra-uterine devices increased the incidence of menorrhagia in 30 to 50 percent women depending on the type used (Israel et al., 1994).

Embleton et al., (1997) reported that chronic anaemia is common in adults after successful cardiac transplantation. Cazzola et al., (1996) reported that Systemic-Onset Juvenile Chronic Arthritis (SOJCA) associated with high levels of circulating *interiukin-6,* is frequently complicated by severe microcytic anaemia. Larsson et al., (1992) observed an increased likelihood of iron deficiency associated with increased number of menstruating days (>65 days/year).

Studies by ICMR (1998) and Choudhury and Vir (1994) reported that the iron content of food increased due to contaminant iron and washing the foods free of contamination lowered the iron content by about 20 to 30 percent.

Consequences

Couper and Simmer (2001) state that infancy is the critical period for brain growth and iron deficiencies may affect psycho motor development and neuro cognition. Young children with iron deficiencies anaemia have been found to score 12 to 15 points lower on the Boyley infant development scale than their iron sufficient children.

Winichagoon (2003) reported that iron is an essential nutrient for several bodily functions, namely cognitive ability and learning potential in children, muscular oxidative capacity, immunity and consequent work performance in all ages.

Lozoff et al., (2000) iron deficiency can lead to serious consequences including both immediate and long term impairment in motor and cognitive development in children. Allen et al., (2000) also state that mental development and physical performance and work capacity in adults are common consequences of concern.

Iron deficiency anaemia has been demonstrated to affect behavioral development both motor and cognitive function (Pollitt et al., 1996). Stunting has been reported in anaemic children and a report from India shows that iron supplementation can decrease the prevalence of stunting (Angeles et al., 1993). Supplementation to children with iron appeared to reverse this impairment (Idjradinata et al., 1993).

The major consequences of IDA include impaired motor development and coordination in infants, impaired language development, behavioral disorders and decreased physical activity in children (Berant et al., 1992).

Iron deficiency consistently and linear reduces maximum aerobic capacity. Evidence is strongly suggestive that IDA significantly reduces both physical endurances and voluntary physical activity among children (Cole et al., 2000)

The common and well known symptoms of IDA are fatigue, nausea, pallor, edema, extensive menstrual bleeding in women, palpitation, loss of appetite and spoon shaped nails in sever anaemic cases(Kamala, 2003).

Madeeros et al., (2002) observed that there is a relation between iron deficiencies and bone strength they may be associated with iron deficiency and bone strength they may be associate in irons in collagen maturation. Szachmiewicz et al., (2003) stated that mild anaemia is a significant and independent predictor of poor outcome in patient with chronic failure

According to Sharma and Tamber (2003) anaemia is a clinical sign of sever iron deficiency and classic symptoms include weakness, skin pallor, easy fatigue, sensitivity to cold, reduced physical work capacity, chelosis, glossitis, loss of gastrointestinal tone with accompanying symptoms of distress. Koilonychias with longitudinal ridding is some times present.

Kulkarni (2003) informs that the parasitic infection is due to poor hygienic conditions especially by hook worms are very common in India. They suck 2 to100ml of blood/day and cause considerable blood loss over a period of time. Hook worm enter the body either through skin (by walking bare foot) or through contaminated food and water.

According to Raman and Sharma (1999) in India it is an important public health problem affecting people of all walks of life. Stolzfus et al., (1997) also estimated that hook worms contribute to 25 percent anaemia. Sharma (2003) showed a main reason for IDA have been determined to be inadequate intake of iron, low availability (1-6%) of dietary iron from plant foods due to inhibitory factors low levels of absorption enhances in the diet.

Alvin (2004) reported that iron deficiency increase lead absorption. It is well known that lead portioning can result in permanent loss of I.Q points. Iron deficiency can cause abnormal dopaminergic neurotransmission and may contribute to the onset of attention deficit / hyper activity disorder (ADHD) (Summer, 2004).

Well controlled longitudinal studies revealed that the children with iron deficiency have reduced learning capacity and school achievements (Grantham, 2001). Show (1984) revealed that iron deficiency reduced level of energy, productivity, impaired immune function, reproductive failure in adulthood and maternal death during child birth.

During anaemia body has to make respiratory adjustment during work, the supply of oxygen depends upon total iron and selected mass, total blood flow and its distribution. The relationship between chronic anaemia and physical work capacity was found in school children and in adolescent (Simmer, 2001)

Deo and Ghatlargi (2004) assessed health status of rural and urban adolescent girls, nutritional deficiency was prevalent among both the groups, rural girls had poor personal hygiene and had higher incidences of worm infestation and pediculosis.

Micronutrient deficiency is still a major problem in many developing countries, this result in a negative nutrient balance due to rapid growth of body tissues/ nutrient losses combined with insufficient nutrient intake. Repeated infections and poor bioavailability of nutrients from food due to the presence of inhibitors or lack of enhances of foods (Untoro, 2000). Iron deficiency may decrease esophageal contraction and impair esophageal transit (Miranda, 2003).

C. Supplementation – An Approach to Combat Nutritional Deficiency Diseases

The prevention of protein and iron deficiency requires different intervention such as dietary improvement, food fortification, and supplementation treatment of anaemia and several other public health actions are integrated (Berger et al, 2005).

Food diversity can be augmented by expanding the production, processing, marketing, consumption of a wide variety of foods. In treating the problem of micro nutrient deficiency food based approach that focus on improving overall dietary quality , rather than merely delivery a single nutrient are particularly useful. First there are complex nutrient interaction that increase bioavailability when nutrient are consumed simultaneously iron absorption is increased when it is combined with vitamin C. (Kennedy, 2003).

Supplementation is a technical approach in which nutrients are delivered directly by means of syrup and pills. Supplementation is most appropriate for targeted population with a risk of deficiency (Manner, 2002).

Iron supplementation remains an important strategy for the prevention and treatment of iron deficiency anaemia and can produce substantial improvement in functional performance of iron deficient individuals and population (Allen, 2002).

The ongoing programmes to prevent anaemia concentrate only on the amount of iron supplemented and the bioavailability iron is least considered. There are a few studies which give importance to iron absorption enhancers combined with the supplemented iron (Yegammai, 2004).

The powdered form of iron is a cost effective and better tolerated method to administrate iron in children, marked reduction in the prevalence of anaemia in children and adolescents long term fortification of whey drink ferrous bi sglycinate (Ahmed, 2003). Moynihan et al., (2001) fortified white flour with folic acid at 2400µg /kg, this flour was supplemented to anaemic adolescent's girls in England to achieve an intake of 400 µg /day.

Supplementation of a mixture of soya flour 30g, wheat flour 30g, sesame seeds 15g, jaggery 10g produced an appreciable increment in the haemoglobin level of children(Amirthaveni and Shobana, 1995).

Bharagava and Kulkarni (2003) also supplemented 25g of chikki (equal amount of ground nut and jaggery) to 80 adolescent girls (13-18 years) for a month to analyzed pre and post menstrual haemoglobin level. Haemoglobin level was 10.8g / dl and 9.9g /dl experimental group. Sharma and Jain (2003) study revealed that 10g of lotus stem powder was supplemented to 40 school children for 30 days, after supplementation period there was reduction in the occurrence of paleness of eyes, skin, tongue and nails. Haemoglobin level was assessed at three stages 8.14± 0.2 (prior), 9.35± 0.20 (during), 10.46± 0.20 gm/dl (after intervention).

Sachdeva et al., (2004) study showed that one gram of spirilina (2 capsules) after mixing in one serving (30g of panjiri) daily for five days a week for two months were supplemented to low middle income adolescents school in Ludhiana the result indicated that the prevalence of clinical signs such as paleness of skin, conjunctiva, fatigue, angular stomatistis and morbidity status was reduced significantly at one percent level.

Venkataraman (1993) also reported an improvement in general health and protection against common aliment as a result of spirilina consumption. Sheshadri and Jayam (1993) reported that reduction of clinical signs of vitamin B complex deficiency as a result of spirilina supplementation of one gram / day among adolescents.

Soemantri (1999) studied the blood iron level and learning achievement in rural Indonesian school children who were supplemented with 10mg of iron sulphate. Hematological status and learning achievement were found to be improved in anaemic children.

Koteecha et al., (2003) study showed that weekly supplementation of iron folic acid for 17 months to 2766 adolescents girls (8^{th}- 12^{th} graded) from Vadohara schools. It was observed that mean rise of haemoglobin was o.64g/dl increase in mean serum ferritin was 5g/ dl. In the same place Kanani and Poojara (2004) supplemented iron folic acid supplemented to adolescents girls in urban area to find out the weight gain (0.83kg), haemoglobin 17.3g/dl. He concluded that IFA supplementation is recommended for growth promotion among adolescents who were underweight.

Anuradha and Sangeetha (2001) supplemented children with six soya malted biscuits containing 5.14mg of iron for a period of 90 days and showed reduction in the symptoms of anaemia and increase in the haemoglobin level by 1.36g /dl.

Saraswathi et al., (1994) conducted a comparative study by supplementation of sweet laddos prepared from jaggery (4.8g), sesame seeds (48g), bengal gram flour (12g) and dried dates (12g) to one group and folifer tablet to another group of moderately anaemic school children. Better results were inferred with iron supplementation than medicinal iron supplementation. Chandrasekar et al., (1998) supplemented 100g of rice flakes balls to a group of 49 moderately anaemic children which resulted in an increment of 2.65g/dl of haemoglobin.

Awasthi et al., (2003) demonstrated that Ethiopian children fed from iron pots had lower rate of anaemia and better growth than children whose food was cooked in aluminum pots. Provision of iron cooking pots for households in less developed countries may be a useful strategy to prevent iron deficiency anaemia.

Darby et al., (1994) reported that spinach, amaranth, lucen leaves contain high amount of iron and trace quantities of vitamin B 12 which will help in treating anaemia which is one of the biggest public health problems of India today.

Chiplonkar et al., (2000) concluded that green leaf vegetables based daily meal improved greens as well as available iron intake which will help in meeting daily requirement of iron especially for vegetarian women of reproductive age. Sharma (2003) reported that consuming guava (30 to 50 g / day) with two major meals by adolescents had significantly high haemoglobin levels.

Kavitha and Marayana (1998) recorded a haemoglobin rise from 9.07 to 10.3 g/dl in a group of anaemic children following the supplementation of five grams of cynodon dactylon (Aruram pul) powder for a period of 11 weeks.

Ramachandran (1992) reported the percentage absorption of iron from rice, wheat and mixed cereal diets to be five, two and three respectively. According to Kumari and Reddy (1995) the percentage bioavailability of iron from whole wheat flour was 25.8, refined wheat flour 16.2, semolina 41.5, chapatti and breads each 21.5 and biscuit 9.4. Sunitha et al., (1995) studied the bioavailability of iron among selected cereal preparations and found that presence of total iron in pongal was 50 percent and 42 per cent in puttu.

Brune et al., (1992) reported that prolonged fermentation of whole rye bread reduced total inositol phosphates and increased iron absorption, in spite of a high fibre content. Indigenous fermentation reduced the level of phytic acid and saponin. According to Hallberg (1990) the phytate content in bread can be reduced by fermentation or by scalding with water at 70°C and adjusting the pH to 4.5 with lactic acid.

Modification in milling and processing methods for cereal grains will reduce their phytic acid and improve iron availability at significant level (Cook et al., 1997). The modem technique of milling rice helps to reduce the phytate content (Tuntawiroon et al., 1990). Whole grain and fortified cereals, legumes, dark green vegetables, nuts, seeds and dried fruits are the plant foods to supply iron in vegetarian diet (Craig, 1994).

According to Grewal and Chauhan (1992) germination reduced phytic acid by 52 percent and saponins by 13 percent and improved iron availability. Significant improvement in iron availability was possible by autoclaving and dehulling. Iron binding phenolic groups such as tannin compounds in tea and coffee reduced the bioavailability of nonhaem iron from foods by forming insoluble complexes (Brown et al., 1990 and Van Dokkum, 1992). Ibrahim et al., (1991) showed that tea intake at meals was negatively correlated with serum ferritin concentration due to tannins and phytates and even in small amounts markedly reduced iron absorption.

Mwanri et al., (2004) reported that to combat anaemia, vitamin A supplement is required 136 anaemia children in Tanzania were grouped into three and administered Vitamin A, iron supplement with corn meals, Vitamin A supplements increased the mean haemoglobin concentration by 13.5g/dl compared with 3.5 g/dl (placebo) the mean body weight by 0.6 kg compared with 0.2 kg (placebo), the mean height by 0.4cm with 0.1cm (placebo). Combination of supplements had the greatest improvements in haemoglobin 18.5 g/dl; 0.7 kg body weight and 0.4 cm height. It was clearly showed that vitamin A deficiency and anaemia could be easily combated by supplementation in developing countries.

Ahmed et al., (2001) proved that adolescent girls who received weekly supplementation of 120 mg of elemental iron and 3.5 mg of folic acid and 2.42 mg of vitamin A, there was a significant increase in haemoglobin concentration and anaemia was reduced by 92 percent, vitamin A deficiency by 76 percent.

In industrialized countries with high bio availability diet, this strategy has been assumed to have a beneficial effect on iron status (Richard et al., 2002). Iron from ferrous sulphate had a significantly greater availability (Silva, 2004). Choudhury and Sheela Vir (1994) found that an increase in the daily intake of about one mg of haem iron, increased iron by 0.25mg. Haem iron in meat is absorbed up to 25 percent and is independent of iron status and meal composition (Hallberg and Rossander, 1998). They also reported that iron absorption is increased by simultaneous administration of vitamin C, succinic acid, fructose and cysteine.

Sprouted pulses have 50 to 60 percent increase in vitamin C which aids in iron absorption. Half a cup of any sprouted seed provides vitamin C equivalent to six glasses of orange juice (Vidushe, 2001). When 100 g of whole green pulse is sprouted, the sprouts provide 0.06mg thiamine, 0.66mg riboflavin, 1.5mg niacin and 82mg ascorbic acid (Indiadiets.com, 1999).

According to Sayer et al., (1990) ascorbic acid added at appropriate level enhances iron absorption from diets. Patterson and Brown (1998) concluded through studies that addition of 5mg of ascorbic acid to a maize meal increases iron absorption by three to five times. Rao and Prabhavathi (1998) reported that at an acid pH of 1.35, the soluble iron was slightly higher than the ionisable and soluble iron decreased in all the foods.

Iron absorption is increased with decreased iron stores, increased erythropoietic activity and during pregnancy (Mehta, 1993). Hallberg et al., (1992) estimated that those who have iron stores of 300 to400mg would absorb about 0.1 mg extra iron, whereas those who are at borderline iron deficient level would absorb an additional 0.25 to0.3mg iron. Hulten et al., (1995) showed that manganese inhibits non haem iron absorption as it shares with iron the same receptor for its uptake into the intestinal mucosal cell.

Sangeetha (1998) found that the absolute available iron in case of raw and poriyal forms of cauliflower leaves was 6.2mg percent and 6.6mg percent respectively. Among the cauliflower leaves incorporated dishes, the available iron was found to be 5.4mg percent for chapatti, 3.3mg percent for vadai and 3.5mg per cent for adai.

According to Jainita (1998) the total iron and absolute iron were maximum in bengal gram and soybean whereas total iron was least for cowpea and absolute iron was least for black gram. On roasting the bengal gram absolute available iron was almost doubled. Chiplonkar (1992) reported that roasting improved iron availability by 12 to19 percent in rice based weaning food. In vitro experiments based on iron availability in soybean products like sprouted soya flour, soy protein isolates and soya flour were found to be more (Yang and Roberts, 1993). A threefold increase in absorption of iron from Tofu, a fermented soya product was reported by Lynch (1997) in comparison with Tempeh, another fermented soya product.

Schendurnikar (1994) and Desai and Choudhury (1995) reported a 50 percent bioavailability of iron from breast milk compared to only 10 per cent for cow's milk and 5 to 10 per cent for iron fortified formulas. The increased bioavailability from breast milk is due to the presence of *lactoferrin* (Yeung, 1998).

According to British Nutrition Foundation (1998) Asian vegetarians are at higher risk because of high fibre intake which reduce iron absorption. The decreased iron absorption from meals containing wheat bran, studied by Winnowson and Malance (1995) confirmed that phytate is an important inhibitory factor in non haem iron absorption. Iron availability can also be influenced by mixing foods with varying amounts and forms of phytate and iron (Theil, 2004).

South et al., (1997) concluded that the consumption of herbal infusions tea at or around meals inhibit iron absorption due to their tannin content. A calcium rich diet of 1200mg per day increased the odds of low iron stores three times when compared to calcium poor isocaloric diet of 400mg. (National Institute of Health Consensus Conference, 1995). Ollivares et al., (1997) reported that dairy products like milk, inhibited *ferrous bisglycine chelate* bioavailability in humans.

Reinhold (1996) demonstrated that the major component of dietary fibre, cellulose and hemicellulose formed complexes with iron thus depressing iron bioavailability. Mahan (1996) observed 50 percent reduction in iron absorption after the ingestion of the food preservative, Ethylene Diamine Tetra Acetic Acid (EDTA). Iron absorption from typical Indian meals by *invivo* and *invitro* methods was shown to be only 2 to 5 percent (Rao, 1997).

Martinez (2002) reported that vitamin C such as oranges, tomatoes, amla and guava also helps to absorb iron from plant foods. Brock (2002) proved that ascorbic acid increase iron absorption 2 to 3 folds

A recent study showed that 27 percent of vegetarian women were iron deficient (Patterson and Brown, 2000). Two other studies reported, markedly reduced ferritin concentration (50%) for both ova and lacto vegetarians when compared to omnivores (Reddy and Sanders, 1990; Alexander et al., 1994).

Coconut Meal Based Food Products and their Nutritional Significance.

"Coconut is a wonderful gift of nature, high in taste appeal, nutritious as a wonder food, versatile in its uses and low in allergenicity." Fries (1998).

There are 1.3 billion malnourished people in the world and the population is increasing at the rate of 1.4 percent or 80 million people every year. In order to meet the food requirements at the present level of consumption we have to produce 50 per cent more food grains or find an alternative source of food supplements (Khush, 2000).

To meet the increasing demands, one of the largely untapped sources is the byproduct of the edible oil industry, namely oilseed meal. It is estimated that 195 million tones of oilseeds can theoretically yield nearly 100 million tones of meal, which is used for the preparation of a number of nutritious and relatively inexpensive foods, particularly for the developing countries. The hull of the edible oilseed imparts undesirable colour to the meal and also increases the crude fibre content of the meal. This problem can be eliminated by dehulling the seeds before oil extraction (Rao et al., 1989).

Technologies are available for the preparation of oilseed flours for edible purposes, protein concentrates and isolates and production of both traditional and fabricated foods (Rao et al., 1989). Regional Research Laboratory, Trivandrum, has released *partially defatted coconut gratings.* The dried gratings are subjected to compressive pressing using hydraulic press, when part of the oil oozes out, leaving behind white coloured (non discoloured) gratings containing the remaining oil. This partially defatted grating is available at an affordable price for producing food formulations and chutney preparations (Mathew, 2000). The yield and quality of copra varies depending on the maturity of the nut, variety, season of harvest, age of the palm, period of storage and agro climatic conditions, which directly affects the quality of the meal (Kabara, 2000).

Hodge and Osman (1994) listed a variety of products namely coconut oil, desiccated coconut, coconut cream, spray dried coconut milk powder, coconut syrup, coconut honey, coconut skim milk powder, tender coconut water and the coconut water based products such as vinegar and Nata-de-coco. All these products have captured vital position in food pattern of millions and yet the deoiled coconut meal has to be popularized more than these products due to its nutritional value and easy availability.

Lamothe and Rongnon (1998) considered coconut oil, edible oil cakes and desiccated coconut as Value Added Products for human consumption. Geevarghese and Pandiyan (2000) produced dairy foods incorporated with coconut meal. The nutritional significance of the meal is increased when milk products such as yoghurt, ice cream, filled milk, cheese, paneer and rasagolla have coconut meal as their basic ingredient in novel preparations.

Filipinos and coconut eating people are much younger than their age which proves that the nut possesses anti- aging agents. The tocotrienols, a subclass of vitamin E present in coconut plays a vital role as an anti-aging agent by reducing the serum cholesterol level (Banzon, 1988; Eapen, 1995).

Oke (1971) states that concentrate obtained from coconut seemed to follow a pattern similar to that of leaf protein except for much arginine and glutanlic acid, with leucine and isoleucine on the lower side. The ratio of Essential Amino Acids (EAA) as nitrogen (N) of coconut protein to total N is lower than in animal proteins.

Studies have indicated that the brown colour of the coconut meal is contributed mainly by the effect of polyphenol oxidase (PPO) or catechol oxidase and peroxidase (POD) like enzymes on the phenolic groups present in the peel, during processing and storage (Jiang et al., 1995).The ascorbic acid content and percentages of total, reducing and non-reducing sugars varied widely between the cultivars of coconuts. The exotic Malayasian cultivars were found to be rich in ascorbic acid and the meal rich in iron (Islam et al., 1994).

Kopyor coconuts i.e., matured coconuts with broken kernel particles contain sucrose (about 92 % of the total sugar), glucose and fructose, total amino acid, citric and malic acid which might contribute to the deliciousness of kopyor kernel. The lipid content was lower than the normal mature kernel with fatty acid profile similar to it. Kopyor water seemed to be a good source of dietary minerals with potassium as the predominant one. The deoiled meal contained about 70 percent of iron per 100g, with higher amounts of ascorbic acid, around 30 percent more than the normal values (Santoso et al., 1996). The study of chemical composition of coconut has paved way to discover the health benefits of coconut oil, meal and water (Mathew, 1991).

The health effects of coconut and its products were recognized centuries ago in ayurvedic medicine (Macalalag et al., 1997). The knowledge of the aborigines of Nicobar Islands and the tribal population of other parts of India, on the medicinal application of coconut palm product is extensive. They depended on these products for treating various ailments (Anzaldo et al., 1995). Monolaurin derivatives of coconut and palm kernel oils are used in the treatment of dental caries, cancer, prostatic hyperplasia, ulcer and allergies (Kabara, 2000).

Morrison (1991) compared the nutritional composition of coconut cake obtained by Expeller and Solvent method. The cake or peel left after the extraction of oil from copra forms about 32 to 40 percent of the copra crushed. The output of cake and its final composition depends upon the extraction methods employed.

Coconut cake or the deoiled coconut meal contains the coagulated proteins which have low molecular weight amino acids. Here, it has to be specified that, amino acids of low molecular weight increases the absorption of dietary iron (as ferrous form) in the mucosal wall, thereby increasing the bioavailability of iron in the gut (Shills et al., 1994).

The ICMR values indicate that 100g of deoiled coconut meal contains 69.4mg of iron. The availability of proteins as amino acids is enhanced by the addition of proteolytic enzyme in the colloid milling process. The fibre is also broken by the method of homogenization to get extra-fine grind product. Integrated Coconut Process (ICP) is useful to produce food grade coconut meal (Armour Research Foundation, 1983).

Coconut meal prepared from good quality copra, expressing the oil in an expeller (screw press) is a good source of protein and fibre (Swaminathan, 1999). Coconut meal at 10 to 20 percent levels enriches poor cereal diets and 30 to 40g/day is recommended, mixed with cereal or pulse flours. (Bhattacharyya and Bhattacharyya, 2002).

The proportion of protein to carbohydrate and fat is about 1:4 in the food-grade coconut meal (Morrison, 1991). Deficiency of lower chain fatty acids as present in coconut oil and ghee is linked to inflammatory bowel disorders such as Crohn's disease, ulcerative colitis and colon cancer (Itengen, 1992). The infusions of butyric acid (C4) may improve defective haemopoiesis seen in Cooly's anaemia by inducing gene expression of globin (Raheja and Bhoraskar, 1999).

Fresh coconut meat (kernel) is rich in fat and carbohydrates, and contains moderate amount of proteins (Woodroof, 1993). Coconut proteins are high in nutritive values and are fairly rich in lysine, methionine and tryptophan. As the fibre contained in the meal interferes with adequate utilisation of protein, attempts are being made to eliminate the fiber content (Subrahmanyan and Swaminathan, 1996).

Vanderbelt (1996) reported that coconut meat contained niacin 0.64mg /100g, pantothenic acid 0.52μg / 100g, biotin 0.02μg /100g, riboflavin 0.12mg / 100g and folic acid 0.003μg / 100g. *Thenga punnakku* as called in Tamil and Malayalam, and *Kobbari pindi* in Telugu and another vernacular name as *Narikela,* the deoiled coconut meal finds an important place in supplementation programmes of today's world. The oil meals are more nutritive and readily digestible in nature (Rao, 1995).

Use of coconut and its meal as a consumable byproduct is the main focal point in the discussions at the FAO Regional Office for Asia and the Pacific at Bangkok, Thialand. Nutritional analyses have paved way for its inclusion as a dietary food for the population in the rural Bangkok villages (Paroda and Mangala, 1995).

Use of coconut and its meal as a consumable byproduct is the main focal point in the discussions at the FAO Regional Office for Asia and the Pacific at Bangkok, Thialand. Even though Philippines is the second largest producer of coconuts in the world, the industry faces numerous problems and so, as a part of the coconut rehabilitation programme, the government offers financial incentives to produce food-grade byproducts for human consumption (Aldaba, 1995).

Raheja and Bhoraskar (1999) suggested that it is high time to revert to traditional food products and byproducts such as coconut meal and oil which can save us from grim health problems of the present and its alarming future prospects. This approach will save human life as it is highly cost effective and well within the reach of everyone. Itengen (1992) of Philippines felt proud that he was nurtured on coconut milk and not on mother's milk when he was an infant and specified that coconut is a wonder food for babies and even adults. Amon (1992) reported that tender coconut and its water increase the secretion of mother's milk in quantity and quality.

Countries like *Papua New Guinea* uses the deoiled coconut meal for nursing mother as a supplementary food and the copra production provides the livelihood for a majority of the population (Bastin, 1992). Very fine coconut meal was used in the development of reduced calorie Thai fruits flavored ice cream for teenagers and the role of meal to increase the nutritional quality was brought out with the increased iron content of the recipe (Pattra, 1997).

Even coconut oil has a place in the area of physiologically functional foods (Enig, 1995). A study conducted by Devadas et al., (1978) by feeding preschool children with coconut meal supplement for a period of three months revealed that there was an increase in weight at five per cent level of significance and an increase in haemoglobin levels at one per cent level of significance.

D. Nutrition and Health Education – A Mile Stone Approach to Overcome Nutritional Problems.

Nutrition education is one of the most important tools in controlling many deficiency disorders (Devadas et al:, 2000). Nutrition education also plays an important role in motivating children in the development of healthy habits and attitudes (Venkataiah, 2000).

The WHO constitution asserts that informed opinion and active cooperation on the part of the public are of the utmost importance in the improvement of the health. (WHO Report, 1998). The role of education in improving dietary and in contributing to health is quick evident and is one of the main contributing health development (Thylefors, 1999).

Realizing the magnitude of the problem several recommendations were made by WHO in order to bring out nutritional problems of adolescent population and one of these emphasizes that mass information and awareness programme are needed to alert Government and public about the importance of health and nutrition (www.who.int/nut/ado.htm).

Nutrition education program showed positive impact on nutrition knowledge and can be used as an effective tool to bring about dietary changes and thereby improve nutritional status (Prakash et al., 2002) Nutrition education involves a combination of activities including providing information, increasing peoples knowledge about the benefits of specific foods, behaviour , influencing and beliefs and motivating the adoption of healthy eating practices(www.fao.nutritioneducation.org,2003).

As youngsters of 21 years of age and below comprises nearly 50 percent of the world population. Today all educational intervention should be carried out at schools and college levels and also through non formal channels of information education and communication (Dube, 1996). So the intervention programme should help the youth for healthy eating and explain the consequences of unhealthy eating (Neumark and Sztainer, 2001).

A continuum of nutrition information, communication promotion and intervention strategies must be integrated in order to design the most appropriate educational intervention (Breach et al., 2002).

Cristacoll et al., (2000) reported that nutrition education that includes teaching specific behaviour skills may help to create a demand for more healthful food choices and eventually change cultural norms.King (1999) opines that health professionals and educators are in a prime position to have trends in this new era to address dietary advice and guidance and issues for optimal health.

Martin (2003) pointed out that nutrition education is a major component of health promotion and disease prevention and programs. Research indicates that behavioral change is directly related to the amount of nutrition education received. Nutrition messages and programs must be cultural relevant and specific to the target group.

The study investigated the effect of nutrition education based on the food guide pyramid on nutrition knowledge of adolescent. A significant difference was found between the post test scores of the control and experimental group; the experiential group demonstrated adequate knowledge of nutrition expect in the area of iron rich foods (Odlham, 2000).

Navy Food Management Team (2005) recently hosted a “nutrition for culinary certification” Class for area culinary specialist .Student were treated to lecture , videos and talk with persons on nutrition related issues. The class is designed to educate on the negative consequences of consuming a high fat diet, while providing option for ways to consume healthy foods and emphasizing physical activity.

Nutrition intervention should always focus on incorporating high fibre foods into children diet, encouraging breakfast consumption, good snacking behaviour and limiting soft drinks (Calderon, 2002).

Nebel et al ., (2002) suggested that computer based interactive education program is to support but not to replace structured education programs and to further motivate and attract patients to education programs. Multi component nutrition education programs include behavioral counselling, promotion of physical activity, parent training, modeling, dietary counselling and nutrition education (JADA-I, 2006).

Salgado et al., (2005) pointed out that Food and Nutrition Knowledge (FNK) may be useful as a model for nutrition education programs to improve the nutrition and health of the school children. Dosete et al ., (2004) stated that nutrition education and promotion of physical activity together with behaviour modification decrease in sedentary activities and the collaboration of the family could be the determining factors in the prevention of childhood health problems .

Osmania (2007) pointed out that adolescent girls consumed more amounts of aerated drinks, bakery items, fast foods and less consumption of millets irrespective of their socio economics conditions. However the consumption of vegetables, greens, and fruits was moderate. So the education on ill effects of aerated drinks, fast foods and the importance of nutrition during adolescents phase should be emphasized in future programs. Fatohy et al., (1998) imparted nutrition education to Egypt students after education their is increase in their daily consumption of fruits, cereals, greens and salad.

The class room based intervention resulted in a significant improvement in nutrition knowledge level of school children. Nutrition education programs provides an opportunity for school children to learn more about nutrition through their teachers in a class room setting if the lesson plans are adopted to the local circumstance(Rao et al., 2006).

Antony and Rao (2007) found a significant improvement in the nutrition related knowledge levels after the interventions, when compared to the baseline survey. The traditional method using print media such as folders, leaflets and charts was effective in improving the nutritional knowledge when compared to the intervention through Audio-visual CD.

Changes in the school environment to support healthful behaviour can be maintained over time. Staff training is an important factor in achieving institutionalization of these programmes. (Feldman et al., 2004).Thomas et al., (2001) reported that failure to change our priorities and current dietary practices will result in continued increases in overweight, chronic diseases and associated costs.

A school based programme involving school food service, physical education, classroom curricularm and the family can help children and adolescents make healthy changes in behaviour. If these changes can be continued for several years, they have a great potential for producing cardiovascular health benefits (CATCH, 2003).

Prevention and education programmes are needed to improve the dietary intakes of adolescents. Programmes that promote appropriate food intakes and use of fortified foods and supplements are needed (Tsang et al., 2000).By altering dietary behaviours, nutrition interventions during adolescents have the potential of affecting children at that time and later in life. (Evans et al., 2002)

The increased flow of goods, people and ideas associated with globalization has contributed to an increase in non communicable diseases in much of the world. One response has been to encourage life style changes with educational programmes, thus controlling the lifestyle related disease. (Wang et al., 2001)

Schoolyard gardens are emerging as a nutrition education tool in academic settings. Although further research is needed, the results of the study, "Garden-based nutrition education and its effects on fruit and vegetable consumption in sixth-grade adolescents", Seems to indicate the efficacy of using garden based nutrition education to increase adolescent's consumption of fruits and vegetables (Rankin and Aleese et al., 2007).

Baring et al., (2002) states that dietary counseling imparting to adolescents resulted in significant improvement in knowledge of the subjects and adoption of desirable practices by the subjects. Winkelby et al., (1992) opinion that education may be good for body as well as mind by influencing life style , behaviour , problem solving abilities, health and values .

Individuals are being expected to assume increasing responsibility for their own health. Every child is required to create health within the settings of his every day, be it at home or school.There is a need to address both under and over nutrition in adolescents in preventive and rehabilitative intervention programme (Jackson et al., 2001).

Nutrition educators may be successful in their pursuit of imparting recommendation of healthy eating to adolescents by delivering healthy eating message presenting them in effective and attractive manner (Croll, 2001).