INTRODUCTION

Most of the countries are hit by several transitions like westernization, urbanization and mechanization along with changes in the dietary pattern adding on with high fat, high energy-dense foods. This brings about several changes in childhood and adult life. As each coin has two sides the transition has also brought a positive impact on the life of several people due to advancement in the field of medicine which has increased life expectancy which is due to advancement in nutrition, hygiene and the control of infectious disease. But on the other, there is a growth seen in obesity, cardiovascular diseases, diabetes and the most leading one is cancer.

India is a diverse country and many states in India are passing through an epidemiological health transition with high rates of urbanization. Urbanization has led to economic improvement, the consequences of which has increased food consumption, tobacco use and decreased physical activity. One of the effects of this economic transition is a shift in the chronic disease (Mohan et al., 2004). Coronary diseases, especially cardiovascular disease, diabetes mellitus, and stroke, have emerged as a major public-health problem in India. Coronary diseases have common risk factors, such as tobacco use, unhealthy diet, physical inactivity, and excess adiposity (Bhagyalaxmi et al., 2013).

Sedentary lifestyle of urban men and women has resulted in the high prevalence of overweight and obesity, which is almost three times higher in urban compared to rural area. The prevalence of hypertension has been reported to range between 20-40% in urban adults and 12-17% among rural adults (Gupta, 2004). Twenty-nine percent of the urban residents and 15.4% of the rural residents were found to have raised blood pressure. For both, men and women, the prevalence of overweight and obesity, hypertension, and lack of physical activities were significantly higher in the urban population while
smoking, smokeless tobacco consumption, poor consumption of fruits and vegetables were more prevalent in the rural population.

Rural-urban variations may be explained partly by differences in physical activity and dietary habits, while the age-specific rates of death from chronic diseases are declining in many high-income countries, the burden of these epidemics is accelerating in low and middle income countries driven by both ageing of population and rapid social and environmental changes that are contributing to the increase in the prevalence of common risk factors. At least 80% of heart disease, stroke and type II diabetes and 40% of cancer could be avoided through healthy diet, regular physical activity and avoidance of use of tobacco (Bhagyalaxmi et al., 2013).

Oxidative stress has been defined as harmful because oxygen free radicals attack biological molecules such as lipids, proteins, and DNA. However, oxidative stress also has a useful role in physiologic adaptation and in the regulation of intracellular signal transduction. Therefore, a more useful definition of oxidative stress may be “a state where oxidative forces exceed the antioxidant systems due to loss of the balance between them.”

Oxidative stress has been suggested to be involved in the etiology of chronic diseases including cancer, cardiovascular disease, cataracts and age-related maculopathies and aging in general (Groot et al., 1998). Reactive oxygen and nitrogen species can attack various substrates in the body including lipids, nucleic acids and proteins. Oxidation of any of these substrates, if unchecked, can theoretically contribute to chronic disease development. For example, oxidatively modified low density lipoprotein (LDL) has been hypothesized to be a causative agent in the development of cardiovascular disease, as is reviewed elsewhere (Groot et al., 1998). Oxidatively modified DNA may also play a role in human carcinogenesis, although a causal relationship has not yet been firmly established (Formica et al., 1995). Many daily habits are closely associated with oxidative stress, which is augmented by smoking, drinking, and
an irregular diet. Oxidative stress is well known to be involved in the pathogenesis of lifestyle-related diseases, including atherosclerosis, hypertension, diabetes mellitus, ischemic diseases, and malignancies (Yoshikawa, 1997). Because so many factors contribute to oxidative stress, individual assessment of susceptibility becomes important. To reduce oxidative stress, dietary antioxidants play very important role. Many experts believe that the recommended dietary allowance (RDA) for specific antioxidants may be inadequate and, in some instances, the need may be several times the RDA. As a part a healthy lifestyle and a well-balanced, wholesome diet, antioxidant supplementation is now being recognized as an important means of improving free radical protection (Percival, 1998).

‘Antioxidants’ are substances that neutralize free radicals or their actions. To protect the cells and organ systems of the body against reactive oxygen species, humans have evolved a highly sophisticated and complex antioxidant protection system (Sies et al., 1992).

There are three main types of antioxidants viz Enzymes, Vitamins and Phytochemicals. Enzymes are antioxidants that can be uniquely synthesized in the human body. They are made from the protein and minerals in the food we eat. It is important to have good quality proteins and minerals in our daily food. Vitamins cannot be created in our bodies. Vitamins need to be supplemented every day, without fail. The typical antioxidant vitamins are vitamins A, C, E, and M (folic acid) etc. Phytochemicals are antioxidants created by many plants to protect themselves and it has been found that if people ingest these plants the phytochemicals also work as antioxidants within our bodies (Percival, 1998).

Phytonutrients and polyphenolic chemicals are plant derived compound which are widely distributed among plant kingdom known for their antioxidant activity. Based on their chemical structure they are classified into groups: Phytochemicals; Flavonoids (Anthocyanins, flavones, flavanones, isoflavon); Phenolic (Flavonals, catechins, epicatechins); Proanthocyanidins (procyanidins,
prodelphinidins); Lignans. A large number of antioxidants occur in foods. Besides β-carotene, vitamin C and vitamin E (which are nutrients), a number of carotenoids, phenols and flavonoids also occur naturally in foods and can act as antioxidants. Most plant foods contain phenols and flavonoids. Green leafy vegetables, fruits and yellow vegetables are particularly rich in carotenoids, flavonoids and vitamin C. Vitamin C and vitamin E prevent formation of nitrosamine, which is carcinogenic. Foods popularly advocated as being rich sources of vitamin C, such as amla (*Emblica officinalis*) and guava (*Psidium guajava*), can also be rich and inexpensive sources of antioxidants. Besides being rich in vitamin C, these two fruits also contain phenolic compounds, including flavonoids.

Vitamin E is present in vegetable oils and the germ portion of cereals. Palm oil is a rich source of both tocopherols and tocotrienols. Rice bran oil contains oryzanol, which can act as an antioxidant, and is rich in plant sterols that, along with oryzanol, effectively lower blood cholesterol. Sesame oil contains sesaminol, which is a powerful antioxidant (Formica et al., 1995).

Various food groups are also rich sources of flavonoids. Cereals are staple foods in most of the countries. Apart from being an important part of diet, these cereals are also rich in various health promoting components. Cereals contain a range of substances which may have health promoting effects, these substances are often referred to as Phytochemicals or Plant bioactive substances (Slavin, 2003 and Goldberg, 2003).

Legumes play an important role in the traditional diets of many regions throughout the world. In addition to the macronutrients, pulses contain a wide variety of non-nutritive bioactive components such as enzyme inhibitors, phytic acid, lectins, phytosterols, phenolic compounds and saponins (Mark, 1999 and Champ, 2002). Legume consumption of four times or more per week compared with less than once a week, was associated with 22% lower risk of CHD, and 11% lower risk of CVD (Bazzano, 2008).
Fruits and vegetables are the major functional foods because they are the main sources of nutraceuticals such as vitamins, minerals and phenolic compounds and provide protection against cancer and cerebrovascular disease (Tomás-Barberán and Espin, 2001; Szeto et al., 2002; Rupasinghe and Clegg, 2007; Gey, 1990; Steinberg et al., 1991; Hollman et al., 1999). The flavonols, quercetin, kaempferol and myricetin are widely distributed in fruits and vegetables. Berries, tomato, potato, broad beans, broccoli, Italian squash, apple, kale and onion are the richest sources of quercetin (Hanasaki et al., 1994; Kerry and Abbey, 1997). In raisins, the most abundant phenolic acids are caftaric acid, coutaric acid, gallic acid, and clorogenic acid (Manach et al., 1997 and Young et al., 1999).

Carotenoids are nature’s most widespread pigments present in green leafy vegetables and fruits like papaya have also received substantial attention because of both their provitamin and antioxidant roles (Robak et al., 1996 and Rice-Evans et al., 1996).

Spices are also rich in phenolic compounds that have been shown to act as antioxidants. Turmeric (Curcuma domestica), which is widely used in Indian cooking, contains a yellow colouring principle, curcumin, which is a powerful antioxidant and can offer protection against cancer.

Phenolic compounds comprise one of the most numerous and widely distributed groups of substances in the plant kingdom, with more than 8000 phenolic structures currently known (Grace, 1994 and Devasagayam et al., 2004). They are found in many foods in different concentrations (Scalbert et al., 2000). The effect of consuming foods rich in polyphenols in terms of preventing diseases such as cancer, coronary disease and reduce damage to DNA (Lapidot, 1999 and Bub et al., 2003).
Flavonoids are also metal chelators and have been found to bind metals, such as copper and iron that catalyze lipid oxidation (Knekt et al., 1997). Yang et al., (2012), reviewed the inhibition of carcinogenesis by dietary polyphenolic compounds that polyphenols may inhibit carcinogenesis by affecting the molecular events in the initiation, promotion and progression stages of cancer. Beyond their antioxidative properties, flavonoids may act in a variety of ways, such as deactivating carcinogens, inhibiting the expression of mutated genes and the activity of enzymes that promote carcinogenesis, promoting detoxification of xenobiotics (Hollman et al., 1997).

They are regularly consumed in the human diet as fruits, vegetables & other foods and have various biological activities including anti-inflammatory, anti-cancer, and anti-viral properties. The flavonoids maybe one of the safest non-immunogenic drugs because they are small organic compounds which have been normally absorbed by the human body for long time.

*In vitro* studies showed significant antioxidant activity for specific dietary flavonoids & some of major metabolites and conjugated derivatives that occur into the circulation after consumption of dietary flavonoids (Evans et al., 1996). In some experiments the antioxidant capacity of flavonoids was shown to exceed of trolox or alfa-tocopherol. Because of diverse chemical structures flavonoids and their metabolites, they can have hydrophilic or relatively lipophilic properties and may interact with plasma proteins as well as the polar surface region of phospholipid bilayers in lipoprotein and cell membrane (Evans et al., 1996). Because of nature of these interactions, flavonoids may have the ability to protect against free radical attack in both aqueous and lipid environments, thus providing an effective antioxidant defense in biological systems (Dawn et al., 2002).

The flavones and catechins seem to be the most powerful flavonoids for protecting the body against reactive oxygen species (ROS). Flavonoids can prevent injury caused by free radicals in various ways. The average daily
flavonoid intake is estimated to be 23 mg/d (Haenen, 1999). Flavonoid intakes seem to vary greatly between countries; the lowest intake (2.6 mg/d) is in Finland and the highest intake (68.2 mg/d) is in Japan (Friesenecker, 1994). Quercetin is the most important contributor to the estimated intake of flavonoids, mainly from the consumption of apples and onions (Knekt et al., 1997).

More recently, genistein has been found to stimulate the production of osteoprotegerin by human paracrine osteoblasts, providing a further mechanism for the bone-sparing effects of soy isoflavones. Genistein and daidzein found in soya, both suppress osteoclast activity by a number of possible mechanisms, including induction of apoptosis, activation of protein tyrosine phosphatase, inhibition of cytokines, changes in intracellular Ca++, and membrane depolarization. Dietary sources of lignans are oilseeds, cereal grains, vegetables, fruits and legumes. Flaxseed and sesame seed have been identified as the richest sources of these compounds (Hollman et al., 1997). Once ingested, plant lignans are converted by bacteria in the large intestine into enterolactone and enterodiol, which are called mammalian lignans because they have been found only in mammals. Mammalian lignans are associated with a reduced risk of CVD and cancer (Hollman et al., 1997).

A Japanese study reported an inverse correlation between flavonoid intake and total plasma cholesterol concentrations, other clinical studies, as mentioned earlier, stated that flavonoid intakes protect against coronary heart disease (Hertog et al., 1993; Hertog et al., 1995 and Middleton et al., 2000). Collagen is the most thrombogenic component of sub endothelium, and flavonoids are known to inhibit the interaction of platelets on collagen coated surfaces (Middleton et al., 2000 & Farkas et al., 1981). Quercetin seems to play a very important role in the prevention and treatment of peptic ulcer. It acts by promoting mucus secretion, thereby serves as gastro protective agent, also quercetin has been shown to inhibit the growth of helicobacter pylori bacterium
in in-vitro studies (Middleton et al, 2000). Among other flavonoids, methyl-3- (+)-catechin interferes with the formation of histamine in gastric mucosa and hence produces the protective effect (Farkas et al., 1981).

Flavonoids of many types have antiviral effects in humans. First Cutting and his coworkers described the antiviral effect of quercetin against rabies virus (Nijveldt et al., 2001). Another fact which was observed was that when quercetin was added to cultures of several viruses associated with human maladies, viruses with an envelope were inhibited while those lacking such an envelope (like polio virus) were moderately or completely resistant to flavonoid. There are reports that people with rheumatoid arthritis experienced an improvement in their symptoms, when they switched from a typical western diet to a vegan diet with lots of uncooked berries, fruits, vegetables, which contains, apart from other nutrients, a lot of flavonoid (Hanninen et al., 2000). The flavonoids in tea might be responsible for the prevention of osteoporosis (Nijveldt et al., 2001).

Many large clinical studies conducted in last two decades have shown that flavonoids exert positive influence on health and diet rich in flavonoids alleviates and prevents many serious diseases. Flavonoids as antioxidants are ideal nutraceuticals for neutralizing stress induced free radicals. Many other actions of flavonoids like in cancer prevention have been reported in recent literature, but still large clinical trials are necessary until these effects are proved thoroughly. Flavonoids constitute a large part of U.S. nutraceuticals market and the current U.S. nutraceuticals market was estimated at $28 billion in 2006 and the demand is expected to grow in coming years. When Hippocrates, father of medicine, said that “Let food be thy medicine, and let thy medicine be food” he was probably referring to foods like flavonoids (Beecher, 2003).

During the past decades, the patents on the health effects of flavonoids have inflated very much and the yearly number of the patents is on an increasing
trend. This review summarizes the current patents on the health effects of various flavonoids. It further suggests the possible expectation that a wide variety of diseases are successfully treated with newly-developed specific flavonoids and their derivatives. In recent patents, specific flavonoids were described to function as anti-oxidants, enzyme inhibitors, hormones, or immune modulators. Moreover, the recent patents also tried to provide the molecular mechanism of the flavonoid compounds on treating or preventing various human diseases. Recent mechanistic studies in molecular level make it possible that specific flavonoids are identified to have a wide range of biological properties that can contribute to the beneficial effects on human health (Katsuyama et.al, 2007).

Epidemiological studies have shown the existence of a significant correlation between the intake of fruits and vegetables and the decrease of mortality and morbidity due to degenerative processes caused by oxidative stress (Birt et al., 2001 and Dragsted et al., 2004).

A study determined that individuals who consumed more meats, salted fish, cold cuts and seasoned cheese had the highest risk for gastric cancer, while those consuming more fresh fruit, raw vegetables, onion, garlic, and spices were associated with lower risk (Buiatti et al., 1989). Epidemiological studies report a dose-dependent negative association between consumption of tree nuts and reduced risk diet-related disorders such as obesity and cardiovascular events. Whereas this benefit is usually attributed to the unsaturated fatty acid composition of nuts, there may be other relevant mechanisms involved including the modulating effect of bioactive nut components on oxidative damage. (Sabate and Ang, 2009). Thus, consumption of nuts, spices, fruits and vegetables provide good amount of antioxidants, flavonoids which have beneficial effects on health.

There are a number of epidemiological studies that have shown inverse correlation between the levels of established antioxidants/phytonutrients
present in tissue/blood samples and occurrence of cardiovascular disease, cancer or mortality due to these diseases. Requirement for antioxidants in Indian conditions differ from that of industrialized western countries due to the nutritional differences. There are also a number of dietary supplements rich in antioxidants tested for their efficacy. Such studies show that compounds with potent antioxidant activity include carotenoids, curcumin from turmeric, flavonoids, caffeine present in coffee, tea, etc., orientin, vicenin, glabridin, glycyrrhizin, emblicin, punigluconin, pedunculagin, 2-hydroxy-4-methoxy benzoic acid, dehydrozingerone, picroliv, withaferin, yakuchinone, gingerol, chlorogenic acid, vanillin (food flavouring agent) and chlorophyllin (a water-soluble analogue of chlorophyll) Devasagayam et al., (2004).

Thus, while going through various literatures in journals like Science Direct, Springer and several other International journals it was felt that there is still a vast scope for research on flavonoids and its effect on health. It was observed that a very little research on the intake of flavonoids and their impacts on health have been carried out in India, in the context of Indian food intake. The literature motivated me to work in this direction as life today has become too stressed and people are facing lot of health issues even at younger age. Medicines to resolve the health issues create other complications and hence dietary management with a proper study on flavonoid content would surely help the society.

In view of above the present study is designed with the following objectives:

**OBJECTIVES:**
1. To determine the total phenol and flavonoid content of staple food ingredients.
2. To evaluate the flavonoid intake of the population of Vallabh Vidyanagar
3. To evaluate the total antioxidant capacity of plasma and its relation to dietary antioxidant intake