

REVIEW OF LITERATURE

The literature pertaining to the study on the **Effect of Supplementation of Health Mix and Nutrition Education on the Health and Nutritional Status of Handloom Weavers** is reviewed under the following headings

- A. Significance of Adulthood and the role of Handloom Weavers**
- B. Nutrition and Health Status of Handloom weavers**
- C. Strategies to improve the Nutritional Status of Handloom Weavers**
- D. Role of Functional Foods in improving Nutrition and Health Status**

A. Significance of Adulthood and the role of Handloom Weavers

India, with 1.27 billion people is the second most populous country in the world. The figures show that India represents almost 17.31 per cent of the world's population, which means one out of six people on this planet live in India. Although, the crown of the world's most populous country is on China's head for decades, India is all set to take the numero uno position by 2030. With the population growth rate at 1.58 per cent, India is predicted to have more than 1.53 billion people by the end of 2030. (www.indiaonlinepages.com/population/india-current-population.html). Adult population is 72 million in the age group of 15-59 years in the year 2011 in India (Census of India, 2011).

Such a huge population needs to be channelized properly. The importance of eradicating adult illiteracy in developing countries as a part of promoting community participation in democracy and in accelerating the rate of national development is given more significance in India. Attempts have been made to link adult education to major developmental and productive activities through programs such as Farmers Training and Functional Literacy Project to increase agricultural productivity, use mass media to communicate programs and agricultural information, develop library

services, develop voluntary organizations to carry out pilot projects and encourage public concern and initiate adult education in urban areas for industrial workers to promote trade union leadership and provide access to continued training and education (www.eric.ed.gov/?id=ED105152).

Skills and knowledge are the driving forces of economic growth and social development for any country. Countries with higher and better levels of skills adjust more effectively to the challenges and opportunities of world of work. At present the capacity of skill development in India is around 3.1 million persons per year. The 11th Five Year Plan envisions an increase in that capacity to 15 million annually. India has a target of creating 500 million skilled workers by 2022. Thus, there is a need for increasing capacity and capability of skill development programs. The skill development initiatives support employment generation, economic growth and social development processes. Skill development policy will be an integral part of comprehensive economic, labour and social policies and programmes. A framework for better coordination among various Ministries, States, industry and other stakeholders will be established. National Skill Development Initiative will empower all individuals through improved skills, knowledge, nationally and internationally recognized qualifications to gain access to decent employment and ensure India's competitiveness in the global market (www.labour.nic.in/upload/.../files/.../NationalSkillDevelopmentPolicy)

Clothing is a basic human need as much as food and shelter. Till the 19th century, when there were no machines for production of cloth, the handloom industry was the sole supplier of cloth for the entire need of the world. Handloom weaving is the India's biggest cottage and labour intensive sector, which has been playing a very important role in the country's economy by forming part of India's rich heritage and exemplifying the rich artistry of the weavers. As an economic activity, the handloom sector occupies a place second only to agriculture in terms of employment. According to the Annual Reports of Ministry of Textiles (2011-12), the handloom sector with about 23.77 lakh handlooms provides employment to 43.31 lakh persons (Raju and Rao, 2013).

References to the use of handloom are abundant in the recorded details of epics like the Ramayana and the Mahabharata. This industry seems to have

flourished between 5000 and 3000 BC. The civilizations of Harappa and Mohanjodaro reveal the use of woollen and decorative embroidery in handloom. The handloom industry being a part of the Indian culture and tradition, is one of the oldest cottage industries in India diffused widely through the country. The artisans of India are famous for hand spinning, hand printing and hand typing. They are accustomed to the art of weaving as a hereditary occupation. This industry transcends sectarian linguistic and communal barriers and provides direct employment to millions of people and generates indirect employment to others like loom manufacturers, dyers, twistors, processors, etc., thus one in every 60 in the country is engaged in this industry in one way or the other (Sameer Sarma, 2005).

The art of weaving and spinning has passed from one generation to another generation. The word loom means 'A weaving machine' thus the word Handloom means 'A machine on which weaving is done manually by hands'. The weaving on handloom is done through the intersection of warp and weft. The warp is a vertical thread wound on a roller and the weft is a thread at right angles to warp/horizontal thread (Anjum *et al.*, 2009). Handloom weaving is one among such occupations practised by specific castes of people in different parts of India. The handloom sector occupies a distinct and unique place in the Indian economy. It is the largest generator of non-farm rural employment. India is the highest handloom producing country in the world (Apparao and Rao, 2012).

The element of art and craft present in Indian handlooms makes it a potential sector for the upper segments of domestic market as well as global. However the sector is beset with manifold problems such as obsolete technologies, unorganized production system, low productivity, inadequate working capital, conventional product range, weak marketing link, overall stagnation of production and sales and above all competition from power loom and mill sector. As a result of effective Government intervention through financial assistance and implementation of various developmental and welfare schemes, the handloom sector, to some extent has been able to tide over these disadvantages. Thus, Handloom forms a precious part of the generational legacy and exemplifies the richness and diversity of our country and the artistry of the weavers (Usha and Patil, 2012).

Handloom assumes importance because it not only meet clothing needs of the people, but also gives expression to Indian art and culture, craftsmanship and heritage (Sunita *et al.*, 2001).

Handloom industry survived mainly on its aesthetics, uniqueness and craftsmanship. Fascinating motifs and super design of the fabric assigned special importance to the sector. Despite strong competition from mill made textiles, the handloom fabrics are still in demand to a great extent, thus fetch a premium price in the modern industrialized market (Amrita *et al.*, 2009).

Handloom industry is a traditional based and home grown activity and has importance for livelihood generation. It is one of the few non-agricultural sectors with a discernable presence in both urban and rural areas. There are strong patterns of geographically clustered hand loom activities. In Ethiopia, hand weaving is a particularly important subsector after agriculture (Abdella and Aycle, 2008).

Singh and Bansal (2010) have observed that Indian handloom is growing in its popularity not only among the people in India but also among the people admiring Indian handloom and Indian handicrafts from around the globe. In spite of having distinct styles and ways of weaving, there is a lot of exchange of styles that happened among the diverse Indian handloom styles.

States like Andhra Pradesh, Kerala, Karnataka, Maharastra and Tamil Nadu come in the list of major handloom cloth producing in India. But it is found that among these states, Tamil Nadu comes first in terms of its huge size, production, total exports, and proportion of population depending on this industry and the vitality of the handloom industry to survive and grow (Survey of Handloom Industry, 2000).

According to Seemanthini and Soumya (2001), weaving activity has components like handloom, power loom and mill industry. Handloom is the largest employer among these three sectors. It is a very important industry among small scale and cottage industries of the country. It has a strategic position in the socio-economic structure of the country due to its nature of work and employability. Textile industry has a place of pride in Indian economy. It has provided employment for millions of people. In this sector employees get their pay on the basis of their productivity. Thus productivity of the worker is very important for the sake of both

workers and industrial development. Productivity in economics refer to measures of output from production process per unit of input, for example labour productivity is typically measured as ratio of output per labour hour on input. Productivity depends on workers health, nutritional status, stress, attitude towards work and service motive. Sometimes personal characteristics, work pressure on worker's mind affects their work efficiency.

The connection between socio economic status and health has been widely documented. Higher-income people rate their health as better and live longer than lower income people (Mahan and Stump, 2007). People with higher socio economic status tend to have a greater sense of control over what happens to their bodies as they are and they may choose healthier life styles (Whitbourne, 2001). Other studies have shown that there is a difference in use of healthcare services among patients from different socio economic status groups (Heyden, *et al.*, 2003). Adler and Stewart, (2010) stated that there is evidence from healthcare services around the world that low socio economic status (SES) is associated with higher risk of diabetes and poorer glycemc control.

Co-operative societies are facing severe problems in managing their assigned activities. Unfortunately, majority of the societies, due to their weak financial position and mismanagement, are not in a position to provide full-time work to their weavers. As a result, majority of the weavers are forced to leave their looms and homes in search of work in other handloom centres or migrate to other professions (Raju and Rao, 2013).

Sunderarajan (2011) has noticed that weaver co-operative societies had become financially unviable since, many weavers were not able to repay their dues because of economic stress.

Over the past decade, the situation of most weavers has deteriorated into a pitiful state, as weavers face increased poverty, hunger, health issues and inability to provide for their families. It is estimated that over 50 per cent of weavers' children are malnourished. Weavers and family members also frequently suffer from a range of health ailments related to malnutrition and exhaustion. A People Vigilance Committee on Human Rights (PVCHR) survey identified 46 severely malnourished children in weaver areas, with an average age of 2.6 years old and an average

weight of 8.2 kilograms. This problem is exacerbated in isolated weaver communities that depend on often delayed government-subsidized food distribution. In the neighborhood of Dhannipur in the outskirts of Varanasi, twelve children have died in 2008 from malnutrition ("The Land of Dying Kids", India Today, 2008). In addition, many weavers cannot even afford basic medical care for their children, much less themselves. Weavers have started supplementing their meager traditional income with laboring work, such as driving cycle rickshaws. Some weavers have become so despondent as to take their own lives (PVCHR, 2013).

B. Nutrition and Health Status of Handloom weavers

i. Risk factors for health problems among Handloom weavers

Exposure to cotton dust, acids, caustics, or by working in dyeing and printing areas in the textile industry have risk of nasopharyngeal cancer (NPC) (Anonymous, 2006). Textile manufacturing goes under several processes such as knitting, winding, spinning, dyeing, etc. Exposure to these processes for years together are causing major health problems as thousands of workers are involved in textile manufacturing. Weavers are the main population who suffer major health problems such as accidents, respiratory problems, musculoskeletal problem and long term diseases like hypertension as well as disabilities such as permanent hearing loss due to exposure to noise (Greenburg *et al.*, 2000).

In India there are about 20 million workers involved in textile industry, among them 1.07 million workers are engaged in the manufacture of cotton textile. Byssinosis, hypertension, noise induced hearing loss, dermatitis and risk of cancer due to various chemicals and dyes are common occupational diseases found among weavers. Byssinosis is the respiratory syndrome that occurs as a result of inhaling dust that is produced when cotton, flax or hemp is handled. A study done by an NGO, reported that in 1995 byssinotic condition was first recorded in Indian history of 150 years. Maximum number of byssinosis cases are reported in the cotton textile industry as it is one of the largest industries in the world (www.icmr.nic.in/00004/achievements1.htm). Several studies have found that, the average lung function is lower in cotton workers than in the general population and in general in those with a history of byssinosis (Rajsri *et al.*, 2013).

Cotton dust leads to many health hazards in majority of textile workers like byssinosis, cough and bronchial asthma. These are highly prevalent in mills of developing countries such as Ethiopia, Sudan, Egypt, Central Africa and to a lesser extent, in South Africa, India and China. In these countries sickness absence due to respiratory problems has also been reported to be high. In developed countries, however modern mill engineering and dust control measures have kept respiratory problems significantly low. Even, where the dust concentration is low, the well being of workers can be affected by other contaminants of cotton. For example, ocular and nasal irritations in workers in spinning mills of cotton have been reported. Other disease conditions related to working in textile mills are muscular-skeletal pain, headache, easy fatigue and changes in blood pressure (Anonymous, 1995).

Noise pollution is a serious and major topic covered under Industrial Hygiene and safety to ensure noise free or permissible noise as per standards established to ensure safe environment for the working staff in any industry (Ilyas, 2008).

A comparative study was done on the effect of noise on blood pressure. The study group consisted of 75 high-noise exposed and 225 low-noise exposed Italian weavers. The findings of the study revealed that the high noise exposed group had significantly increased hypertension than that of low noise exposed group (Farouk *et al.*, 2009).

A cross sectional study was done in china on a dose response relation for noise induced hypertension that is the effect of industrial noise on the prevalence of hypertension in a group of 1101 female workers in a textile mill. The findings indicated that exposure to noise is a significant determinant of prevalence of hypertension among the industrial workers (Zhao *et al.*, 1991).

Epidemiological evidence of cancer risk in textile industry workers was undertaken in an attempt to evaluate the cancer risk developing on the type of textile fibre used. It was reported that lung cancer risk was higher in cotton and wool dust among weavers and spinners (Mastrangelo *et al.*, 2000).

Work-related musculoskeletal disorders (WMSDs) have emerged as a major health problem among workers in both industrialized and industrially developing countries. Several work place factors, such as repetitive work, awkward and static

postures, have been identified as being associated with upper extremity pain and discomfort (Punnett *et al.*, 2000).

An evaluative study conducted in India on the prevalence of upper extremity repetitive strain injuries among the handloom weavers revealed that substantial percentage of the weavers suffered from discomfort on upper extremities. The feeling of pain at night after work indicated changes of repetitive strain injuries (Gangopadhyay and Banerjee, 2003).

Studies in Iranian hand woven carpet industry have reported high prevalence of musculoskeletal problem among weavers due to constraints of working postures, poor design of loom, working time, repetitive work and seat type. Physical and psychosocial load, poor climatic conditions, and vibrations have been identified as risk factors contributing to development of MSDs among agricultural workers. In machine manufacturing plant and textile units, high physical demands, poor postures and insufficient recovery time are the contributing factors to develop low back pain. In spite of apparently similar occupational pattern of work, gender differences do exist in the prevalence and severity of MSDs and perception of work as stressors (Choobineh *et al.*, 2007).

Anjum *et al.*, (2009) stated that workers have to work 12 hours in a standing position that lead to joint pain. Long hours of static work with awkward posture at traditionally designed looms can cause high prevalence of musculoskeletal disorders among weavers.

As a largely cottage industry, carpet weaving is fraught with the hazards imposed by impoverished homes with small, crowded rooms that have poor lighting and inadequate ventilation. Carpet weavers are subject to skeletal deformations, eye sight disorders and mechanical and toxic hazards. The squatting position that the weavers must occupy on the old type of loom and the need for them to lean forward to reach the place into which they knot the yarn, may over time, lead to serious skeletal problems. They are often compounded by the nutritional deficiencies associated with poverty. Especially among those who start as young children, the legs may become deformed (genuvalgum) or a crippling arthritis of the knee may develop. The constant close focus on the point of weaving or knotting may cause eye strain, particularly when the lighting is inadequate. It was observed that electric

lighting is not available in many home work places, and the work, which is often continued into the night must be performed by the light of oil lamps. There have been cases of almost total blindness occurring after only about 12 years of employment at this work. The constant tying of small knots and the threading of the weft yarn through the warp threads may result in swollen finger joints, arthritis and neuralgia (Rajsri *et al.*, 2013).

According to Raju and Rao (2013) food insecurity, malnutrition, anemia, tuberculosis, asthma and gynecological illnesses among the weavers, houselessness and a high dropout rate among children are some of the issues that have characterized the multiple deprivations among the weavers in Andhra Pradesh.

Nutrition in the adult years emphasizes the importance of diet in maintaining wellness and preventing disease. The role of nutrition has expanded significantly and it is now viewed as a tool that can be used not just to prevent disease but to promote health. Healthy people 2010, a U.S. Department of Health and Human Services (DHHS) report, recognizes the importance of nutrition and other lifestyle factors in achieving health goals and increasing years and quality of healthy life (USDHHS, 2010).

A defensive nutrition paradigm for adults in the twenty-first century emphasizes making food choices to promote wellness and support organ systems for optimal functioning during aging. Combined with a regular exercise program, a plant-based diet can help adults maintain a healthy weight. Plant based food programs can have a significant and positive impact on aging by reducing the risk of cardiovascular disease, cancer, diabetes and other chronic diseases. Increased fruit and vegetable intake reduces incidence of chronic diseases (Caldwell and Esselstyn, 2001).

ii. Prevalence of Non-communicable Diseases

India is experiencing a rapid health transition by carrying an increasing burden of non communicable diseases among adults with more than 30 million people with chronic heart disease and 118 million people with high blood pressure. This figure is expected to go up to 214 million people with blood pressure by the year 2025 if preventive measures are not taken (Goenka *et al.*, 2009).

The World Health Organization has predicated a global increase in diabetes prevalence of 39 per cent between the years 2000 and 2030, which will increase the absolute number to 366 million people (Wild *et al.*, 2004).

Valliyot *et al.*, (2013) showed individuals above 50 years of age have five times more chance to get diabetes when compared with those in the 20-30 years age group. Majority of the patients with diabetes in developed countries were above 64 years of age. It is predicted that by 2030, the number of people aged above 64 with diabetes will be around 82 million of which about 48 million will be in developing countries. India has the largest diabetic population and it is expected to increase to 174 million in the year 2025. In developing countries, the majority of people with diabetes are in the 45-64 years age group (Sicree *et al.*, 2003).

Ahmad *et al.*, (2011) have reported that the prevalence of diabetes mellitus increases significantly with the advancing age, and showed that there is almost 3 times increase in the prevalence of diabetes after 60 years of age. Himanshy *et al.*, (2014) stated that prevalence of diabetes was 19.36 per cent and 16.98 per cent for male and female respectively. Diabetes Mellitus (DM) is a chronic disease characterized by hyperglycemia associated with impairment in insulin production by pancreas or by ineffectiveness of the insulin produced along with a metabolic disorder of carbohydrate, protein and fat metabolism (Gardner *et al.*, 2011). Complications of type 2 diabetes mellitus include kidney failure, blindness, risk of infections, coronary heart disease and stroke (Kramer *et al.*, 2009).

A high burden of hypertension and other cardiovascular disease risk factors occurs in Central India, despite the higher prevalence of almost all factors in urban areas (Ajeet *et al.*, 2014). According to Lawes *et al.*, (2006) Blood Pressure and hypertension are more prevalent in East Asia. Asia-Pacific Cohort studies collaboration Committee reported that the population-attributable fraction of hypertension for cardiovascular disease is as high as 60 per cent in Asian countries (Matriniuk *et al.*, 2007). In addition, the total number of individuals with hypertension in China and India is expected to increase to more than 500 million by 2025 (Perkovic *et al.*, 2007).

Hypertension is a major risk factor for cardiovascular disease, coronary heart disease and death, remaining largely silent until the development of complications

(McAlister *et al.*, 2011). Worldwide, high Blood Pressure affects more than 40 per cent of adults and is the leading global risk factor for death or disability. Blood Pressure control rates are nearly 65 per cent in Canada and 13.2 per cent globally (Chow *et al.*, 2013).

Prevalence of dietary calcium insufficiency is not known but there is evidence suggesting that people of all ages worldwide, including the United States fail to consume adequate amounts of calcium. Low calcium intakes are very common in developing countries because of the infrequent consumption of dairy products. Adulthood is a critical time to optimize peak bone mass and inadequate consumption of calcium in these years increases the risk of osteoporosis and bone fractures in later life (Flynn, 2003).

Bone loss in adulthood is widespread and to protect against these losses, high calcium intakes early in life is recommended. A calcium-poor diet during the growing years may prevent a person's achievement of maximum peak bone mass. Too little calcium packed into the skeleton during childhood and young adulthood strongly predicts susceptibility to osteoporosis later in adulthood (Mahan and Stump, 2007).

C. Strategies to improve the Nutritional Status of Handloom Weavers

Man needs a wide range of nutrients to perform various functions in the body and to lead a healthy life. During adulthood nutrients are required for the purpose of energy, for replacement of worn out tissues and maintenance of body functions. Though there is no growth during adulthood, protein is required for the replacement (Debartati, 2013).

Community nutrition programs are designed to encourage participants to change food choice to improve health. Positive behaviour change among graduates of the Expanded Food and Nutrition Education Program (EFNEP) and retention of this change over time has been reported (Arnold and Sobal, 2000). According to World Health Organizations Report (WHO, 2002), population-wide health education strategies to reduce cholesterol are cost-effective. Nutrition and nutritional supplementation for working population are becoming increasingly important (Elmadfa and Meyer, 2008).

Stuijvenberg *et al.*, (2001) found that multiple micronutrient supplementations have been used for improving anaemia, micronutrient status, growth and morbidity in children and adolescents. Biscuits were fortified with beta carotene, iodine and iron with a cold drink as a carrier for vitamin C and given to address micronutrient deficiencies in primary school children in South Africa. The 12-months intervention resulted in significant improvements in blood levels of vitamin A, ferritin, iron, haemoglobin, haematocrit and urinary iodine levels.

Nutrition in the adult years focuses on maintaining health by using foods, particularly plant-based foods and their constituents (phytonutrients), to optimize the function of the digestive and liver detoxification systems and other organ systems of the body, including the immune system with a nutrition program based on a nutrition paradigm that promotes defensive eating. Adults of all ages can maintain and promote health and productivity while preventing disease. Education is important, the less schooling people have had, the greater the chance that they will develop and die from communicable diseases, injuries or chronic ailments. This does not mean that income and education cause good health instead, they are related to environmental and life style factor that are likely to be causative (Adler and Newman, 2002).

In the views of Diane *et al.* (2004) better educated and more affluent people have healthier diets and better preventive health care and medical treatment. They exercise more and are less likely to be overweight and smoke less. They are more likely to use alcohol, but use it in moderation.

Food is a term which is basically related to the component necessary for several life sustaining functions like production of energy, supply of nutrients, support of various metabolic activities besides growth and maintenance of the body. During last two decades the knowledge of the dietary influence on health and well-being has been highly increased which has led to design new and healthier foods reducing the risk of several chronic diseases (Doyon and Labrecque, 2008).

Dietary education entails the intake of fiber and protein from local resources, low glycemic whole grain and avoidance of empty calories from sweetened drinks and fried foods. Physical activity education needs to be focused on individual and group counseling, with demonstrations to reach the young people (Kumar, 2012).

Education is for development. Health education is the profession of educating people about health. People value health highly. Health is a fundamental priority for all societies anywhere in the world. Healthy life style counts on the basic knowledge of exercise and proper nutrition. To empower individuals to take action and devote themselves in maintaining their Blood Pressure is now a greatest challenge (Chidambarantha and Jenitta, 2011).

High dietary intake of fruits, vegetables and whole grains is strongly associated with reduced risk of developing chronic diseases, such as cancer and cardiovascular diseases (CVD), which are the highest causes of death in Europe, United States and in most industrialized countries (EFSA, 2008). It is estimated that one-third of all cancer deaths in industrialised countries could be avoided through appropriate dietary formulations. This suggests that dietary behavioral changes, such as increasing consumption of fruits, vegetables and whole grains and related changes in lifestyle, are practical strategies for significant reduction in the incidence of cancer and non communicable diseases (Terry *et al.*, 2001).

The types of vegetables or fruit that most often appear to be protective against cancer are raw vegetables, followed by allium vegetables, carrots, green vegetables, cruciferous vegetables and tomatoes (Denny and Buttriss, 2005).

Nutrition recommendations for people with diabetes are to prevent or slow complications of diabetes by achieving blood glucose levels as close as possible to normal range and a lipid profile that reduces the risks for cardiovascular disease and blood pressure levels in the normal range (ADA, 2008).

Nutritional counseling, increasing dietary fiber intake deserves attention due to its ability to reduce total cholesterol and hyperglycemia in patients with both impaired glucose tolerance and type 2 diabetes mellitus. In addition, increased fiber intake may improve insulin sensitivity and reduce systemic inflammation (Qi *et al.*, 2006).

Dietary intake of plant fibers is important for maintaining a healthy gut and reducing glucose absorption, which can be beneficial to diabetic patients. Consumption of insoluble fibers such as cellulose and hemicelluloses, as found in bran, leafy vegetables or fruit skins (e.g. apples and pears), serve as roughage and

help to reduce the calorific value of diets. This is important in obese and diabetic conditions (Mircea, *et al.*, 2009). Dietary fiber plays an important role in prevention of various diseases like cardiovascular diseases, cancer, diabetes, constipation and others (Lario *et al.*, 2004). Considering type 2 Diabetes Mellitus, early dietary education is important to delay or prevent the onset of the disease. Accordingly dietary intervention aimed at improving diet quality has been shown to be effective (Pimentel *et al.*, 2010).

High dietary intake of fruits, vegetables and whole grains is strongly associated with reduced risk of developing chronic diseases. It is estimated that increasing consumption of fruits, vegetables and whole grains reduced risk of alimentary track and respiratory tracts. The main antioxidant substances found in fruits and plants include ascorbic acid, carotenoids and phenolic compounds (Savikin *et al.*, 2009).

Functional foods are defined by the institute of Medicine of the US National Academy of Sciences (Thomas and Earl, 1994) as foods that encompass potentially healthful products, including any modified foods or food ingredients that may provide a health benefit beyond the nutrients it contains. The functional foods center at USA has defined a functional food as a natural or processed food that contains known or unknown biologically active compounds with defined quantitative amounts provides a clinically proved and documented health benefit, and thus an important source in prevention, management and treatment of chronic diseases of the modern age.

However the institute of Medicine's Food and Nutrition Board (IOM/ FNB, 1994) defined functional foods as any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains.

Consumer interest in the relationship between diet and health has increased the demand for information on functional foods. Rapid advances in sciences and technology, increasing health care costs, changes in food laws affecting label product claims, an aging population and rising interest in attaining wellness through diet are among the factors fueling interest in functional food (Sudhir *et al.*, 2011).

Epidemiological studies and randomized clinical trials carried out in different parts of the world have been demonstrated or at least suggested numerous health effects related to functional food consumption such as reduction of cancer risk, improvement of heart health, enhancement of immune functions, lowering of menopause symptoms, improvement of gastrointestinal health, anti-inflammatory effects, reduction of Blood Pressure, antibacterial and antiviral activities, reduction of osteoporosis etc (Mahan and Stump, 2007).

General interest in improving or maintaining health by increasing intake of all natural and organic products combined with busier schedules has created a desire for more streamlined approaches to nutrition. Analysis of data from the 2007-2010 National Health and Nutrition Examination Survey (NHANES) revealed that 49 per cent of US adults reported using a supplement within 30 days of the study. The main reasons for taking supplements were identified as being to improve overall health (45%) and to maintain health (33 %) (Melissa *et al.*, 2013).

D. Role of Functional Foods in improving Nutrition and Health Status

i. Introduction to Functional Foods

The term functional food was first used in Japan, in the 1980s for food products fortified with special constituents that possess advantages on physiological effects, functional food may improve the general conditions of the body or decreases the risk of some diseases (Sudhir *et al.*, 2011). Japan is the only country that has formulated a specific regulatory approval process for functional foods known as Foods for Specified Health Use (FOSHU), these foods are eligible to bear a seal of approval from the Japanese Ministry of Health and Welfare (Arai, 1996). Currently, 100 products are licensed as FOSHU foods in Japan.

Increasing awareness among consumers to know which specific molecules present in their food possess disease preventive or curative properties has led to the concept of functional foods. Functional foods, pharma foods, designer foods and nutraceuticals are synonymous terms of foods that can prevent and treat diseases (Sudhir *et al.*, 2011).

Mounting evidence supports the observation that functional foods containing physiologically active components, either from plant or animal sources, may enhance

health. Clearly, all foods are functional, as they provide taste, aroma, or nutritive value. There has been an explosion of consumer interest in the health enhancing role of specific foods or physiologically-active food components, so-called functional foods. It should be stressed, however, that functional foods are not a magic bullet or universal panacea for poor health habits. There are no "good" or "bad" foods, but there are good or bad diets (Gaffe, 2010).

Nutraceuticals / functional foods/food supplements (broadly including probiotics, prebiotics, synbioitcs, phytochemicals *etc.*), especially the need for consuming appropriate diets, health issues surrounding failure to adhere to the known healthy eating models, development of new nutraceuticals/functional foods/food supplements with novel health benefits, elucidation mechanisms of action of these products, development of study systems such as in-vitro co-culture cell models. Appropriate diet culminates in a healthy, properly functioning GI tract, resulting in attainment of proper human physiology, hence healthy living; otherwise the opposite becomes true. Modeling new eating habits using the existing knowledge is needed for the eventual ideal of health for all vision (www.mdpi.com/journal/nutrients).

Functional foods and dietary supplements are a rapidly growing segment of the overall food market and contain numerous biologically active compounds that may contribute to the health-promoting properties of these foods. It is important both for the food industry and for the food inspection authorities to have analytical tools for quality and authenticity control of functional foods and related products (Scheber and Lopes, 2011).

Functional food can be defined as any health food similar in appearance to conventional foods, consumed as part of a usual diet, and claimed to have physiological benefits like health-promoting or disease-preventing property beyond the basic function of supplying nutrients. Functional food may be the new one produced by genetic modification or feeding trial, or a processed food influencing on diseases and health. Worldwide efforts are being made for development of newer functional foods. Market of functional food is expanding and global market is expected to reach a value of atleast 90.5 billion US\$ by 2013 (Kaur and Das, 2011).

The Philosophy that food has health benefit beyond its nutritional value has gained considerable acceptance in recent years and the specific disease preventing effects of nutrition have even led to the new science of functional foods (Jason and Chris, 2008). Functional food or medicinal food is any fresh or processed food claimed to have health promoting and disease preventing property beyond the basic nutritional function of supplying nutrients (Clover, 2000).

Functional food is a Natural or processed food that contains known biologically-active compounds which in quantitative and qualitative amounts provides a clinically proven and documented health benefit and thus an important source in the prevention, management and treatment of chronic diseases of the modern age (Danik, 2011).

Functional foods are similar in appearance to conventional foods. When food is being cooked or prepared using scientific intelligence with or without knowledge of how or why it is being used, the food is called functional food. Thus functional food provide the body with the required amount of vitamins, fats, proteins, carbohydrates etc needed for its healthy survival (FAO, 2010).

The beneficial effects of functional foods and nutraceuticals can be concluded that reduced risk of cardiovascular diseases, reduced risk of cancer, weigh loss/management, reduced osteoporosis, improved memory, quicker reaction time, improved fetal health and reduced risk of many other diseases. Functional foods and nutraceuticals will be hopeful to good health in the future; it has been convincingly demonstrated to be beneficial for their intended purposes when consumed as part of a generally well-balanced and healthful diet (Sohaimy, 2012).

Functional foods are defined as products that resemble traditional foods but possess demonstrated physiological benefits. However, nutraceuticals are commodities derived from foods, but are used in the medicinal form of pills, capsules or liquids and again render demonstrated physiological benefits. In Canada, the latter group has now been integrated under a new category as natural health products that promote health. This category includes both nutraceuticals and herbal as well as other natural products. In some countries, however, functional foods and nutraceuticals are used interchangeably to improve health and reduce disease risk through prevention thereby reduce the increasing burden on the health care system

by a continuous preventive mechanism. A large number of phytochemicals and bioactives are present in foods of plant origin as well as seafoods and other animal-based products. The synergistic effects rendered by a combination of bioactives present in source materials and the complementary nature of phytochemicals from different sources are important factors to be considered in the formulation of functional foods and in the choice of a healthy diet (Fereidoon, 2012).

Types of Functional foods

Functional foods are divided into whole foods, enriched foods, fortified foods and enhanced foods. **Whole foods** are oats, soy, fruits and vegetables, fish, garlic, grapes, flax seed and nuts. These foods reduce cholesterol and constipation, reduce risk of heart disease and also reduce risk of osteoporosis and certain cancers. **Fortified foods** are juices with calcium, grains with folic acid, infant formulas with iron, grains with added fiber, milk with vitamin-D and juices with added fiber. These foods reduce the risk of osteoporosis, heart disease, neural tube birth defects and increases blood glucose control. **Enhanced foods** are dairy products with probiotics, beverages and salad dressings with antioxidants, sports bars, spreads with stanol esters, foods containing sugar alcohols in place of sugar and eggs with omega-3 fatty acids. These foods reduce the risk of colon cancers, treatment of respiratory allergies, diarrhoeal disorders, reduces cholesterol and reduces risk of heart disease (www.diet.com/g/functional-foods).

The role of functional foods in chronic disease risk reduction has been given increasing attention over the past 10 years by researchers. Media promotions have heightened consumer awareness about the cardiovascular benefits of some foods such as whole grains, nuts, fish and flax seed. Several recent reviews have highlighted the positive effects of legumes or dry beans in improving serum lipid profiles in patients with coronary heart disease (Winham *et al.*, 2007)

Functional foods and dietary supplements are two of the major classes of nutraceuticals or food-related products that have purported health or medical benefits, such as improving cardiovascular health and prevention or treatment of disease. Functional foods can include foods that have been either enriched or fortified to restore preprocessed nutrient levels (enriched flour), to improve nutritional quality of an otherwise nutrient-deficient food (calcium in orange juice) or to resolve

public health problems (Vitamin D in milk, iodized table salt). Some consider a functional food to be any food that provides health benefits beyond basic nutrition, such as the soluble fibre found in oatmeal and the monounsaturated fat found in avocados (Sprinkle, 2012).

Dietary supplements, including concentrated forms of food-derived nutrients, are the other major class of nutraceuticals. Unlike functional foods, dietary supplements are not intended to be food or meal for consumption for added nutrients or perceived health benefits. Global dietary supplements sales continue to rise, growing 6.1 per cent in 2011, from \$79.43 billion to \$ 84.26 billion. The most common dietary supplements are multivitamin-mineral products, calcium and ω -3 / fish oil (Zambetti, 2012).

Growing consumer understanding of the relationship between diet and disease/ health has stimulated the commercial development of functional foods containing validated physiological benefits beyond basic nutritional functions. Functional foods targeting digestive health, child nutrition, elderly nutrition, weight management, obesity and beauty enhancement are gaining great market leverage. Bioactive compounds possessing properties for these health targets include alkaloid, anthocyanin, carotenoid, flavonoid, glucosinolate, isoflavone, phenolic acid, tannin and terpene phytochemicals as well as protein hydrolysates (Marriott, 2000).

a. Carrot

Carrot (*Daucus carota*) is grown in mountain areas that have cold temperatures and moist atmosphere, approximately at a height of 1200 meters above sea level. Studies show that diets high in carotenoids are associated with a lower risk of heart disease and regular consumption of carrots reduces LDL cholesterol levels. Soluble fiber in carrots can help lower blood cholesterol levels by binding with and removing bile acids (Hezy, 2010).

Carrot is considered as one of the most important vegetables due to its pleasant flavor, nutritive value and great health benefits related to its antioxidant, anticancer, antianaemic, healing and sedative properties. Carrot is composed of approximately 90 per cent of water and 5 per cent of carbohydrates, vitamins and minerals. Other constituents are also present at lower concentrations (Shivhare *et al.*, 2009).

Carrots contain a wide array of phytochemicals such as carotenoids, phenolics, α -tocopherol and poly acetylenes. Carrots are most known for their pro-vitamin A carotenoids but also contain other phytochemicals with documented health benefits (Metxger and Barnes 2009).

Carrots are a rich source of nitrates, which may be converted into nitric oxide to increase vasodilation, possibly decreasing Blood Pressure. The Mediterranean diet, known for relatively low rates of CVD compared to the typical Western diet, is rich in dietary nitrates and green leafy vegetables containing potassium. Carrot juice is also a rich source of potassium which may in part have contributed to lowering Systolic Blood Pressure (Hermansen, 2000).

b. Tomato

Tomato (*Lycopersicon esculentum* L.) is one of the most widely consumed vegetable, being the second most important vegetable crop worldwide. It is a key component in the so-called “Mediterranean diet”, which is strongly associated with a reduced risk of chronic degenerative diseases (Agarwa and Rao, 2000).

Tomato has a unique nutritional and phytochemical profile. Vitamin C, vitamin A (as carotenoids), fiber, potassium, and the antioxidant lycopene are natural components of tomatoes. Lycopene is the major dietary carotenoid and tomatoes and tomato-based foods are the richest sources of lycopene in the American diet (<http://www.ars.usda.gov/nutrientdata.com>).

Tomato is a major source of antioxidants contributing to the daily intake of a significant amount of these molecules. It is consumed fresh or as processed products such as canned tomato, sauce, juice, ketchup, stews and soup (Lenucci *et al.*, 2006). In fact, epidemiological studies have shown that consumption of raw tomato and its tomato based products is associated with a reduced risk of cancer and cardiovascular diseases (Giovannucci *et al.*, 2002).

Tomato antioxidants include β - carotene, a precursor of vitamin A, and mainly lycopene, which is largely responsible for the red color of the fruit, vitamins such as ascorbic acid and tocopherols, and phenolic compounds such as flavonoids and hydroxycinnamic acid derivatives (Borguini and Torres, 2009). These compounds may play an important role inhibiting reactive oxygen species responsible for many

important diseases, through free-radical scavenging, metal chelation, inhibition of cellular proliferation, and modulation of enzymatic activity and signal transduction pathways (Crozier *et al.*, 2009).

Lycopene-the carotenoid of tomatoes-has attracted attention because of its role in the prevention of chronic diseases in which oxidative stress is a major etiological factor, such as cancer, cardiovascular and neurodegenerative diseases and hypertension, among others. Antioxidants, including lycopene, interact with reactive oxygen species, can mitigate their damaging effects and play a significant role in preventing these diseases (Waliszewi and Blasco, 2010).

c. Cauliflower leaves

Cauliflower leaves are rich source of vitamin C, Vitamin K, Vitamin A and B vitamins, including B6(pyridoxine), B5 (Pantothenic acid), B2 (riboflavin), B3 (niacin), and vitamin B1 (thiamin), folate and fiber and minerals such as potassium, phosphorus, manganese, magnesium, iron and calcium. These leaves contain phytonutrients and antioxidants (Ambrosone and Tang, 2009).

Cauliflower has the highest wastage index, that is the ratio of non-edible to edible portion after harvesting (Kulkarni *et al.*, 2001), and thus generates a large amount of organic solid waste, which creates a foul odour on decomposition. It is considered as a rich source of dietary fiber and possesses both antioxidant and anticarcinogenic properties. Phenolic compounds and vitamin C are the major antioxidants of *brassica* vegetables, due to their high content and high antioxidant activity (Podsedek, 2007)

Disposal of the non-edible portion of cauliflower (cauliflower waste), which contributes to about 45–60 per cent of the total weight of the vegetable, remains a crucial problem (Oberoi *et al.*, 2007). Unfortunately, cauliflower waste in developing countries like India does not find any significant commercial use, despite containing appreciable amount of proteins and minerals. There is very scanty literature available on the use of vegetable residues, especially cauliflower waste for enzyme production (Oberoi *et al.*, 2008).

d. Amla

Amla (*Phyllanthus emblica*) belonging to the family Euphorbiaceae, is a herbal plant used widely in indigenous medicinal preparations used to treat a variety

of diseases. It is also known as the Indian gooseberry or amlaki, and is used in Indian medicine as a cardiogenic (Antony *et al.*, 2006).

Amla is known for its medicinal and nutritional properties. It is the richest source of vitamin C among fruits like Barbados cherry or West Indian cherry. It is one of minor fruits even though it has got an important fruit crop among the farmers, nursery men and scientists because of commercial significance and highly remunerative without much care. The demand for its processed products is gearing up day by day in domestic as well as in global market (Periyathambi, 2006).

Amla is highly nutritious and is one of the richest sources of vitamin-C, amino acids and minerals (Srivastu, 2012). It contains several chemical constituents like tannins, alkaloids and phenols. Among all, hydrolysable tannins, Emblicanin A and B; gallic acid, ellagic acid are reported to possess biological activity. Almost all parts of the plant possess medicinal properties, particularly fruit, which has been used in Ayurveda as a powerful rasayana and in customary medicine in the treatment of diarrhoea, jaundice, inflammation and several other ailments (Zhang *et al.*, 2003). Amla fruit powder controls high blood pressure (Devalaraja *et al.*, 2011).

Amla fruit has been said to be useful against many diseases, including cancer, diabetes, hepatic disorders and heart diseases. Research has been done with amla for its role as an antioxidant, in ulcer prevention, for people with diabetes, for mental and memory effects and its anti-inflammatory benefits. Amla extract supplements not only retain the lost body energy and vigor but also helpful in those undergoing radiation therapy. Amla Tonic has a hematinic and lipolytic function useful in scurvy and jaundice (Dasaraju and Gottumukkala, 2014).

The fruit is reputed to have a broad range of therapeutic effects including anti carcinogenesis and antimutagenic, antitumour and induction of apoptosis (Jose *et al.*, 2001). There is growing evidence that the humble amla berry offers nearly legendary powers in healing and preventing atherosclerosis and related cardiovascular disease (Kim *et al.*, 2005).

Amla contains more potent antioxidants than vitamin C and reduce arthritis and osteoporosis as well as lower cholesterol (Kuhn and Winston, 2007). Researchers concluded that amla's polyphenol rich extract protects against metabolic

disorders by reducing total cholesterol level (Kim, 2010), earlier studies have established this effect in human models. Indian gooseberry was found to reduce cholesterol levels in men aged 35-55 years (Jacob, 2010).

e. Flax seed

Flax (*Linum Usitatissimum*) is a blue flowering crop that produces small, flat seeds that range in color from golden yellow to reddish brown. Flax seed is commonly found as whole or ground seed or flax seed oil. Whole flax seed contains 41 per cent fat, 28 per cent dietary fibers, 21 per cent protein and minerals, vitamins and carbohydrates (Morris, 2001).

Flax seed is high in phytochemicals, including many antioxidants. It is perhaps the best source of lignans (Laura, 2014). Its unique oil is composed of 73 per cent polyunsaturated fatty acids (PUFA), 18 per cent monounsaturated fatty acids (MUFA) and 9 per cent saturated fatty acids (SFA), making it a low-saturated fat food. It is also the richest known source of omega 3 (n-3) fatty acid, ALA, which comprises 55 per cent of the total fatty acids. The ability of whole flax seed (or its powder) to reduce cholesterol in humans has been supported in several studies. A review of 9 clinical trials suggest that 15-50 grams of flax seed a day (either whole or powder) can modestly reduce total and LDL cholesterol by 1.6 to 18 per cent in both normo and hypertensive patients without any significant effects on HDL or triglycerides. Flax seed oil does not seem to be as effective in reducing cholesterol as whole flax seed and flax seed powder (Heli *et al.*, 2009).

Omega-3 fatty acids are a key force against inflammation in our bodies. Mounting evidence shows that inflammation plays a part in many chronic diseases including heart disease, arthritis, asthma, diabetes and even some cancers. This inflammation is enhanced by having too little Omega-3 intake (such as in fish, flax and walnuts), especially in relation to Omega-6 fatty acid intake (in oils such as soy and corn oil) (Laura, 2014).

Flax seed is a functional food that has recently gained attention in the area of cardiovascular disease prevention because it contains three key constituents: α -linolenic acid (ALA), soluble fiber and lignans. Flax seed and flax seed oil are considered as potentially useful foods by the American Heart Association (Charles *et al.*, 2006).

Daily consumption of 15 to 50 g of ground flax seed meal (1-5 Tbsp/day) can modestly reduce total cholesterol and LDL concentrations without significantly altering TG or HDL (Bloedon *et al.*, 2004).

High blood or hypertension is a major risk factor for cardiovascular disease which causes almost 50 per cent of deaths in Europe and is reported to cost the EU economy an estimated € 169 billion per year. However, new research from Canada suggests that protein from flax seed reduce blood pressure and potentially reduce the risk of cardiovascular disease (Soplie Inglis, 2009). Hasler, (2010) reviewed that consumption of flaxseed reduces total and LDL-cholesterol along with platelet aggregation.

f. Soya Bean

Soya bean was found in Chinese books dating back to 2838 B.C. It has been the primary protein source for people in Asia for centuries. Research has shown that incorporating soy protein into the diet provides numerous health benefits, including reducing the risk of heart disease and reducing the levels of LDL, or bad cholesterol in the blood streams. The United States Food and Drug Administration (FDA) recently issued a recommendation for consumers to include 25 grams of soy protein per day in their diets (Ruth, 2011).

Soya bean is a versatile legume that contains high quality protein, minimal saturated fat and is an essentially unique dietary source of iso flavones (Rowland *et al.*, 2003). In Soy beans, the three isoflavones genistein, daidzein and glycitein comprise approximately 50, 40 and 10 per cent of total isoflavone content respectively (Murphy *et al.*, 2002). Isoflavones particularly genistein, have been shown to act as antioxidants (Guo *et al.*, 2002).

In recent years, soya beans have been studied extensively for their ability to reduce the risk of several chronic diseases, particularly CVD. More than 100 clinical studies have examined the effects of soy protein on blood cholesterol levels. Soy protein directly lowers blood low-density-lipo protein cholesterol (LDL-C) levels by 3-5 per cent (Zhang *et al.*, 2005).

Soy is becoming increasingly recognized as a food that is beneficial for metabolic syndrome, particularly for its effects on serum lipids and inflammatory

cytokines. Extensive body of literature indicates that soy food consumption lead to significant reduction in total cholesterol (10-19%), LDL cholesterol (14-20%), and Triglycerides (8-14%) (Merritt, 2004).

g. Bengal gram dhal

Recent researches have associated the consumption of pulses with a decreased risk for a variety of chronic degenerative diseases (Patterson *et al.*, 2009). Bengal gram dhal consumption is reported to have some physiologic benefits that may reduce the risk of chronic diseases and optimize health and hence considered as a 'functional food' in addition to their accepted role of providing proteins and fibre (Kerem *et al.*, 2007).

h. Black gram dhal

Black gram (*Phaseolus mungo*) (or) urad is one of the important pulse crops in India, which is the largest producer and consumer of Black gram in the world. It contains about 26 per cent protein which is almost three times that of cereals. Black gram supplies a major share of protein requirement of vegetarian population of the country (Kavitha *et al.*, 2013). Black gram contains potassium which helps to balance sodium and potassium and revoke hypertension (www.herbalhealth2v.com/into-news/ayurveda-medicinal-properties-of-black-gram-vigna-mungo-urad-dal/).

i. Condiments and Spices

Black pepper is important for its medicinal value. Medicinally black pepper can be used for digestive disorders like large intestine toxins, different gastric problems, diarrhoea and indigestion and also can be used against respiratory disorders including cold, fever and asthma (Paraganiha *et al.*, 2011). Pepper is a widely grown commodity that is consumed worldwide. Pepper is also thought to exert biological activities against diseases such as cancer, as well as potentially pathologic physiological conditions such as inflammation and oxidative stress (Alvarex *et al.*, 2011).

Black cumin (*Nigella sativa*) has been used for decades for both culinary and medicinal purposes. Black cumin seeds have a strong and hot peppery taste (Ramadan *et al.*, 2007). It is used as a natural remedy for asthma, hypertension,

diabetes, inflammation, cough, bronchitis, headache, eczema, fever, dizziness and influenza (Ali and Blunden, 2003).

Coriander (*Coriandrum Sativum* L) an annual herb of the Apiaceae family, originated from the Mediterranean and is native to regions of southern and Eastern Europe, North Africa and Asia (Barros *et al.*, 2012). Coriander seeds are also used in traditional medicine as one of the ingredients to treat rheumatism and pain in the joints, gastrointestinal complaints, indigestion, insomnia, convulsions, anxiety and loss of appetite (Emamghoreishi, *et al.*, 2005).