2. REVIEW OF LITERATURE

Research is a scientific and systematic search for pertinent information on a specific topic and a systematic method, consisting a problem, formulating a hypothesis, collecting the past data, analyzing the fact and reaching certain conclusions. It gives the investigator an excellent overview of work done in the field and helps in keeping up with recent developments. In this way review of literature helps us to distinguish between what has been done and what needs to be done. The review of literature has been discussed under the following heads:

2.1 Importance of Micronutrients

2.2 Micronutrient deficiencies
   2.2.1 Deleterious effects of Micronutrient deficiency
   2.2.2 Prevalence of Micronutrient deficiency

2.3 Approaches to combat Micronutrient deficiencies
   2.3.1 Government Initiatives against Micronutrient deficiency

2.4 Food based approaches with focus on Green Leafy Vegetables

2.5 Effect of processing techniques on Nutrient and Anti nutrient composition

2.6 Value addition and Organoleptic evaluation

2.7 Nutritional estimations of value added products

2.8 Effect of processing on shelf life of products
2.1 Importance of Micronutrients

Micronutrients are those substances which are needed only in minuscule amounts. They are known as “magic wands” that are important for proper growth and development. UNICEF (1998) defined micronutrients as nutrients that are only needed by the body in minute amounts, which play leading roles in the production of enzymes, hormones and other substances, helping to regulate growth activity, development and functioning of the immune and reproductive systems. Micronutrients of known public health importance include the following: iron, iodine, zinc, copper, vitamins A, E, C, D, B₂, B₆ and folate (Ekweagwu, Agwu, & Madukwe, 2008).

According to Singh (2004), minerals and vitamins are required for regulation of biological processes and further stated that they are required for energy production and providing protection against reactive oxygen free radical. Micronutrients are vital to the proper functioning of all the body’s systems. It is responsible for maintaining the proper fluid balance in the body, which helps fluid pass through cell walls and helps regulate appropriate pH levels in the body. They also promote bone formation and energy production which helps to metabolize the macro nutrients like protein, carbohydrate and fat. It helps the heart to maintain its normal rhythm and also enable to convert glucose (blood sugar) into energy and it is necessary for the metabolization of the micro nutrients like calcium and vitamin C. They produce red blood cells and lymphocytes. It helps to regulate water and electrolytes within the cell as well as helping to maintain cellular pH. They are also required for sexual maturation and neuro motor development. They also recognized to boost both cell-medicated and humoral immune deficiencies of the body.

Therefore, it can be concluded that Micronutrients are essential vitamins and minerals that everyone needs in minute quantities for good health and without them; the human body does not grow and function properly.

2.2 Micronutrient deficiency

Micronutrient deficiencies rank among the top twenty risk factors for morbidity and impaired quality of life worldwide, with particular burdens falling on populations in poor countries. The statistics of micronutrient deficiency are alarming. It is an ecological problem that occurs along with its consorts like poverty, disturbed family structure, ignorance, lack of awareness and knowledge in view of nutrition (Ecker, Agwu, & Madukwe, 2010). Multiple micronutrient deficiencies are more common than single
deficiencies in developing countries and the cause for their high prevalence is low dietary intake by populations and poor net bioavailability of nutrients. According to a new World Bank report, micronutrient deficiency is costing poor countries up to three percent of their yearly gross domestic product and malnourished children are at risk of losing up to ten percent of their lifetime earning potential (Karva, Bharati, & Chimmad, 2010).

Micronutrient deficiency is found to be a widespread problem in developing countries irrespective of topographical description. In developing countries, where poverty prevails, deep rooted traditions, taboos and false beliefs have imprisoned the people, the serious deficiency disorders of micronutrients and its impact is more acute and profound. In 1990, the World Health Organization (WHO), United Nations Children’s Fund (UNICEF), and the World Summit for Children endorsed the elimination of micronutrient deficiency in developing countries by the year 2000, specifically deficiencies of vitamin A and two trace elements – Iron and Iodine. Deficiencies of these micronutrients were estimated to affect the health, mental and physical function, and the survival of more than two billion people worldwide. As government has launched the programme of fortifying salt with iodine on a large scale, which is easily available even in the remote areas and community shops at affordable price. Hence we have concentrated mainly on vitamin A and Iron deficiencies (Gibson & Hotz, 2001).

They affect low-income countries but are also a significant factor in health problems in industrialized societies with impacts among wide vulnerable groups in the population. Numbers of individuals in the world suffering from clinical manifestation of micronutrient deficiency run into several millions. Moreover, these problems certainly overlap and interact; so many people must have multiple deficiencies (Thu et al., 1999).

2.2.1 Deleterious effects of Micronutrient deficiency

Vitamin A is a fat-soluble vitamin. Two different types of vitamin A are found in the diet. Preformed vitamin A is found in animal products such as meat, fish, poultry and dairy foods. The other type, pro-vitamin A is found in plant-based foods such as fruits and vegetables. The most common type of pro-vitamin A is beta-carotene. Vitamin A helps to form and maintain healthy skin, teeth, skeletal and soft tissue, mucus membranes, and skin. It is also known as retinol because it produces the pigments in the retina of the eye. Vitamin A promotes good vision, especially in low light. It may also be needed for reproduction and breast-feeding (Ekweagwu, Agwu, & Madukwe, 2008).
According to West, Klemm, & Sommer, (2010) moderate to severe vitamin A deficiency is marked by the presence of night blindness or clinical eye signs which can and does impair physical growth in young children. In severe Vitamin A Deficiency, such as that resulting in keratomalacia, the mortality rate is as high as 60%. Lowered resistance to infections due to Vitamin A Deficiency has been observed in children even before eye symptoms appear. Vitamin A intervention in deficient children has been shown to restore cell-mediated immune response and enhance antibody response as well as macrophage functions, suggesting an immune potential effect of vitamin A. Children with even mild VAD have a threefold higher risk of diarrhea, twofold higher risk of ARIs, and 6 to 9 times greater risk of death. In developing countries, diarrhea and measles account for 58% of deaths among children under five year of age (Hadi et al., 2000). Vitamin A deficiency is an important child health problem in many developing countries, with consequences ranging from potentially blindness xerophthalmia to increased risks of infection and mortality (Sommer & West, 1996).

Deficiency of vitamin A is the most common preventable cause of blindness among children. Recently, it has become evident that vitamin A plays important roles in ensuring protection against infections and maintaining many normal body functions, especially body immunity. Mortality in childhood and infancy, as well as even intrauterine fetal loss, have been associated with vitamin A deficiency (West et al., 1995). The integrity of epithelial barriers and the immune system are compromised before the visual system is impaired. This leads to increased severity of some infections and the risk of death, especially among children (Hussain, Kvale, & Odland, 1995).

Iron is one of the trace minerals that play a vital role in the body. The whole body contains about 4 g of iron. Three-fourth of this is found in association with the protein, hemoglobin. In foods, iron occurs in two forms ferrous and ferric but the absorption form of iron is only in ferrous state. The function of iron in the body can’t be overlooked as it is involved in the synthesis of other compounds in the body. Iron is important in reactions involving energy release in the body (oxidation and reduction reactions). It is a component of oxygen carrying compounds e.g. hemoglobin, myoglobin (Ekweagwu, Agwu, & Madukwe, 2008).

Deficiency of these micronutrients has a significant impact on children as well as on the economic development of communities and nations. These deficiencies can lead to
serious health problems, including reduced resistance to infectious diseases, blindness, lethargy, reduced learning capacity, mental retardation and in some cases, to death. Among the debilitating consequences of these dietary deficiencies is loss of human capital and productivity. The full genetic potential of the child for physical growth and mental development may be compromised due to sub clinical deficiencies of micronutrients, which are commonly referred to as ‘Hidden Hunger’. Children with these sub clinical deficiencies of micronutrients are more vulnerable to develop frequent and more severe common day to day infections thus triggering a vicious cycle of under nutrition and recurrent infections (Ekweagwu, Agwu, & Madukwe, 2008).

According to Domellof & Hernell (2002) poorer cognitive and motor functions have shown in young children with iron deficiency anemia than do controls. These differences have remained when controlling for social background factors, even though the possibility of confounding environmental factors or nutritional deficiencies. Hass & Brownlie (2001) suggested in their study that prevalence of iron deficiency anemia is alarming worldwide and its public health significance can’t be judged solely on its prevalence. Therefore, significance deleterious consequences of iron deficiency must also be documented in making this judgement. Physical working capacity is one of the several areas of human performance that have been widely reported as being impaired by iron deficiency.

Iron deficiency results from depletion of iron stores and occurs when iron absorption cannot keep pace over an extended period with the metabolic demands for iron to sustain growth and to replenish iron loss, which is primarily related to blood loss. The primary causes of iron deficiency include low intake of bio available iron, increased iron requirements as a result of rapid growth, pregnancy, menstruation and excess blood loss caused by pathologic infections, such as hook worm causing gastrointestinal blood loss and impaired absorption of iron (Till & Crundman, 1997; Rockey & Cello, 1993).

Micronutrient deficiency continues to cause severe illness or death in millions of people world-wide. Due to the complexity and variety of deficiency problems within countries and other geographical and social strata, the precise causes of micronutrient deficiencies are accordingly specific. Micronutrient deficiency results from either inadequate nutrient intake or disease both of which are brought about by one or a combination of three interrelated conditions; inadequate household food security,
inadequate maternal and child care, insufficient health services and unhealthy environment. These underlying causes have a base in the social, political and economic environment that determines the utilization of potential resources. Dietary inadequacy is thought to be the major cause for micronutrient deficiency (van den Broek, 2003).

Ekweagwu, Agwu, & Madukwe (2008) suggested that night blindness is the first signs of vitamin A deficiency, which makes the cornea very dry thereby the retina and cornea. It was also observed that vitamin A deficiency diminishes the ability to fight infections. Vitamin A deficiency occurs when insufficient vitamin A is consumed in the diet, too little is absorbed from the food eaten, or too much is lost due to illness (Gorstein, Bhaskaram, Khanum, Hussaini, Balakrishna, & Goodman, 2003). In the developing world, vitamin a deficiency is common because the cereal based diets commonly consumed predispose people to low intake and insufficient absorption of several vitamins including vitamin A due to their high phytate content. Therefore, the key risk factors for vitamin A deficiency are a diet low in sources of vitamin A; poor nutritional status; poverty and ignorance; a higher rate of infections in measles and diarrheal diseases. During infections, both demand and loss of vitamin A increase (UNICEF, 2006; Stephensen, 2001).

Vitamin A deficiency is a serious public health problem in many developing countries, including most of the countries of eastern, central and southern Africa. There are two main causes of vitamin A deficiency in humans: failure to consume adequate amounts of vitamin A (or vitamin A precursors) and failure to absorb vitamin A during digestion, due to poor health caused by malaria, measles, intestinal parasites and other diseases. Absorption of vitamin A precursors can also be reduced if fat is lacking in the diet (Low et al., 1997; World Health Organization, 1995).

In the case of developed countries, decreased iron absorption and blood loss account for the more likely etiologies of iron deficiency (Johnson-Wimbley & Graham, 2011). Decreased iron absorption may also be resulted in mal absorption syndromes especially celiac disease (Bermejo & Lopez, 2009).

Ekweagwu, Agwu, & Madukwe(2008) stated that the main nutritional cause of iron deficiency anemia are diets that provide too little iron, poor absorption of most dietary iron, and the presence of other dietary factors that inhibit iron absorption. Although an inadequate iron diet is by far the major cause of anemia, it also can occur as a result of
parasitic infections, inherited disorders, and deficiencies of other nutrients. Rockey (2005) observed that the main common cause of iron deficiency anemia is Gastro intestinal bleeding (acute or chronic). Low iron bioavailability of the diet is the primary cause of iron deficiency anemia in the developing countries (Berger & Dillion, 2002; Yip & Ramakrishnan, 2002).

Infants and young children are the most adversely affected by iron deficiency because they are growing and developing at such a fast rate (Draper, 1996). If iron deficiency is not corrected, it leads to anemia, which is the most common nutritional disorder in the world. Draper (1996) also observed that iron deficiency anemia is associated with impaired development of mental and physical coordination skills and impaired school achievements in older children. It lowers resistance to disease and weakens a child’s learning ability and physical stamina. It also slows mental and motor development and reduces work performance.

2.2.2 Prevalence of Micronutrient deficiency

Micronutrient deficiency is widespread in the industrialized nations. They affects approximately one third of the world’s population, even more so in the developing regions of the world. It is a silent massacre: every year some 11 million children – 6 million of them just five years old or younger – are dying from micronutrient deficiency (Saradha & Rajeshwari, 2008).

Vitamin A deficiency ranks among the four major public health nutritional problems affecting not only children but also women of the reproductive age group and others. However, over the last decades there has been marked declined in keratomalacia and nutritional blindness. The problem to content with now is the less severe but more widespread moderate deficiency inform of night blindness, Bitot’s spots, low serum levels of vitamin A and functional impairment (Semba et al., 2010). Vitamin A deficiency is a major cause of morbidity, mortality and blindness in the developing world, affecting an estimated 125-130 million preschool aged children and 7 million pregnant women in low income countries (Kraemer et al., 2008). Table No 2.1 shows the prevalence of vitamin A deficiency across the world. Nonetheless, Africa has the highest prevalence of clinical vitamin A deficiency (Micronutrient Forum, 2007).
Table No 2.1

Prevalence of Vitamin A Deficiency across the world

<table>
<thead>
<tr>
<th>Region</th>
<th>Serum retinol &lt;0.7 µmol/l</th>
<th>Xerophthalmia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>No. (millions)</td>
</tr>
<tr>
<td>Africa</td>
<td>32</td>
<td>33.4</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>21</td>
<td>12.7</td>
</tr>
<tr>
<td>South/South East Asia</td>
<td>23</td>
<td>55.8</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>14</td>
<td>17.1</td>
</tr>
<tr>
<td>Americas</td>
<td>17</td>
<td>8.2</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>127.3</td>
</tr>
</tbody>
</table>

Source: Micronutrient Forum, 2007

World Health Organization, (2006) estimated 0.5 percent of preschool age children and around 10 percent of pregnant women to be affected by night blindness in South-East-Asia. Further, the estimates show that the South-East-Asian region has the highest proportions of preschool age children (approximately 50 percent) and pregnant women (17.3 percent) with biochemical VAD, as indicated by a serum retinol concentration below 0.70 µmol/l. Vitamin A deficiency affects approximately 25 percent of pre-school children in the developing world. It is associated with blindness, susceptibility to disease and higher mortality rates affecting approximately 3 million children each year (Thapa, Choe, & Retherford, 2005).

According to World Health Organization criteria, a greater than 1% prevalence of night blindness in children aged 24-71 months, indicates a public health problem. It has been suggested recently that a prevalence of night blindness of more than 5% in pregnant women should be added to the list of criteria that signify a public health problem (World Health Organization, 2004). There is now extensive evidence that vitamin A deficiency is widespread in young children in many developing countries. World Health Organization, (2004) estimates that globally, over 250 million children under five years of age are affected by vitamin A deficiency. The prevalence of both clinical and sub clinical vitamin A deficiency is highest in Africa and South East Asia (World Health Organization, 2004). In Sub Saharan Africa, it is estimated that 42% (43.2 million) children under five
years of age are at risk of vitamin A deficiency (Gorstein, Bhaskaram, Khanum, Hussaini, Balakrishana, & Goodman, 2003). According to West (2002) 127 million preschool children and 7 million pregnant mothers are deficient in vitamin A and a total of 800,000 children die every year due to lack of vitamin A.

Vitamin A deficiency is widely prevalent, particularly in the developing world. Worldwide, about 3 million preschool children develop ocular sighs of vitamin A deficiency. Recent analysis indicated that there are approximately 727 million and 4.4 million pre-school children with vitamin A deficiency and xerophthalmia respectively (World Health Organization, 2002).

A cross sectional study was carried out to determine the prevalence of vitamin A deficiency in children between the age group of 6-9 years in northern Ethiopia. The data were analyzed for 824 (61.5%) out of 1339 eligible children. The prevalence of xerophthalmia was 5.8%; serum retinol levels were below 0.35 µmol/l in 8.4% and between 0.35 to 0.70 µmol/l in 51.1% of the children respectively. The high prevalence of severe vitamin A deficiency in children between 6-9 years indicated the need to re-evaluate the practice of targeting vitamin A supplementation programmes on children under 6 years of age in areas where vitamin A deficiency is endemic (Kassaye, Receveur, Johns, & Becklake, 2001).

A population based, cross sectional study, using a two-staged stratified cluster sampling method was conducted in Nigeria. The national prevalence of xerophthalmia was reported to be 1.1%, prevalence of vitamin A deficiency using serum retinol < 20 µg/dl (or 0.7 µmol/l) as cut-off was 28.1%; both values are indicative of a problem of public health significance. Hence, there was an urgent need for the relevant authorities to pursue active and realistic policies in order to prevent further unnecessary blindness, morbidity and mortality in Nigerian children (Ajaiyeoba, 2001).

Approximately 3 million children in the world develop xerophthalmia annually, 250,000 to 500,000 of whom become blind, and at least 60% die within one year. Estimates of sub clinical deficiency among preschool aged children range from 75 million to 250 million. Recently reported studies suggest that in South Asia alone, 1-2 million pregnant women may be at risk from sub clinical vitamin A deficiency (Kidala, Greiner, & Gebre-Medhin, 2000).
A study conducted by National Institute of Nutrition in (2006) undertook exclusive surveys in eight states viz., Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Orissa, Tamil Nadu, Maharashtra and West Bengal, to assess the prevalence of vitamin A deficiency among the vulnerable groups of rural population. The investigations included assessment of prevalence of clinical forms of vitamin A deficiency among preschool children. The prevalence of sub clinical VAD was significantly high among preschool children in being 69.3% among Muslim, and 68.8% in Christian communities, 74.1% in scheduled tribe and 62.9% in other backward communities. Occupation wise labor among 64.1%, and 65.4% among business. Only about 41% of the mothers having children between 1-5 years old preschool category were aware of causes and consequences of night blindness. The overall prevalence of Bitot’s spots was 0.8% among preschool children. The prevalence of Bitot’s spots was higher than the WHO cut off level of 0.5% in 6 out of 8 states surveyed, indicating that Vitamin A Deficiency continues to be a nutritional problem of public health. The prevalence of Bitot’s spots was nil in the state of Kerala, it was about 0.3% in Orissa.

According to the survey carried out by National Nutrition Monitoring Bureau, (2006) in 10 states of India, analysis of blood samples revealed that the overall median vitamin A level was 16.8 mg/dl, and it ranged from a low 9mg/dl in Madhya Pradesh to a high 20.1 mg/dl in Tamil Nadu. The levels were similar between age groups and gender. About 62 percent of children in general, had vitamin A levels of <20 mg/dl, indicating sub clinical VAD, and this ranged from as low as 49 percent in the state of Tamil Nadu to a high as 88 percent in Madhya Pradesh. The proportion of children with sub clinical VAD was significantly higher among 3-5 year old children (63.1 percent) in comparison to 1-3 years (59.6 percent). No significant gender differentials were observed in the present survey.

A study was carried out by National Nutrition Monitoring Bureau, (2003) in Southern states to assess prevalence of vitamin A deficiency among preschool children. a total of 75600 households from 633 villages were covered. Clinical examination of 71591 preschool children was conducted and results of the survey indicated that prevalence of Bitot’s spots ranged from nil in Kerala to a maximum of 1.4% in Madhya Pradesh, followed by 1.3% in Maharashtra, and 1.2% in Andhra Pradesh. Overall prevalence of night blindness was about 0.3% and that of conjunctival xerosis was 1.8%. Toteja, Singh, Dhillon, & Saxena, (2002) carried out a study in 16 districts of India to find out the
prevalence of Vitamin A Deficiency disorders among children and pregnant women. The findings revealed prevalence of Bitot’s spots among more than 0.5 percent of children (<6 years) in the district of Bikaner, Rajasthan, which according to WHO cut-off values indicated a public health problem.

In Industrialized countries, the most affected groups are pregnant women (18 percent) and preschool children (17 percent), followed by non pregnant women and older adults, both at 12 percent. The prevalence of anemia is low for adult males in industrialized countries (5 percent) but no less than one third of adult males are anemic in developing countries. With regard to preschool children, anemia prevalence is the highest in Africa and Asia. In Africa the middle part of the continent from West to East is most affected, with anemia prevalence ranging from 42 percent to 53 percent. In Asia the most affected sub-region is South Central Asia. In the American, the Caribbean is most affected, with a prevalence of 39 percent, while anemia prevalence in South and Central America are similar to those observed in the remaining parts of Africa and Asia. Among industrialized countries, anemia prevalence is lowest in Northern Europe (2 percent) and around (5 percent) in Western and North America (World Health Organization, 2007).

World Health Organization (2006) reported that Iron deficiency is the most prevalent, estimated that just over 2 billion (40% of the world’s population) people suffer from iron deficiency. The mean prevalence among specific population groups were estimated to be:

- Pregnant women, infants and children aged 1-2 years (50%).
- Pre-school aged children (25%)
- School going children (40%)
- Adolescent (30-55%)
- Non pregnant women (35%)

Iron deficiency is mainly a problem in developing countries; it also seems to affect large fractions of population in the industrialized world. It is estimated that 36 percent out of an estimated population of 380 million in developing countries and 8 percent of an estimated population of 1200 million in industrialized world are affected by iron deficiency anemia. In India alone, depending on age and sex Iron deficiency anemia has been reported to range from 38-72 percent, majority of them being women and children. The prevalence of iron deficiency anemia rate beyond the age of six years
increases in girls. Estimates suggest that about 25-50 percent girls become anemic by the time they reach menarch. Among all anemia, iron deficiency anemia is the most common (90 percent) and major public health problem in our country (World Health Organization, 2004; Bentley & Griffiths, 2003; Agarwal & Kripani, 2002).

Iron deficiency anemia is a problem of serious public health significance. It occurs when an insufficient amount of iron is absorbed to meet the body’s requirements. Over 1.2 billion people worldwide suffer from Iron Deficiency anemia arising from a variety of causes including insufficient intake of iron rich foods. Globally, about 53% of school age children suffer from Iron deficiency anemia, of which, the prevalence was 58.4% in Asia and 49.8% in Africa (Drake et al., 2002). Iron deficiency anemia can have significant negative impacts on the growth and development of children.

In developing countries most highly affected population groups are pregnant women (56 percent), school age children (53 percent), non pregnant women (44 percent) and preschool children (42 percent). On the whole, iron deficiency and its anemia affects 3.5 billion people in the developing world (Stolzfus, 2001). Global anemia prevalence when examined for each physiological group using the World Health Organization (2000) global database on anemia. Reports highlighted that most affected groups were pregnant women (48 percent) and 5-12 years old children (46 percent). Predictably, the prevalence of anemia in developing countries was three to four times higher than in industrialized countries.

A study was designed by Bhoite & Iyer, (2011) on magnitude of malnutrition and iron deficiency anemia among rural school aged children in Vadodara district, Gujarat. Forty eight government primary schools were selected for the study. On examination, the prevalence of iron deficiency anemia was 73%. Majority children were in mild to moderate category hence, concrete efforts should be made to curtail the prevalence otherwise it may worsen to severity. It was seen that percentage of anemic children increased as the severity of underweight increased. Only 25% of the mild underweight children were anemic as against 42% of anemia in severely underweight category.

A high prevalence of anemia among adolescent girls was found, belonging to lower socio economic strata. It was observed that anemia affects overall nutritional status of the adolescent girls (Siddharam, Venketesh, & Thejeshwari, 2011). Zanvar, Devi, & Arya (2008) reported that the most crucial segment of the population from the point of
view of quality of future generation i.e. today’s young girls who are just on the threshold of marriage and motherhood. A cross sectional survey was conducted in selected Anganwadi centers of rural areas of Hassan district, Karnataka. The sample size consisted of 314 adolescent girls between 10-19 years of age and the intervention period extended for 3 months. Results showed that the prevalence of anemia was found to be 45.2%. A statistically significant association was found between weight loss and anemia, pallor and anemia. It was seen that about 44.1% were mildly anemic, 54.92% were moderately anemic and 49.2% were severely anemic.

A study was conducted on the Assessment of nutritional status of 7-10 years school going children of Allahabad District. Schools were selected from Allahabad district, Uttar Pradesh. A total of 150 school going children (7 to 10 years) were selected randomly. Out of the total children, 65.33% had Hb level below the normal (12 g dl) values, indicating anemia, out of 53.33% were mild anemic and 12% were moderate anemic. Feeling breathlessness and easily tired were experienced by 30.5 and 23.73% of the subjects respectively (Handa, Ahamad, Kesari, & Prasad, 2008).

A cross sectional study was conducted to assess the magnitude of anemia in school going, pre adolescent and adolescent girls along with associated demographic variables. The study was conducted on girls of school going age (6-18 years) residing in 15 randomly selected slums of the north zone of Ahmadabad city. Twelve hundred ninety five girls were selected for the study from which about 89% agreed to give blood samples for hemoglobin estimation. Majority (81.8%) of girls was anemic and the overall prevalence of mild, moderate and severe anemia was 55.2%, 26% and 0.6% respectively (Verma, Rawal, Kedia, Kumar, & Chauhan, 2004).

National Family Health Survey II (2000) also reported that overall 52 percent of married women and 74 percent of children aged 6-35 months are anemic in India, out of which majority are moderately anemic. In Rajasthan, the highest prevalence of anemia i.e. 82.3 percent in pre-school children has been reported.

2.3 Approaches to combat Micronutrient deficiency

India was the first developing country to take up a National Programme to prevent vitamin A deficiency and anemia among children, pregnant women, lactating mothers and children. Government of India introduced the Vitamin A Prophylaxis
Programme and National Nutritional Anemia Prophylaxis Programme now referred to as (National Nutritional Anemia Control Programme) in 1970 (Semba et al., 2010; Kalaivani, 2009). These National programmes distribute the dosage to the entire vulnerable group in India through the primary health care system. So the vast majority, who never seek health care, could benefit from this outreach programme. It was hoped that these programmes will bring about a reduction both in the prevalence and severity of these deficiencies. However, all the national surveys (National Family Health Survey -2, 2000; National Family Health Survey -3, 2005; Toteja & Singh, 2004; National Nutrition Monitoring Bureau, 2003) indicated that coverage under all these programmes was very low and there has not been any change either in the prevalence of these deficiencies or the adverse consequences associated with vitamin A deficiency and anemia (Kalaivani, 2009).

Hence, different strategies should be implemented to reduce or control micronutrient deficiencies. They should operate in concert with broader strategies to improve the quality of life in particular countries and communities. Actions at all level-international, local and family to improve household food security, individual health and care can have an impact on micronutrient deficiency and their control (Singleton, Orthofer, & Lamuela-Raventos, 1999). There are two basic approaches to meet all the requirements:

- Medicinal approach.
- Food-based approaches (Singleton, Orthofer, & Lamuela-Raventos, 1999).

2.3.1 Government Initiatives against Micronutrient Deficiency

Medicinal approach

The provision of micronutrients taken orally or by injection is simply called “supplementation” rather than “medicinal supplementation”, but in fact these supplements are generally provided as medicine or used in a medicinal sense (Solon, Klemm, Sanchez, Darnton-Hill, & Crafy, 2000). Supplementation with medicinal iron has the advantage of producing rapid improvements in biochemical status. As a strategy it also has a desirable specificity. It can be targeted at the population groups at the greatest risk of becoming micronutrient deficient (Gorstein et al, 2003).

Vitamin A is a fat soluble vitamin; once absorbed, it is excreted slowly and a good proportion of a high dose remains for some time in the body. Therefore large doses of
vitamin A can be given at long intervals. Two lakh IU of Vitamin A dose should given to children (1-4 years) and all mothers irrespective of their mode of infant feeding up to six weeks postpartum if they have not received vitamin A supplementation after delivery. One lakh IU should be given to infants aged from 9 to 11 months (World Health Organization, 1999). Government is using medicinal vitamin A supplementation through universal supplementation programme to reach all children of a defined age group in our country (Gibson, Hotz, Temple, Mittimumi, & Ferguson, 2000).

Dairo & Ige, (2009) conducted a study for assessing the effects and safety of vitamin A supplementation in children 6-59 months of age. Adverse effects were reflected within 48 hours of receiving supplements. The adverse effects included blurring of open fontanelles in younger infants, and nausea and/or vomiting and headache in older children with closed fontanelles.

Many times in intervention programmes toxicity due to over dosage of vitamin A have also reported the sign and symptoms of acute vitamin A toxicity include nausea, vomiting, diarrhea, change in humor (irritability, drowsiness, dizziness, lethargy), increased intracranial pressure (headache, bulging of fontanelle, diplopia, papilloedema), skinning change (World Health Organization, 2009). However, sign and symptoms of chronic vitamin A toxicity produce low grade fever, headache, fatigue, irritability, anorexia and loss of weight, vomiting and other gastrointestinal disturbances, skin changes (yellowing, dryness, sensitivity to sunlight, brittle nails, hair loss), anemia, hypercalcemia, raised intracranial pressure (papilloedema mimicking brain tumors, visual disturbances which may be severe), subcutaneous swelling, nocturia and pains in the bones and joints (Gibson, Hotz, Temple, Mittimumi, & Ferguson, 2000).

The National Nutritional Anemia Prophylaxis Programme (NNAPP) was initiated in 1970 to control iron deficiency anemia in the vulnerable groups through daily supplements of iron-folic acid tablets. The suggested prophylactic doses of iron and folic acid respectively were 60 mg and 500 µg for pregnant women and 20 mg and 100 µg for children per day for 100 days. These tablets were distributed to the high risk groups by the local health workers. An evaluation in 11 states during 1985-86 indicated very poor coverage and performance of the Programme. There was no impact of the Programme on the prevalence of anemia in pregnant women of more than 37 weeks of gestation. Hence,
the dosage of iron in iron-folic acid tablets was increased from 60 to 100 mg in 1992 (Indian Council Medical Research, 2000).

Most iron supplementation programmes worldwide use ferrous sulphate, which provides iron in a form that is well absorbed. It is usually given in tablets providing 60 mg of elemental iron, and women are advised to take three tablets per day throughout pregnancy. It is reported that many women do not take the tablets because of perceived adverse side effects. About 200 mg of iron which is in the form of ferrous sulphate is given for the age of 5 to 10 year children on daily or weekly basis for 2 months (Gibson, Hotz, Temple, Mittimuni, & Ferguson, 2000).

The institute of medicines has set certain guidelines on the upper limit of iron intake on daily basis. For adult children and infants, the upper limit for adults and teenagers is 45 mg per day regardless of pregnancy and lactation. Infant and child have a maximum recommended dose of 40 mg per day. In clinical practice a patient of iron deficiency anemia (mild to moderate) responds readily to treatment with oral supplementation, but common adverse drug reactions found with iron supplements are mainly gastrointestinal intolerance like nausea, vomiting, constipation, diarrhea and abdominal pain. The severity and occurrence of the effect depends upon the formation of the supplement and the amount of iron released in the stomach (Patil, Khanwelkar, & Patil, 2012; Underwood, 2000).

A study was carried out by National Nutrition Monitoring Bureau (NNMB), 2003 to assess prevalence of iron deficiency anemia among preschool children, adolescent girls and pregnant and lactating women. A total of 75600 households from 633 villages were covered. Three thousand two hundred ninety one preschool children, 6616 adolescent girls, 2983 pregnant women and 3206 lactating mothers were covered for hemoglobin estimation. About 9% pregnant women, 4% lactating women and 0.3% preschool children reported side effects on consumption of IFA tablets, mostly in the form of vomiting (0.2-4.1%), nausea (0.1-5%) or black stools (0.1-1.2%).

Policies and programmes should focus on effectively alleviation of micronutrient deficiencies by measures like increasing overall food intake, increasing consumption of micronutrient rich foods, modifying intake of dietary inhibitors and enhancers by effective processing techniques, using improved processing, preservation and preservation and
preparation techniques, consumer education for behavior change, improving food quality and safely and public health, and food fortification and supplementation (Baccini et al., 2006).

2.4 Food Based Approaches with focus on Green leafy vegetables

Food based approaches for improving nutrition have often been overlooked as governments, researches, donors and the health sector sought solutions with rapid start up times and quick, measurable results. However, experiences in a number of developing countries have shown that well-designed food based interventions – combined, where appropriate, with the use of supplements and supported by health and nutrition education – can improve the diets of vulnerable populations in a relatively short period of time and that those improvements are sustainable (Fanzo, Cogill, & Mattei, 2012; Food and Agriculture Organization, 2011a; MacDonald, Bennett, Potter, & Ramankutty, 2011; Shivashankaran et al., 2011; Shetty, 2011; Thompson & Subasinghe, 2011; Arimond et al., 2010; Food and Agriculture Organization, 2006a).

Yadav, Kumar, Srivastava, Kumar, & Sharma, 2011 conducted a research to analyze the hemoglobin status of adolescent girls. Thirty three subjects were taken as experimental group and fed 100 gram of standardized chakli by incorporating 10% dehydrated onion stalk for 30 days. Control group (n=40) was not given any supplementation. After 30 days of feeding experiment, the mean hemoglobin level of experimental group was ranged from 8.20±0.21 g/dl to 8.58±0.26 g/dl, hence a significant improvement was observed. However, the change in the control group was found non significant, ranged from 7.58±0.19 g/dl to 7.67±0.21 g/dl. Hence, supplementation of dehydrated onion stalks based product Chakli can significantly improve the hemoglobin status of adolescent girls.

Community trials have shown that preschool child mortality can be reduced by 25-30 percent in malnourished population when children over five months of age are supplemented with vitamin A directly or vitamin A fortified food. These supplementations lead to approximately 2.5 million preventable child deaths occurring each year due to underlying vitamin A deficiency (Singh, Kawatra, & Sehgal, 2005).
Twenty girls (20-22 years) residing in the hostel of PSG college of Arts and Science, Coimbatore selected for the study. The subjects were divided into two groups for the feeding trial. One group was given control recipe without cauliflower leaves. The experimental group was given recipe by incorporating cauliflower leaves providing 15 mg of iron was given for 100 days to the anemic adolescent girls. After completion of 100 days, the blood hemoglobin levels were measured. The mean hemoglobin levels before the feeding trial in both the control and experimental groups were found to be 10.32 g/dl and 10.6 g/dl respectively. The mean hemoglobin levels after the feeding trial in the respective groups were found to be 10.3 g/dl and 13.56 g/dl respectively. This highlighted that statistically significant increment in Hb levels of experimental group (Mohankumar & Bhavani, 2004).

Hence we can conclude that a food-based rather than drug-based approach will be the proper answer to the problem of micronutrient deficiency. Various researches done on food products in fresh or processed form has showed significant results in combating micronutrient deficiencies without any side effects. One such product is Green Leafy Vegetables. However, the moisture content of green leafy vegetables is very high and hence their shelf life is poor. But, numbers of processing techniques are available which can improve their shelf life and ensure their daily consumption.

2.5 Effect of processing techniques on nutrient and anti nutrient content of green leafy vegetables

Green leafy vegetables are considered to be the major contributors of vitamins and minerals in the diet. According to available official figures leafy vegetables are grown in about 0.11 million hectares of land in India and the production is about 0.73 million tones. Despite the fact that green leafy vegetables are a store house of many micronutrients, their consumption is far from satisfactory (Yeggammai & Unnithan, 1992).

NNMB survey (2006) also reported mean consumption of green leafy vegetables to be only 37 percent of Recommended Dietary Intake. Besides this, the Green leafy vegetables are highly seasonal and are available in plenty at a particular season of the year. Abundantly supply during the season results in spoilage of large quantities. Preservations of these green leafy vegetables can prevent huge wastage as well as make them available
throughout the year. There are number of household processing technique which can be utilized for improving the shelf life of green leafy vegetables.

Blanching is one of the method for preserving the nutrients losses in food products especially of Green Leafy Vegetables. Blanching is a unit operation prior to freezing, canning or drying in which fruits or vegetables are heated for the purpose of inactivating enzymes, modifying texture, preserving color, flavor, and nutritional value, and removing trapped air. Blanching is a prerequisite for preservation of green leafy vegetables (Amin, Norazaidah, & Emmy-Hainida, 2006).

Rajeswari, Bharati, Ramachandran, & Naganur, (2013) conducted a study on processed Amaranthus leaves and its quality evaluation. Initially the leaves were blanched by immersing in boiling water for two minutes and thereafter they were dried at 60°C for 2 hrs 37 minutes in a cabinet drier. The results revealed that blanched dehydrated leaves registered higher moisture (3.72%), protein (18.34%), ash (18.64%), iron (56.21%) and copper (0.50%) in comparison to unblanched leaves, which had registered lower values of moisture (3.25%), protein (17.81%), ash (16.24%), iron (33.84%) and copper (0.46%). Therefore, it can be concluded that blanched dehydrated sample retained better nutrients in comparison to unblanched dehydrated sample.

Paul, Verma, Paul & Paul, (2012) investigated the effect of different domestic cooking and processing methods on anti nutrient content in selected green leafy vegetables (Spinach and Bathua). The effect of processing techniques (Fresh, Blanching, Dehydration, Pressure cooking, Open pan cooking) for green leafy vegetables on oxalate and phytic was determined on raw and processed samples. Among the treatments given, blanching for 10 minutes was found to be the best methods for lowering the phytic acid and oxalate content. The reduction of anti nutrients on processing is expected to enhance the nutritional value of green leafy vegetables. Statistical analysis showed that there was a significant influence of blanching on oxalate content of selected samples at 0.05%

A study was done by Gupta, Lakshmi, & Prakash, (2008) to identify a suitable blanching treatment and conditions for commonly consumed green leafy vegetables that ensures enzyme inactivation and maximum ascorbic acid retention. Ten commonly consumed leafy vegetables were selected, viz. Amaranth, Ambat chukka, Bathua, Brahmi, Drumstick, Fenugreek, Keerae, Kilkeerae, Shepu and Spinach. These were blanched for 1, 2 and 4 min at 80°C, 90°C and 98°C in water and chemical media, steamed for 5 to 10 min
with and without chemical treatment and micro waved for 1 and 1.5 min, un blanched greens served as control. Retention of ascorbic acid was reduced as the blanching time and temperature was increased. The study revealed that Blanching at 80°C for 1 min, steaming for 5 min and microwaving for 1 min was sufficient to inactivate peroxidase and maximum nutrient retention.

Premavalli, Majumdar, & Madhura, (2001) studied processing effect on vitamins of green leafy vegetables (Fenugreel, Chakota, Dhandu, Khirkhire, Palak, Honagone, Kachi). The leaves were chopped and subjected to blanching for two minutes and dried at 60°C in air flow drier. Moisture content of dehydrated leaves ranged from 4-5 percent. Retention of total carotenoids was highest in chakota (94%) followed by palak (89.33%), kachi (79.30%), dhandu (71.42%), fenugreek (71.20%), khirkhire (66%) and honagone (36.15%). The loss of ascorbic acid was recorded in dhandu (28.64%), khirkhire (37.05%), honagone (39.87%), kachi (48.60%), palak (63.54%) and chakota (67.27%). The retention of vitamin A in terms of beta carotene was highest in chakota, fenugreek and palak recorded 93.75%, 92.91% and 82.90% respectively compared to other vegetables.

A study was done by Almazan & Begum,(1996) on the nutrients and anti nutritional factors of peanut greens (Spanish variety). A hot plate (conventional) and a microwave oven were used as the heat source for blanching the cut greens into boiling water (3g/20ml). The residual oxalic acid amounts after conventional blanching (63-85%) increased with time probably due to better extraction as the leaves become tenderer. This was not observed when the greens were microwave blanched. Also, increasing microwave blanching time did not increase the oxalic acid concentration that leached into the water. Both methods had the same efficiency in reducing oxalic acid concentration. Conventional blanching was more effective in the reduction of tannic acid in the greens (30-40%) but the reduction was not affected by blanching period. Apparently, only 9-19% of the acid was removed by microwave blanching, the increased amount observed with time probably also due to increasing leaf tenderness.

The effect of blanching on the anti nutritional (Phytic acid, Tannic acid and Oxalic acid) content was studied in cabbage, turnip, collard, sweet potato and peanut leaves. Levels of phytic acid was significantly reduced by conventional and microwave blanching methods. In general, blanching is recommended as an effective method for reducing the anti nutritional factors in green vegetables. Blanching also helps to destroy
microorganisms on the surface of the vegetables (Mosha, Pace, Adeyeye, Mtebe, & Laswai, 1995).

Dehydration is a simple and economic method for preservation of vegetables. Processing by dehydration makes the green leafy vegetables light in weight, easily transportable and storable product. Dehydrated vegetables can be easily incorporated in different recipes and can be used throughout the year. So, these green leafy vegetables can be dried during peak season and stored for use during the off season. They can thus be used for the preparation of several types of mix vegetables and other new recipes after incorporation of dehydrated green leafy vegetables (Gupta & Prakash, 2011).

A study was done to investigate the influence of dehydration on nutrient composition of Amaranthus gangeticus, Chenopodium album, Centella asiatica, Amaranthus tricolor and Trigonella foenum graecum. The green leafy vegetables were steamed blanched for 5 min after pretreatment and dried in an oven at 60°C for 10-12 h. The fresh and dehydrated samples were analyzed for selected proximate constituents, vitamins, minerals, anti nutrients and minerals. Dehydration seems to have little effect on the proximate, mineral and anti nutrients content of the green leafy vegetables. Among the vitamins, retention of ascorbic acid was 1-14%, thiamine 22-71%, total carotene 49-73% and β carotene 20-69% respectively, of their initial content (Gupta, Gowri, Lakshmi, & Prakash, 2011).

Bathua leaves were dried at a temperature of 50 to 60°C for 3-4 hours. Proximate composition, iron content and carotene content of leaves were analyzed. Results showed that dehydrated leaves were rich source of protein (32.95g/100g), carbohydrate (34.46g/100g) and ash (18.3g/100g). Iron and carotene content of dehydrated leaves were 27.48 mg/100g and 14826.6 µg/100g, respectively, which were 6-8 times greater than the fresh leaves i.e. 5.46 mg/100g and 1740 µg/100g, respectively. Thus, dehydrated bathua leaves are concentrated source of essential nutrients and the incorporation of dehydrated bathua leaves in various conventional food items can improve the nutritional quality of the products (Singh et al., 2007).

A study was conducted by Antia, Akpan, Okon, & Umoren, (2006) on the nutritional and anti nutritional content of sweet potatoes leaves. The leaves were oven dried at 60°C for 24 hours. Nutritional estimations of the processed leaves highlighted following results. Crude protein, crude fat, crude fiber, ash, carbohydrate, moisture
contents and calorific values were 24.85%, 4.90%, 7.20%, 11.10%, 51.95%, 82.21% and 351.30 kcal respectively. The vitamin composition was found to be at the levels of 0.672 mg/100g for vitamin A and 15.20 mg/100g for vitamin C. The elemental analysis of the leaves in mg/100g on dry matter indicated that the leaves contained appreciable levels of zinc (0.08), potassium (4.05), sodium (4.23), manganese (4.64), calcium (28.44), magnesium (340.00) and iron (16.00). The anti nutrient composition for phytic acid, cyanide, tannins and total oxalate were 1.44 ± 0.01, 30.24 ± 0.02, 0.21 ± 0.02 and 308.00 ± 1.04 mg/100g respectively. These results revealed that the leaves contain an appreciable amount of nutrients, vitamins and minerals elements and low levels of toxicants and should be included in diets to supplement the daily allowance needed by the body.

Kowsalya & Vidhya, (2004) conducted a study on Green leafy vegetables like Ariakeerai, Mullakeerai, Paruppu keerai and drumstick leaves. The leaves were dried (sun, shade and cabinet) and their nutrient composition was assessed. From this, it can be concluded that dehydration resulted in concentration of nutrients especially micronutrients. Cabinet drying ranked first, appreciable amounts of nutrient retention was found in shade drying and sun drying.

Several studies have reported the significance of drumstick leaves as a source of vitamin A as these leaves retained 50 percent of their beta carotene on shade dehydration and the dehydrated leaves could be easily incorporated into traditional Western Indian recipes without altering their acceptability characteristics as coded in the study conducted by Nambiar, Bhadalkar, & Daxini, (2003).

The green leafy vegetables like Ariakeerai, Coriender Leaves, Curry Leaves, Drumstick Leaves, Mint and Mulla Keerai were subjected to dehydration by using different methods (sun, oven, microwave, vacuum, freeze and solar drying). Carotene analysis was performed for the entire fresh and dehydrated samples. Results revealed that 90% carotene retention was observed in freeze drying as well as microwave drying technique. Thus it can be interpreted that dehydrated vegetables are concentrated source of carotenes and addition of small amount of these foods in various dietary preparations could be of immense value in meeting the daily vitamin A requirements (Kowsalya, Chandrasekhar, & Balasasirekha, 2001).
Several studies have indicated that household processing techniques like Blanching and Dehydration seems to be the simplest convenient technology for preserving these sources of micronutrients. Irrespective of the losses of vitamins that take place during processing, dehydrated GLV are a concentrated natural source of nutrients, especially micronutrients (Satwase, Pandhre, Sirsat, & Wade, 2013; Arslan & Ozcan, 2012; Gafar & Itodo, 2011; Afolayan & Jimoh, 2009; Radek & Savage, 2008; Singh & Sagar, 2008; Taiga, Suleiman, Aina, Sule, & Alege, 2008; Akubugwo, Obsai, Chinyere, & Ugbo, 2007; Lakshmi & Kohila, 2007; Srivastava, Kapoor, Thathola, Srivastava, 2006; Punna & Parchuri, 2004; Gupta & Jyoti, 2003; Lalitha & Sathya, 2003; Singh, Kawatra, & Sehgal, 2001; Mosha & Gaga, 1999). These processed leaves can serve as a pool house of micronutrients and value addition of traditional products with these leaves can then be advocated as a feasible food based approach to combat micronutrient deficiencies.

2.6 Value addition and Organoleptic evaluation

Value addition or Product development is critical for boosting food industries in country like India which is the second largest producer of fruit and vegetables. The new products developed have to be evaluated with simple and scientific methods, for example sensory evaluation techniques, which when applied to new concept of recipes and less popular regional fruit and vegetable products can proved to be revolutionary (Sri Lakshmi, 2003).

A study was aimed to formulate micronutrient rich products with dried greens. Keerae (Amaranthus paniculatus) and shepu (Peucedamum graveolens) greens were steam blanched after chemical pre treatment and dried in hot air oven. Dehydrated greens were incorporated into ‘Mathri’ and ‘Thalipeeth’ at 4, 8 and 12% levels. The products were evaluated for sensory evaluation in comparison to control (without greens) by an untrained panel of 80 individuals. Results of sensory analysis revealed that products incorporated with 4% dehydrated greens were similar to control in texture, taste and overall acceptability. However, acceptability scores reduced with increasing concentration of greens (Gupta & Prakash, 2011).

Nambier & Parnami, (2008) standardized traditional Indian recipes with Drumstick (Moringa Olifera) leaves. Freshly blanched drumstick leaves were incorporated
in three pulse based recipes commonly consumed in India such as boiled and seasoned mung (Phaseolus Aureus), Kabuli channa (Cicer Arietinum) and desi channa (Cicer Aritinum). One serving of each of these recipes (30 g raw weight of pulses which is equivalent to approximately 100 g cooked weight) could blend with a maximum of 20 gram of fresh drumstick leaves. The study showed that all the three recipes (mung, kabuli channa and desi channa) were found to be acceptable by the panel of judges (18 to 21 years old women), with an overall composite score ranging from 3.06 to 3.53 (on a scale of 1 to 5) for the three test recipes. The overall composite score for desi channa was highest at 3.53 ± 0.71, followed by kabuli channa at 3.4 ± 0.49 and mung at 3.06 ± 0.57.

Dehydrated Bathua leaves were incorporated at 3-15 percent levels in two conventional foods namely green gram dhal and paratha. Organoleptic properties of products were judged by nine point hedonic scale. The scores for overall acceptability of green gram dhal at 7 percent level of incorporation and paratha at 5% level of incorporation were highest, whereas all the treatments of green gram dhal and paratha were also found to be acceptable by the panel members. Paratha at 10 and 15 percent incorporation levels were also liked moderately (Singh et al., 2007).

Nande, Dudhmogre, & Vali, (2007) studied acceptability of recipes prepared from different varieties of betel leaves. Three recipes namely coconut burfi, cutlet and muthia were developed and the recipes prepared from spinach served as control. Sixty grams of leaves was incorporated in coconut burfi and cutlet whereas, 70 gram leaves was incorporated in muthia preparation. Coconut burfi prepared from sweet betel leaves was given high scores ranging from 4.17 (color) to 4.34 (taste) on five point scale followed by kapuri betel leaves (3.61 to 4.17) and bangle betel leaves (2.54 to 3.50) respectively. Burfi with spinach received high scores of 4.5. Cutlets prepared from kapuri betel leaves (3.83 to 4.49) were highly acceptable and very close to spinach cutlets (4.17 to 4.61) for all sensory characteristics followed by cutlets prepared from sweet betel leaves (3.67 to 4.34) and bangle betel leaves (2.45 to 4.17). Muthia with betel leaves and control showed significant difference for their overall acceptability (t=3.1, P < 0.01 for spinach versus sweet; t=2.2, P<0.05 for spinach versus kapuri and t=9.2, P<0.01 for spinach versus bangle betel leaves).

A study was conducted on the evaluation of Leafy vegetable ‘Parantha’ by Pandey, Abidi, Sadhana, & Singh, (2006). Green leafy vegetable namely Palak, Chaulai and Bathua were mixed with wheat flour for preparation of paranthas. The leaves were
added in the flour and kneaded. The prepared paranthas were presented to a panel of judges and were evaluated organoleptically using nine point hedonic scale. The bathua paratha were liked moderately scoring 7, whereas, chauli and palak paratha scores 8 points each and were very much liked by the panelists.

Kaur & Kaochar, (2005) carried out a study on organoleptic evaluation of preparations using underexploited greens (greens of cauliflower, radish, turnip and carrot). To evaluate the products for sensory attributes Hopkin’s seven point scale was used. The study revealed that 30 percent greens incorporated Parantha was most acceptable in case of carrot and turnip greens it was 50 percent. The respective scores for overall acceptability ranged from 5.42 (cauliflower greens) to 6.02 (radish greens). Bhurji prepared by using cauliflower greens scored highest (6.08). Puri with turnip and carrot greens scored 5.54 and 6.52 at 50 and 60 percent incorporation respectively. Pulav developed by incorporating carrot and turnip greens at 30 and 40 percent scored 5.78 and 5.52 points. Pakora prepared by incorporating 40 percent greens was best acceptable with scores of 5.42 and 6.30 respectively.

Shah (2005) carried out a study to develop value added products by incorporating Bengal gram leaf powder. Sixteen recipes, based on cereals, pulses, oilseeds were developed by incorporation of Bengal gram leaf powder at 4, 8, 12 and 16 percent level. The products were evaluated for sensory attributes using five point rating scale. The results indicated that the scores for overall acceptability ranged from 4.41 to 5.00, for pulse based recipes (plain dal, mung dal, masoor dal and moth bean dal) from 4.66 to 5.00, for nuts and oil seed based chutneys (prepared from ground nut, sesameum, niger seed and linseed) from 4.58 to 5.00 and snacks (udad dal wada, chaki, mung dal wada and shev) ranged from 4.75 to 4.83.

Singh & Awasthi, (2003) conducted a study to investigate the effect of powder made from Kachnar, Drumstick, Colocasia and Curry leaves incorporated in food products viz., biscuits, murukku, mathri and namakpare on sensory parameters. Green leafy vegetable powders were incorporated at 5, 10, 15 and 20 percent level and products were evaluated through organoleptically. Acceptable level of green leafy vegetables in biscuits, murukku, mathri and namakpare was 15, 10, 20 and 10 percent respectively.
Motey & Lele (2003) also reported cauliflower leaves powder to be a good source of calcium. Incorporation of cauliflower leaf powder at 3 percent and 5 percent level was found to be acceptable in cutlets and patties, while the acceptability decreased at 7 percent level. Cauliflower leaf powders incorporated at 10 percent level of masala biscuits, masala buns, gingelly chikki, wheat soy halwa, had mean acceptability scores of 3.4, 3.6, 3.4 and 3.9 respectively on a five point scale. Products were found to be rich in iron, beta carotene and calcium (Begum, Deshpande, & Farzana, 2000).

Several other researches have proved that addition of dehydrated greens increases the nutrient density of all the value added products (Kowsalya & Indra, 2010; Kaur & Kochar, 2009; Vasundhara & Waghray, 2009; Lakshmi & Kohila, 2007; Gulanan, Gupta, Lakshmi, & Prakash, 2004).

2.7 Micro Nutritional estimations of value added products

Micro Nutritional importance of vegetables cannot be neglected our daily meals. Some of the vegetables are used in raw form as salad, but most of them require cooking for the improvement of digestibility and palatability. Many raw vegetables contain high levels of vitamins and minerals, but cooking can remove much of this nutritionally important content. Some of the vitamin loss that occurs during cooking is caused by oxidation, degradation and vaporization. Method of cooking, temperature and duration may also effect significantly on the nutritive values of vegetables. Excessive cooking may also cause an adverse affect on the digestibility of the vegetables. In cooking, there is 5 to 30 percent loss of nutrients especially of beta carotene and vitamin C. Baking can result in the loss of nutrients and it only depends upon the duration and temperature (Sri Lakshmi, 2003).

A study was conducted on fortification of mathri with fresh and dehydrated vegetables and assessment of nutritional quality. Organoleptic evaluation of mathri was done by a panel of ten judges using 9 point hedonic scale. Levels of incorporation of powder of dry green vegetables (spinach 1.5g, mint 1.5g, carrot 1g and lotus stem 6g) was added in mathri at 7%. Iron content was found to be high in dried vegetables mathri (5.37mg) in comparison to control mathri (1.3mg). The ash content of mathri varied significantly and values were 2.1% and 1.4% for dried and control respectively. Thus it can be concluded that dry vegetable powder mathri being good sources of micronutrient which
may be incorporated in the daily diets of vulnerable sections of population *(Verma & Jain, 2012)*.

**Wani, Sood, & Kaul, (2011)** in their research added cauliflower leaf powder in roasted wheat flour of noodles. The alterations in chemical constituents (moisture, protein, fat, ash and fibre) of noodles were examined by adding cauliflower leaf powder to the noodle formulation at the level of 0, 10, 15, 20 per cent flour weight basis. Results of study indicated that samples of cauliflower leaf powder added noodles, for all addition levels, contained more protein, fibre and ash in comparison to control sample.

**Gupta & Prakash, (2011)** conducted a study with an aim to analyze nutritional and sensory quality of micronutrient rich traditional products. Blanched and oven dried Keerae (Amaranthus paniculatus) and Shepu (Peucedanum graveolens) were incorporated in Mathri and Thalipeeth at 4%, 8% and 12% levels. The iron content of mathri was found to increase from 2.39 mg in control (with zero percent incorporation) to 6.03 mg/100g for the 12% greens incorporated product. The calcium content almost doubled. The total and β-carotene content also increased extraordinarily. A serving size of 25 g of mathri can provide the daily requirement of β-carotene for an individual. The nutritive value of the Peucedanum graveolens incorporated thalipeeth showed marginal increase in the dietary fiber content in comparison with the control. The iron content almost doubled in 8%. A significant increase was seen in the calcium, total and β-carotene content of thalipeeth that were incorporated with dehydrated greens in comparison to the control.

**Singh et al., (2007)** evaluated a study on preparation of value added products from dehydrated Bathua leaves (Chenopodium album Linn). The leaves were tray dried and incorporated in two conventional foods namely green gram dal (3%, 5% and 7%) and parantha (5%, 10% and 15%). Organoleptic properties of products were judged by nine point hedonic scale. Green gram dal and parantha incorporated with 7 and 5 percent dehydrated bathua leaves were liked most. Iron content of green gram dal (2.09 mg/100g) at 7% and parantha (8.81 mg/100g) at 15% incorporated with dehydrated bathua leaves was higher than their respective control. In comparison to control enriched parantha (4255.66 µg/100g) and green gram dal (984 µg/100g) has many fold greater carotene content. Therefore, it can be concluded from the results that incorporation of dehydrated bathua leaves in various conventional items can improve the nutritional quality of the products as well as add variety in the diet.
Singh & Kawatra, (2006) conducted a study on development and nutritional evaluation of recipes prepared using fresh and dried amaranthus leaves. Pakora, vada, namakpara, kurmura, biscuit and cake were prepared with the addition of fresh and dried powder of amaranthus leaves. Protein content of the products ranged from 7.4 per cent in biscuit to 17.9 per cent in vada on dry weight basis. Ascorbic acid content ranged from 2.6 (cake) to 27.5 mg/100 g (kurmura) on dry weight basis, the content being higher in products prepared with fresh amaranthus leaves. Beta-carotene content was maximum in namakpara (368.5 mg/100 g) containing amaranthus leaf powder. Total iron content ranged from 7.9 (kurmura) to 12.4 mg/100 g (vada), whereas the total zinc content varied from 2.38 mg/100 g in vada with fresh leaves to 0.42 mg/100 g in cake prepared from dried amaranthus leaves.

A study was assessed by Singh, Kawatra, & Sehgal, (2005) on the development and nutritional evaluation of products from dried powder of cauliflower leaves. These leaves considered as waste, dried, powdered and used for preparing namakpara, kurmura, biscuit and cake. Protein content was maximum in kurmura (12.25%) and minimum in biscuit (7.42%) when evaluated nutritionally. Ascorbic acid and beta carotene contents of all the products, ranged from 2.21 to 4.29 and 2.04 to 4.98 mg/100g respectively. Total iron content was highest in cake (9.90 mg/100g) whereas ionizable iron content was maximum in biscuit (2.83 mg/100g). Hence, it was concluded that products developed from dried cauliflower leaves contained appreciable amount of iron and beta carotene. These products if supplemented in the diet can help to meet the RDA of iron and beta carotene and also help in combating iron and vitamin A deficiency and thereby help in improving the health conditions.

Value added wheat based papads were developed by Kaveri, Gupta, Lakshmi, & Prakash, (2004) by incorporating different levels of green leafy vegetables viz., shepu (Peucedanum graueolens) and kilkeerae (Amaranthus tricolour) in papads. Fresh leaves were incorporated at 15 and 20 per cent levels and dehydrated forms in 5 and 10 per cent levels. The fried papads were subjected to sensory analysis by a panel of 100 members. Papads with fresh (15-20 %) and dehydrated greens (5%) scored above 6 on a scale of 10 indicating acceptability of papads incorporated with greens. Expansion volume of papads prepared by incorporating fresh greens and dehydrated greens (5%) were satisfactory. Mineral, vitamin and fiber content of greens-incorporated papads increased remarkably.
Acceptability of papads in terms of physico-chemical characteristics, sensory attributes and nutritional quality suggested suitability of papads incorporated with greens.

2.8 Effect of processing on shelf life of products

Shelf-life studies can provide important information to product developers enabling them to ensure that the consumer will see a high quality product for a significant period of time after production. The shelf life of the product is evaluated by identifying the quality attributes such as color, flavor and texture as well as microbial analysis. Shelf life is the recommended maximum time for which products can be stored, during which the defined quality of a specified proportion of the goods remains acceptable under expected (or specified) conditions of distributions, storage and display (Adyeimi & Adeyemi, 2002).

Determining shelf life is an important issue when developing new food products, but it is difficult to fit this within commercial time constraints for long shelf life products. Shelf life is most influenced by several factors: exposure to light and heat, transmission of gases (including humidity), mechanical stresses and contamination by things such as microorganisms. These conditions affect physical, chemical and microbial changes, determine the moment when a product is not safe or more general not fit for use any more and this marks the end of its shelf life. Physical changes include mishandling of foods like bruising of fruits and vegetables during harvesting, moisture uptake or re-crystallization due to temperature fluctuations. Chemical changes are associated with enzyme reactions, oxidative reactions like lipid oxidation or non-enzymatic browning. For microbial changes with respect to shelf life growth rate, increase of pathogen rate or production of toxins are very relevant issues (Awogbemi & Ogunleye, 2009).

Green leafy vegetables occupy an important place among the food crops as these provide adequate amounts of many vitamins and minerals for humans. They are rich source of beta carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorus. In nature, there are many under-utilized greens of promising nutritive value, which can nourish the ever increasing human population. Many of them are resilient, adaptive and tolerant to adverse climatic conditions. Although, they can be raised comparatively at lower management costs even on poor marginal lands, they have remained under-utilized due to lack of awareness and popularization of technologies for utilization. Now a day, underutilized foods are gaining importance as a means to increase
the per capita availability of foods. Since low consumption of green leafy vegetables in
diet is one of the major factors, which leads to deficiency of Vitamin A and Iron.

Most developing countries depend on starch based foods as the main staple food
for the supply of both energy and protein. This accounts in part for protein deficiency
which prevails among the populace as recognized by Food and Agriculture Organization
(Ladiji, Okoye, & Ojobe, 1995). In most of the tropical countries where the daily diet is
dominated by starch staple foods, dehydrated vegetables are cheapest and most readily
available source of important proteins, vitamins, minerals and essential amino acids
(Akubugwo, Obsai, Chinyere, & Ugbogu, 2007). Many of the local vegetable materials
are under-exploited because of inadequate scientific knowledge of their nutritional
potentials. Many workers (Ekkop, 2007; Edeoga, Omosun, & Uche, 2006; Hassan &
Umar, 2006; Akindahunsi & Salawu, 2005; Lockeett, Calvert, & Grivetti, 2000) have
reported the compositional evaluation and functional properties of edible wild plants in use
in the developing countries.

Hence, it should be ensured that the consumption of vegetables especially Green
leafy vegetables should be done on daily basis for their rich nutrient composition and for
their various health benefits. Though several works reporting compositional evaluation and
functional properties of various types of edible wild and less utilized plants in use in the
developing countries abound in literature, much still need to be done.