Review of Literature

REVIEW OF LITERATURE

II

The literature pertaining to the present study entitled **"Effect of Selected Spices on Hyperlipidemic and Diabetic Adults"** is reviewed under the following headings:

A. Significance of Spices in Human Nutrition

B. Effect of Spices on Hyperlipidemia

C. Effect of Spices on Diabetes Mellitus and

D. Role of the Selected Spices of the Study

1. **Cinnamon**
2. **Cloves**
3. **Garlic**
4. **Turmeric**

A. Significance of Spices in Human Nutrition

1. Definition and Classification

Research is turning up the heat on zesty herbs and spices, pointing out that a spicier life may be a healthier one. Spices are important ingredients in our daily diet although they are used in small quantities (Khanum *et al.*, 2001). Spices and herbs have occupied an important place in the culinary preparations of several ancient and modern kitchens from time immemorial.

According to the International Organisation for Standardisation of Spices "Spices and Condiments" are defined as "such natural plant or vegetable products or mixtures thereof in whole or ground form which are used for imparting flavour, aroma and piquancy to and for seasoning foods" (Prakash, 1990). A spice is a dried seed, fruit, root, bark or vegetative substance used in nutritionally insignificant quantities as a food additive for the purpose of

flavouring and sometimes as a preservative by killing or preventing the growth of harmful bacteria (Turner, 2004).

Spices are usually dried roots, barks or seeds used whole, crushed or powdered. Herbs are usually the fresh leaves, stems or flowers of herbaceous plants. Spices are stronger than herbs but they can be used in combination without loss of flavour (Srilakshmi, 1999). No country in the world produces as many kinds of spices as India with quality spices coming from Kerala, an Indian state. At present, India produces around 2.5 million tones of different spices valued at approximately 3 billion US $and holds the premier position in the world. Because of the varying climates - from tropical to sub-tropical to temperate-almost all spices are grown in this country. In almost all of the 25 states and seven union territories of India, at least one spice is grown in abundance (www.spiceskerala.com).

Manay and Shadaskarswamy, (1999) classified spices depending on the origin and active principle present in the spices as pungent spices – pepper, ginger, chillies and mustard; aromatic fruits – cardamom, nutmeg, mace, fenugreek, aniseed, caraway, dill, celery, cumin, coriander, etc.; aromatic barks – cinnamon and cassia; phenolic spices containing eugenol – clove and pimento; and coloured spices – paprika, saffron and turmeric.

The basic classification of spices based on the parts used is as follows:

- Leaves and/or branches of aromatic plants; all or part of the plant can be used. Examples include basil, bay leaf, parsley, rosemary, tarragon and thyme, oregano and chervil.
- Ripened fruits or seeds of plants. Examples include dill, fennel, coriander, fenugreek , berberis , mustard and black pepper.
- Roots or bulbs of certain plants. Examples include garlic, onion, celery and ginger.

According to Prakash (1990), spices can be classified based on the part of the plant from which the commercial products are produced, their properties and the botanical families to which they belong. There are nearly 100 major species grown in different parts of the world. If one considers strictly the botanical point of view of the various parts of the plant being used, the classification includes dried flower buds – cloves; fruits – allspice, black pepper, nutmeg and vanilla; bark – cassia and cinnamon; seeds – anise, caraway, fenugreek, coriander, cardamom, dill, poppy and cumin; and leaves – basil, bay, curry leaves, mint, rosemary, ajowan etc.

2. Culinary Benefits of Spices

India is considered to be the "Home of Spices" (Manay and Shadaskarswamy, 1999). The fact that spices contain no calorie is of potential interest to many who are calorie conscious. Some of the spices are rich in vitamins and minerals including trace elements (Pruthi, 1999).

Spices are used traditionally for aroma and as preservatives. Spices are used to mask spoiled meat flavour, improve colour and flavour and of late to improve shelf life of foods (Khanum *et al.,* 2001). Hot and spicy foods create a niche for healthy foods. Spices, herbs and chillies will be increasingly used to enhance foods that have reduced or no salt or fat, such as snacks, sauces, salad dressings and marinades. Although spices are used primarily to enhance the taste of otherwise bland foods, their beneficial effects stretch far beyond our tongues (Falcon, 2002).

The advantages of spice and their products like powders of spices, spice extracts, tea etc. are they are sterile, free from extraneous materials, soluble in a variety of systems, stable under good storage conditions and represent up to 98 per cent savings in weight and storage space (Hassel and Lawrence, 2001).

The independent use of nutritional supplements has increased dramatically over the past several years. Cinnamon for improvement of abnormal glucose and insulin regulation and garlic for hypercholesterolemia are among the more popular nutritional supplements being used by the population at large (Duncan, 1999).

3. Medicinal Uses of Spices

Herbal medicines are unique and play a vital role in the indigenous system of medicine all over the world and India is no exception wherein a number of medicinal plants are used as the source of raw drugs in the Indian system of medicine (Sastry, 2000). People today are more concerned about the side effects and the cost effectiveness of drugs and have began to rely more firmly upon herbs which are comparatively less exploited for their nutritive and medicinal qualities.

In traditional medicine, namely, Ayurveda, several spices and herbs are believed to possess medicinal properties. Consuming a diet rich in plant foods will provide a milieu of phytochemicals, non nutritive substances in plants that possess health protective benefits. The foods and herbs with the highest anticancer activity include garlic, soybeans, cabbage, ginger, licorice and the umbelliferous vegetables (Craig, 1999).

Herbal medicines have been practised worldwide since time immemorial and are now recognized by WHO as an essential building block for primary health care (Retnam and De Britto, 2005). According to WHO (1998), herbal medicines serve in the healthcare for about 80 per cent of the world population. It also shows that the goal of health for all cannot be achieved without herbal medicines (Kannaiyan *et al.*, 2001).

Even little spice in our diet could boost our immune system, decrease the risk of cardiovascular diseases and high blood pressure and fight against

cancer. Spices which are simply plant based ingredients used to flavour foods, contain a variety of powerful phytonutrients and phytochemicals (Moore, 2006).

Diabetic patients in increasing numbers are taking dietary supplements and herbs from which they expect additional health benefits (Rustenbeck, 2007).

Bapu and Srinivasan (1993) reviewed that curcumin, capsaicin, ginger, black pepper, cumin, mustard, fenugreek and onion significantly lowered adrenal cholesterol levels in rats which were accompanied by reduced ascorbic acid content in the adrenals of curcumin, capsaicin, fenugreek and onion fed rats. These are indicative of the stimulatory influence of dietary spices on adrenal steroidogenesis.

Srinivasan and Satyanarayana (1988) pointed out that the active principles in spices, namely, capsaicin, eugenol, curcumin and ferulic acid, a common plant constituent were found to counter many of the metabolic changes caused by the high sucrose diets which were also found to lower liver triglycerides, free fatty acids, phospholipids, serum total cholesterol, LDL cholesterol, triglycerides and also elevate HDL cholesterol levels. Singh *et al.*, (1994) found that administration of 50 mg of gugulipid, the compound present in *Commiphora mukul* for 24 weeks decreased the total cholesterol level by 11.7 per cent, the LDL cholesterol by 12.5 per cent and triglycerides by 12 per cent in patients with hypercholesterolemia.

a. Cayenne Pepper (*Capsicum annuum)*

Cayenne is the red hot mama of healing spices. Alternative Medicine practitioners are realizing that healing herbs should be part of their arsenal against disease. The newest touted natural herb is Capsicum, found in cayenne pepper. It has many benefits whether taken internally or externally (Watson *et al.,* 1989). When taken internally, capsicum is an antibacterial agent which will encourage healing and deflect infections while slowing the absorption of fat

in the intestines to help fight obesity. Because capsicum, this natural herbal remedy is a stimulant, it improves circulation. Capsicum will also stabilize blood pressure and lower cholesterol (Jensen and Larson, 2001). Herbalists are finding capsicum to be useful in fighting a variety of ailments. The active ingredients in the herbal remedy, Capsicum, stimulate the brain and salivary glands releasing endorphins into our body. Endorphins are nature's natural painkiller giving us the feeling of pleasure. Capsicum is also the main ingredient in pain killing rubs for Arthritis (Todd, 2002) and Diabetes nerve damage (Jensen and Larson, 2001). Capsicum will affect the breakdown of carbohydrates which will control the fluctuation of sugar levels after eating meals (Hanna, 2006).

b. Black Pepper (*Piper nigrum*)

Black pepper induces sweating, which consequently cools down the body and relieves feverish symptoms. Black pepper is useful for those with poor circulation. It is said to promote mental clarity, which is useful when studying. It can help clear up colds, viral infections and flu when prepared in a tea. Black pepper helps to prevent gas and flatulence. It induces urination, which is good when the kidneys are not functioning properly. Black pepper is a powerful anti-oxidant (Srinivasan, 2005). It is antibacterial and hence useful for meat preservation before the introduction of refrigerators. Black pepper helps to break down and digest fats and meat proteins much more easily, as it induces the production of saliva and gastric juices needed for digestion in the stomach (Karpiska *et al.*, 2001).

Black pepper is a good source of manganese and iron, which are important for the body to function correctly. Components of black pepper are often added to mouthwashes and gargles used to treat sore throats. Black pepper is a stimulant that can stimulate various parts of the body such as the heart, kidneys, circulation and the stomach (Sheila, 2007). When foods are eaten with black pepper, the body is able to absorb valuable vitamins and nutrients from the food much easier. Black pepper has been used to treat

fatigue and tiredness. It stimulates the appetite and has been used to treat anorexia and people with eating disorders. A strong black pepper and mint tea will help clear chest and lung infections and bring out unwanted mucous and phlegm (Fragiska, 2005).

c. Bay Leaf (*Laurus nobilis*)

Bay leaf is one of the most popular culinary spices in Western countries and its herbal medicine has pharmacological activity which includes anti bacterial, anti fungal, anti diabetes and anti inflammatory effects (Fang *et al.*, 2005).

d. Cool Cumin *(Cuminum cyminum)*

Cumin is widely used in Ayurvedic medicine for the treatment of dyspepsia, diarrhoea and jaundice. Oral administration of 0.25 g/kg body weight of cumin for 6 weeks to diabetic rats resulted in significant reduction in blood glucose and glycosylated haemoglobin and an increase in total haemoglobin (Talpur *et al.*, 2005). It also prevented a decrease in body weight. A significant reduction was also seen in tissue cholesterol, phospholipids, free fatty acids and triglycerides (Sahelian and Dhandapani, 2002).

e. Flavoury Cardamom (*Elattaria cardamomum*)

Cardamom, sometimes called the "The grains of paradise" is a pungent aromatic herb. The ancient Egyptians chewed cardamom seeds as a tooth cleaner; the Greeks and Romans used it as a perfume (Ninfali *et al.,* 2005). Cardamom is broadly used to treat infections in teeth and gums, to prevent and treat throat troubles, congestion of the lungs and pulmonary tuberculosis, inflammation of eyelids and also digestive disorders (Billing and Sherman, 1998). It is also reportedly used as an antidote for both snake and scorpion venom. In Chinese medicine it is used to treat stomach-aches, constipation, dysentery and other digestive problems (Love, 2004).

f. Small Coriander (*Coriandrum sativum*)

Coriander has been used as a folk medicine for the relief of anxiety and insomnia in Iranian folk medicine. Experiments in mice support its use as an anxiolytic (relieving tension or anxiety). Coriander seeds are also used in traditional Indian medicine as a diuretic by boiling equal amounts of coriander seeds and cumin seeds, then cooling and consuming the resulting liquid. In holistic and some traditional medicine, it is used as a carminative and for general digestive aid (Emamghoreishi, *et al.*, 2005).

g. Cute Asafoetida (*Ferula assafoetida*)

Asafoetida has certain medicinal uses and is most commonly used as a digestive aid. It is reputed for lessening flatulence and is often added to lentil or eggplant dishes in small quantities. It is also helpful in cases of asthma and bronchitis. As a folk traditional remedy for children's colds it is mixed into a foul-smelling paste and hung in a bag around the afflicted child's neck. In Thailand it is used to aid baby's digestion and is smeared on the child's stomach in an alcohol tincture known as "mahahing" (Craig, 1999). Asafoetida has also been reported to have contraceptive / abortifacient activity. Asafoetida oleo-gum-resin has been reported to be antiepileptic in classical Unani as well as ethnobotanical literature (Abdin *et al.*, 2006).

h. Exotic Fenugreek (*Trigonella foenum graecum*)

Fenugreek is mainly used as a digestive aid (Sharma *et al.*, 1996). Fenugreek seed is widely used as a galactagogue (milk producing agent) by nursing mothers to increase inadequate breast milk supply. Studies have shown that fenugreek is a potent stimulator of breast milk production and its use was associated with increases in milk production of as much as 90 per cent (Swafford and Berens, 2000). Supplements of fenugreek seeds were shown to lower serum cholesterol, triglyceride and low-density lipoprotein in human patients and experimental models of hypercholesterolemia and hypertriglyceridemia (Basch *et al.*, 2003).

Fenugreek is currently available commercially in encapsulated forms and is being prescribed as dietary supplements for the control of hypercholesterolemia (Thompson and Ernst, 2003) and diabetes (Gupta *et al.*, 2001) by practitioners of complementary and alternative medicine. In recent research, fenugreek seeds were experimentally shown to protect against cancers of the breast (Amin *et al.,* 2005) and colon (Raju *et al.*, 2004). The hepatoprotective properties of fenugreek seeds have also been reported in experimental models (Raju and Bird, 2006; Kaviarasan *et al.*, 2006; Thirunavukkarasu *et al.*, 2003).

i. Flowering into Saffron (*Crocus sativus*)

Saffron contributes a luminous yellow-orange colouring to foods. Medicinally, saffron has a long history as part of traditional healing; modern medicine has also discovered saffron as having anticarcinogenic (cancer-suppressing) (Aung *et al.,* 2007), anti-mutagenic (mutation-preventing), immuno-modulating and antioxidant like properties (Schmidt *et al.*, 2007). Saffron has been used as a fabric dye, particularly in China and India and in perfumery (Ferrence, 2004).

j. Glimpsy Aniseed (*Pimpinella anisum)*

Aniseed or Anise, like fennel, contains anethole and is known to be a phytoestrogen. Anise is a mild antiparasitic and its leaves can be used to treat digestive problems, relieve toothache and its essential oil to treat lice and scabies. In aromatherapy, aniseed essential oil is used to treat cold and flu (Chaudary and Tariq, 2006).

k. Poppy Poppy Sesame (*Sesamum indicum*)

The seeds are rich in manganese, copper and calcium (90 mg per tablespoon for unhulled seeds, 10 mg for hulled)and contain vitamin B1 (thiamine) and vitamin E (tocopherol). They contain lignans, including unique content of sesamin, which are phytoestrogens with antioxidant and anti-cancer

properties. Among edible oils from six plants, sesame oil had the highest antioxidant content. Sesame seeds also contain phytosterols associated with reduced levels of blood cholesterol. The nutrients of sesame seeds are better absorbed if they are ground or pulverized before consumption (Cheung *et al.*, 2007).

I. Oh, Oregano (*Origanum vulgare*)

Dining on fresh green herbs like oregano can offer the same benefits as eating fruits and vegetables, thanks to generous levels of phytochemicals and antioxidants. In one study, oregano had the highest antioxidant activity among 27 culinary herbs and 12 medicinal herbs tested, ranking even higher than fruits and vegetables. Oregano also presents antimicrobial activity against pathogens like *Salmonella typhimurium*, E. coli, *Staphylococcus aureus* and *Staphylococcus epidermidis* (Arcila *et al.*, 2005).

B. Effect of Spices on Hyperlipidemia

1. Hyperlipidemia - Definition and Classification

Hyperlipidemia, hyperlipoproteinemia or dyslipidemia is the presence of raised or abnormal levels of lipids and/or lipoproteins in the blood (Third Report of NCEP, 2002). Lipid and lipoprotein abnormalities are extremely common in the general population and are regarded as a highly modifiable risk factor for cardiovascular disease due to the influence of cholesterol, one of the most clinically relevant lipid substances on atherosclerosis (Henley *et al.*, 2002).

Hyperlipidemias are classified according to the Fredrickson classification which is based on the pattern of lipoproteins on electrophoresis or ultracentrifugation. It was later adopted by WHO. They are Hyperlipoproteinemia type I (also known as Buerger-Gruetz syndrome, primary hyperlipoproteinemia, or familial hyperchylomicronemia), II (Familial hypercholesterolemia), III (dysbetalipoproteinemia,), IV (endogenous hyperlipidemia), V (familial hypertriglyceridemia) (Thompson, 2004).

High cholesterol is characterized by elevated levels of LDL cholesterol, normal or low levels of HDL cholesterol and normal or elevated levels of triglycerides (American Heart Association, 2000). Elevated concentrations of oxidized LDL particles, especially small LDL particles are associated with atheroma formation in the walls of arteries, a condition known as atherosclerosis, which is the principal cause of coronary heart disease and other forms of cardio vascular disease (Ornish and Scherwiz, 2007).

2. Prevalence of Hyperlipidemia

Hyperlipoproteineimias cause atherosclerosis which is a major cause of death in the developed world and is also now becoming a major cause of morbidity and mortality in India, especially with changing lifestyles and increasing stress and food habits shifting towards the 'fast food' era (Ghatak and Asthana, 1995).

It has been projected that, by 2020, chronic diseases will account for almost three-quarters of all deaths worldwide and that 71 per cent of deaths due to ischaemic heart disease (IHD), 75 per cent of deaths due to stroke and 70 per cent of deaths due to diabetes will occur in developing countries (WHO, 1998). On a global basis, 60 per cent of the burden of chronic diseases will occur in developing countries. Indeed, cardiovascular diseases are even now more numerous in India and China than in all the economically developed countries in the world put together (WHO, 2002).

The rapidly increasing burden of chronic diseases is a key determinant of global public health. Already 79 per cent of deaths attributable to chronic diseases are occurring in developing countries, predominantly in middle-aged men (Mortality and Morbidity Weekly Report (MMWR), 2004). About one- fourth of these deaths occur in people below the age of 45 years (Reddy, 1998). There is increasing evidence that chronic disease risks begin in fetal life and continue into old age (Barker, 1995). As for overweight and obesity, not only has the current prevalence already reached unprecedented levels, but the rate

at which it is annually increasing in most developing countries is substantial (Popkin, 2002).

Of all the ethnic groups, people of Indian origin have one of the highest incidences of CVD. In India, prevalence of CVD has been reported as being 11 per cent in 2001. WHO predicts, that by 2010, India will have 60 per cent of world's CVD patients below the age of 40 (Nishtar, 2003). In terms of the population-attributable risk, nearly 50 per cent of disease was attributed to hypertension, 20 per cent to high cholesterol levels and 5 per cent to diabetes mellitus (Mahoney *et al.,* 2008).

The entire risk of heart disease and heart attack can be predicted and the impact of factors causing attacks is the same whether people live in rich country or a poor one. An abnormal ratio of bad to good cholesterol and smoking were responsible for two thirds of the global risk of heart attack (Sahelian, 2005). It is estimated that 14 per cent of cardiovascular deaths are related to inadequate control of multiple risk factors in people without previous heart attack or stroke (Olendzki and Domino, 2006). Patients with diabetes are more likely to die from first event of cardiovascular disease than their counter parts (Sharma, 2007).

3. Risk Factors of Hyperlipidemia

An elevated lipid level does not lead to specific symptoms unless it has been longstanding. Hyperlipidemia is an associated complication of diabetes mellitus. The major risk factors for cardiovascular disease are hypercholesterolemia, hypertension, smoking, high alcohol consumption and lack of physical activity (US Department of Health and Human Services, 2000).

Gender is a non-modifiable risk factor. The incidence of premature disease in men of 35 to 44 years of age is three times as high as the incidence in women of the same age. More than 45 years of age is considered as a risk factor for men (NCEP, 2001). For women the increased risk comes after the

age of 55 years, which is after menopause for most of the women. Factors that increase risk of hyperlipidemia include having close relatives who have had hyperlipidemia (having a family history of the disorder), being overweight, consuming a diet high in saturated fats and cholesterol, being physically inactive and consuming a moderate to excessive amount of alcohol (The Merck Manual of Medical Information, 2004).

Men with high cholesterol levels, particularly if they were detected before the age of 50, may have an increased risk of developing prostate cancer. Two servings a day of soy protein such as that found in tofu, soy milk or soy powder can lower cholesterol levels as long as the soy is uncooked. The National Cholesterol Education Program is advising doctors to consider more intensive treatment options for people at high and moderately high risk for a heart attack. These options include setting lower treatment goals for LDL ('bad') cholesterol and initiating cholesterol-lowering therapy at lower LDL thresholds.

Increasing understanding of the biology of different forms of adipose tissue has shown that visceral fat or central obesity (male type or apple type obesity, also known as belly fat) has a much stronger correlation, particularly with cardiovascular disease, than the BMI value alone (Yusuf, 2004).

The prevalence of persons being overweight or obese has been increasing dramatically for the past 30 years (Flegal *et al.*, 2002). One out of every three adults is obese, which is defined as having a body BMI of 30 or more. Also, two of every three adults are overweight, defined as having a BMI of 25 or more (Hedley *et al.*, 2004). It is well documented that obesity is a risk factor for many chronic diseases, including type 2 diabetes (Patterson *et al.,* 2004), hypertension (Okosun *et al.*, 2004), dyslipidemia, Coronary Heart Disease (CHD), gall bladder disease, respiratory disease, cancer and osteoarthritis (Owens, 2003).

Cholesterol is an essential part of a healthy body, high levels of cholesterol in the blood (hypercholesterolemia) increase a person's risk for

cardio vascular disease which can lead to stroke or heart attack (Howard and Eckel, 2000). Heredity may be a factor for some people; increasingly sedentary lifestyles combined with diets high in saturated fats appear to be the main culprits (Merrit, 2007). Low fruit and vegetable intake is estimated to cause 31 per cent of coronary heart disease and 11 per cent of stroke worldwide (Yusuf, 2004).

Every one per cent reduction in total cholesterol levels produces a two per cent reduction in the risk for (fatal or non-fatal) heart attack (National Cholesterol Education Programme, 2001). The risk of cardiovascular disease doubles for every 10 points increase in diastolic blood pressure or every 20 points increase in systolic blood pressure. People with uncontrolled high blood pressure are 7 times more likely to have a stroke than people with controlled high blood pressure (WHO, 2005).

There is a high prevalence of standard coronary risk factors like smoking, physical inactivity, hypertension, hypercholesterolemia, diabetes and obesity--as well as factors peculiar to south Asians truncal obesity, low HDL-cholesterol and high triglycerides in urban Indian population (Gupta *et al.*, 2002). Hypertension, diabetes and smoking were the common risk factors among all the subtypes of ischemic stroke (Kaul *et al.*, 2002). Smoking 10 or more cigarettes or beedis / day carries an independent four-fold increased risk of acute myocardial infarction (Pais *et al.,* 2001). Smoking is an independent risk factor for type 2 diabetes mellitus (Sahay and Sahay, 2002).

Vegetarian diets tend to be high in complex carbohydrates and dietary fibre, which has a beneficial effect on carbohydrate metabolism, lowering blood sugar levels. The leanness of vegetarians also contributes to reduced incidence of diabetes. Total fiber intake has been associated with reduced lipid risk factors for coronary artery disease (CAD) in young people (Ludwig *et al.,* 1999)and increased whole-grain intake appears not only to reduce the incidence of CAD and diabetes but also to reduce blood glucose, fasting insulin

and evidence of insulin resistance in obese subjects (Pereira *et al.*, 2002). Nuts' protein and associated phytochemicals may provide some of the same advantages as seen with soy and inclusion of nuts in the diet has been shown to lower serum cholesterol in non-diabetic subjects (Jenkins *et al.,* 2002).

4. Management of Hyperlipidemia

The best treatment for people who have high cholesterol or triglyceride levels is to lose weight if they are overweight (Katz and McHorney, 2000), stop smoking, decrease the total amount of fat and cholesterol in the diet, increase physical activity and take a lipid lowering diet (Grover *et al.*, 1995).

Stone (1996) highlighted that diet and drug therapy are two of the principal approaches to lipid management. The aim of both is to reduce LDL cholesterol to goal levels established by National Cholesterol Education Program Expert Panel. In prescribing diet therapy, it is important to determine the patient's willingness to initiate and adhere to dietary modifications, their skill at reading nutrition labels, adapting recipes and ordering heart healthy foods when eating out. Diet therapy is not always adequate. High risk individuals and those with coronary artery disease are potential candidates for drug therapy, depending on their LDL cholesterol levels (NCEP, 1993).

Phytoestrogens are among the dietary factors affording protection against cancer and heart disease in vegetarians. Hence consumption of foods containing these compounds provides potential health benefits (Knight and Eden, 1996).

5. Role of Spices in Hyperlipidemia

Many actions associated with herbal supplements may help prevent or potentially alleviate hyperlipidemia. Herbs such as garlic and ginkgo (*Ginkgo biloba)* appear to directly affect the hardened arteries by multiple mechanisms (Gardner *et al.,* 2003). Herbs such as psylliu, guggul and fenugreek reduce cholesterol and other lipid levels in the blood – known as risk factors for

hardened arteries. A related group of herbs, including green tea, prevents the oxidation of cholesterol, an important step in protecting against atherosclerosis (Warshafsky *et al.,* 1993). Herbs such as ginger and turmeric reduce excessive stickiness of platelets, thereby reducing atherosclerosis (Stevinson *et al.*, 2000).

A diet rich in cayenne spiced chilli protected against the formation of LDL cholesterol (Shobana and Naidu, 2000). Rosemary, a staple in Mediterranean cuisine, fights the formation of blood clots and reduces inflammation, making it a powerful ally against heart disease (Halvorsen *et al.,* 2002). A common household spice, nutmeg is a natural stimulant to the cardiovascular system (Arora and Kaur, 1999). Fenugreek binds with cholesterol in the intestine and encourages the excretion of cholesterol from the body (De *et al.,* 1999). Celery seed is used to treat heart disease, high blood pressure and reduce cholesterol (Lampe, 2004).

Basil enriches the taste and cardiovascular health benefits of our life. It is a very good source of beta carotene, provitamin A since it can be converted into vitamin A. Beta carotene is a more powerful anti-oxidant than vitamin A and not only protects epithelial cells from free radical damage, but also helps prevent free radicals from oxidizing cholesterol in the blood stream. Only after it has been oxidized does cholesterol builds up in blood vessel walls, initiating the development of atherosclerosis, which results in a heart attack or stroke (Behall *et al.*, 2004).

C. Effect of Spices on Diabetes Mellitus

1. Diabetes Mellitus - Definition and Classification

Awareness of diabetes mellitus disease dates back to 1500 B.C. The term "diabetes" was first used in the second century A.D. and expanded to diabetes mellitus in the sixth century A.D. Diabetes mellitus is a public health threat that represents a group of metabolic diseases characterized by defects in insulin secretion and / or insulin action (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 2003).

Diabetes mellitus is a clinical syndrome characterized by hyperglycemia caused by an absolute or relative deficiency of insulin and insulin resistance. Lack of insulin whether absolute or relative, affects the metabolism of carbohydrates, proteins, fats, water and electrolytes (World Health Report, 2004). Diabetes mellitus is a disorder of carbohydrate metabolism and WHO has declared India as the "Diabetic Capital of the World" (Neelam and Elizabeth, 2005). India is referred to as the 'Diabetic Paradise of the World' in view of the high prevalence of diabetes mellitus in the country (Jayakumar and Nisha, 2005).

Diabetes has been rightly termed as the silent killer as in a majority of cases, it remains asymptomatic, gradually weakening the very foundations of human system. It has a profound effect on health, quality of life and financial burden to both the individual and society (Collene *et al*., 2005).

Diabetes mellitus is the most common chronic disease in the industrialized world. The classification and diagnostic criteria for diabetes were proposed by the American Dietetics Association (ADA), Japan Diabetes Society (JDS) and WHO (1994). Diabetes is classified into four etiological categories; type 1, type 2, diabetes due to other specific mechanisms or conditions and gestational diabetes. Type 1 Diabetes Mellitus formerly referred to as Insulin Dependent Diabetes Mellitus (IDDM) and juvenile onset diabetes, usually arises in childhood. It is an autoimmune disorder in which the diabetic person's immune system produces antibodies that destroy the insulin producing beta cells. Because the body is no longer able to produce insulin, daily injections of the hormone are required.

Type 2 diabetes mellitus is a metabolic disorder in which the body is unable to utilize the hormone insulin properly. Insulin is normally secreted by the beta cells of the pancreas in response to food intake; its role is to "unlock" cells so that glucose, the simple sugar into which food is broken down, can enter the cells and be converted into energy. When glucose cannot get into

cells, it builds up in the blood stream, which sets the stage for diabetes and its many serious complications such as kidney disease, potentially blinding eye disease, damage to the nerves of the feet and lower limbs that can necessitate amputation and cardio vascular disease which is the cause of premature death in more than one half of diabetes cases (American Diabetic Association, 2000).

Genetic susceptibility to this form of diabetes may not be expressed unless a person has excess body fat, especially abdominal obesity. Weight loss often helps to normalize blood glucose. Oral antidiabetic agents may also be used. Lifestyle intervention like diet and exercise is highly effective in delaying or preventing type 2 Diabetes in high risk individuals (Rao *et al.*, 2000).

Another classification is according to the degree of metabolic state into three categories based on fasting plasma glucose (FPG) and 2-h plasma glucose (2hPG) in the 75 g oral glucose tolerance test, normal type (FPG < 110 and 2hPG < 140 mg / dl), diabetic type (FPG < 126 and / or 2hPG < 200 mg / dl) and borderline type (neither normal nor diabetic type). The borderline type corresponds to the sum of impaired fasting glycemia (IFG) and impaired glucose tolerance (IGT) based on ADA and WHO (Kuzuya, 2000).

2. Prevalence of Diabetes Mellitus

India ranks number one followed by China and USA in the prevalence of diabetes mellitus (Poulose, 2005). In North America and Europe the prevalence in adults is 7 to 8 per cent and it is estimated that there are more than 100 million cases worldwide. WHO predicts that the number of patients with diabetes will rise from 130 million to over 300 million in the next 25 years. Diabetes affects 1 in 30 people living in England and Wales and accounts for more than £2 billion of hospital costs annually. The number of diabetic patients in UK is predicted to double to 3 million by the year 2010 (Perera and Lumsden, 2000).

The prevalence of diabetes among all age groups world wide was estimated to be 2.8 per cent in 2000 and 4.4 per cent in 2030. The total number of people with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030. The prevalence of diabetes is higher in men than women, but there are more women with diabetes than men due to their increased life expectancy. The diabetes mellitus in urban population in developing countries is projected to double between 2000 and 2030 (Unwin and Marlin, 2004).

India is facing an epidemic of type 2 diabetes, with high prevalence in urban areas. According to Sadikot *et al.,* (2004) the prevalence of diabetes mellitus and impaired fasting glucose among Indian urban population (4.6 %) was significantly higher than among rural population (1.9 %).

Urban residents with abdominal obesity and sedentary activity had the highest prevalence of self reported diabetes (11.3 %), intermediate in peri-urban, while rural residents without abdominal obesity performing vigorous activity had the lowest prevalence (0.7 %) and concluded that urban residence, abdominal obesity and physical activity are the risk factors associated with diabetes (Mohan *et al.*, 2008).

Dietary Glycemic Index (GI) and Glycemic Load (GL) were associated inversely with HDL cholesterol and GI was associated directly with triacylglycerols. Dietary GI and GL were related inversely to fasting glucose and directly to post-load glucose. The protective effect on diabetes risk remained significant after adjustment for employment grade, smoking and alcohol intake (Mosdol *et al.*, 2007).

3. Risk Factors Affecting Diabetes Mellitus

Wasmuth and Kolb (2000) exhorted that introduction of cow's milk based infant formula within the first three months of life is associated with increased risk of type 1 diabetes mellitus i.e. cow's milk proteins were proven to be diabetogenic. Ramachandran *et al.,* (2000) observed a positive association of

duration of type 1 diabetes with retinopathy, nephropathy and neuropathy in Asian Indians.

Type 2 diabetes is a chronic progressive condition with a prevalence which rises with age. Its origin is believed to be multi-factorial and include genetic defects and environmental interactions, which may start in the uterus (with an association with low birth weight) and early developmental plasticity, resulting in compensatory growth through childhood and a tendency to abnormal glucose tolerance in adult life (Aspray, 2005).

Increasing prevalence of diabetes could be attributed to a high genetic risk and lower risk thresholds for acquired risk factors such as age, obesity, abdominal obesity and a high percentage of body fat. Diabetes occurs at a younger age in Indians compared to Whites. The risk of diabetes increases with a body mass index of > 23 kg / m2 and waist circumference of 85 cm for men and 80 cm for women among Asian Indians (Ramachandran *et al.,* 2004). This goes in accordance with the reports in Science Daily (2006) and Chandola *et al.,* (2006), that both men and women from lower employment grades were more likely to have the syndrome, confirming that the syndrome has a social gradient.

Indians have characteristic features of insulin resistance such as high central adiposity and high percentage of body fat in comparison with many other populations which worsens with small increments in weight and also with lack of physical activity, both of which are encouraged by modern living (Signorino and William, 2007).

Lifestyle factors that have been consistently associated with increased risk of type 2 diabetes are overweight and physical activity, diet composition particularly with low fibre intake, a high trans fatty acid intake and a low unsaturated: saturated fat intake ratio and absence of or excess alcohol consumption (Parillo and Riccardi, 2004).

Primary cause of obesity is the development of an obesogenic environment due to ease of access to high calorie food and reduced energy expenditure in work and leisure activities. Genetic component to human obesity is also a strong evidence (Vickers *et al.,* 2007).

A close relationship between obesity and type 2 diabetes, an epidemic of diabetes is close behind the obesity epidemic. Preventing and treating obesity is becoming an increasing priority. Being overweight or obese increases the risk of diabetes (Aucott, 2008). In the United States, over 60 per cent of the adult population is overweight or obese and thus at increased risk of developing diabetes and cardiovascular disease (Hill and Peters, 2002).

Olinto *et al.*, (2004) exhorted that waist circumference is an independent determinant for hypertension and diabetes in Brazilian women and is age specific. Most patients with type 2 diabetes are asymptomatic at diagnosis. Earlier diagnosis of diabetes may be possible by considering diabetes in patients with weight loss and skin infections and ensuring that borderline abnormal tests are adequately followed up (Watson and Hamilton, 2008).

Diabetes is often associated with raised blood cholesterol levels and a vegetarian diet confers protection against this (Snowdon, 1985). Substituting soy or other vegetable proteins for animal protein decrease renal hyperfiltration, proteinuria and renal acid load and in the long term reduce the risk of developing renal disease in type 2 diabetes. The vegetarian diet contains a portfolio of natural products and food forms of benefit for both the carbohydrate and lipid abnormalities in diabetes. It is anticipated that the combined use in vegetarian diets will produce very significant metabolic advantages for the prevention and treatment of diabetes and its complications (Jenkins *et al.,* 2003).

Increased fiber intake may improve glycemic control in diabetes (Barnard *et al.*, 1982). Studies have confirmed large reductions in LDL

cholesterol of 25–30 per cent in healthy subjects on vegan diets based on fruits, leafy vegetables and nuts (Jenkins *et al.*, 2001). Cereal fiber consumption has consistently been associated with reduction in risk of both CVD and diabetes (Liu *et al.,* 2000).

4. Management of Diabetes Mellitus

The first step in the management of diabetes includes lifestyle modification such as weight reduction, diet, smoking cessation and aerobic exercise. Estrogen replacement therapy and discontinuance of drugs that secondarily lower HDL cholesterol are additional treatment options. The uses of lipid altering agents are adopted for the same. Nicotinic acid appears to be an effective agent for increasing HDL cholesterol (Mostaza *et al.*, 1997). Regular exercise helps to control blood glucose levels and improve the body's ability to use insulin (Gregg, 2003).

5. Role of Spices in Diabetes Mellitus

The spice cabinet may prove to be a source of help for diabetes patients. Diet has been recognized as a cornerstone in the management of diabetes mellitus. The herbs and spices from the Indian continent seem to be among the most active agents for improving blood sugar (Al-Habori and Raman, 1998). Spices are the common dietary adjuncts that contribute to the taste and flavour of foods. Besides, spices are also known to exert several beneficial physiological effects including the anti-diabetic influence. Some of the most commonly used dried herbs and spices such as fenugreek, jeera, cloves etc. may help block the inflammation believed to drive diabetes and other chronic diseases (Dragland *et al.*, 2003).

According to Srinivasan (2005) among the spices, fenugreek seeds (*Trigonella foenum graecum*), garlic (*Allium sativum*), onion (*Allium cepa*) and turmeric (*Curcuma longa*) have been experimentally documented to possess antidiabetic potential. In a limited number of studies, cumin seeds (*Cuminum*

cyminum), ginger (*Zingiber officinale*), mustard (*Brassica nigra*), curry leaves (*Murraya koenigii*) and coriander (*Coriandrum sativum*) have been reported to be hypoglycaemic.

Cinnamon, garlic, ginger, basil, oregano, nutmeg, tea, bay leaf, allspice, curry and others were found to play a role in lowering blood glucose, increasing insulin sensitivity and increasing glucose synthesis in response to food intake. In addition, these spices may improve blood circulation, decrease platelet aggregation, lower blood pressure and act as blood vessel protectants, ameliorating the cardiovascular disease often associated with type 2 diabetes. To gain these benefits, only average amounts commonly used in foods are necessary, such as amounts usually sprinkled in foods or amounts used in recipes. At high concentrated doses, the advantages to utilizing spices may be inhibited. The findings that phytochemicals in common household spices can improve insulin activity in the body present a more natural way to possibly treat and prevent type 2 diabetes (Kelble, 2005).

There is very limited scientific evidence for the effects of herbs and spices on type 2 diabetes mellitus, with the best evidence being available for the effect of ginseng on glycaemia (Tapsell *et al.*, 2006).

D. Role of Selected Spices of the Study

1. Cinnamon (*Cinnamomum zeylanicum*)

Cinnamon has been known from remote antiquity and it was so highly prized among ancient nations that it was regarded as a gift, fit for monarchs and other great potentiates. Cinnamon is native to India (*Encyclopaedia Britannica*, 2008). Cinnamon bark is widely used as a spice. It is principally employed in cookery as a condiment and flavouring material. It is used in the preparation of chocolate, especially in Mexico, which is the main importer of true cinnamon (Mancini-Filho *et al.*, 1998).

Cinnamon bark is widely used as a spice due to its distinct odour. Its flavour is due to an aromatic essential oil that makes up 0.5 per cent to 1 per cent of ts composition (www.keralaspices.com). It is of a golden-yellow colour, with the characteristic odour of cinnamon and a very hot aromatic taste.

The pungent taste and scent come from cinnamic aldehyde or cinnamaldehyde and by the absorption of oxygen as it ages, it darkens in colour and develops resinous compounds. Chemical components of the essential oil include ethyl cinnamate, eugenol, cinnamaldehyde, beta-caryophyllene, linalool and methyl chavicol (Encyclopaedia Britannica, 2008).

In medicine it acts like other volatile oils and once had a reputation as a cure for colds. It has also been used to treat diarrhoea and other problems of the digestive system. Cinnamon is high in antioxidant activity (Shan *et al.,* 2005). The essential oil of cinnamon also has antimicrobial properties (Lopez *et al.*, 2005), which can aid in the preservation of certain foods. Cinnamon has traditionally been used to treat toothache and fight bad breath and its regular use is believed to stave off common cold and aid digestion.

The principal component of cinnamon is cinnamic aldehyde. Cinnamon is principally employed in cookery as a condiment and flavouring material, being largely used in the preparation of some kinds of desserts, chocolate, spicy candies, tea, hot cocoa and liquors. Cinnamon bark is one of the few spices that can be consumed directly (Encyclopaedia Britannica, 2008).

Cinnamon, Hyperlipidemia and Diabetes Mellitus

So much has been written about the benefits of cinnamon for lowering blood sugar that many diabetes patients now take cinnamon supplements. "About a teaspoon of cinnamon, for example, is plenty to get the hypoglycemic effects" (Dearlove, 2008).

Cinnamon is widely used in traditional system of medicine to treat diabetes in India. Babu *et al.*(2007) proved that oral administration of cinnamaldehyde for a period of 12 weeks significantly decreased glycosylated haemoglobin, serum total cholesterol, triglyceride levels and at the same time markedly increased plasma insulin hepatic glycogen and HDL cholesterol levels. Also cinnamaldehyde restored the altered plasma enzyme levels proving the hypoglycemic and hypolipidemic effect of cinnamon.

"Cinnamon" has been reported to have remarkable pharmacological effects in the treatment of type 2 diabetes and insulin resistance. However, the plant material used in the study was mostly from cassia and only few of them are truly from *Cinnamomum zeylanicum* (Khan *et al.*, 2003). Recent advancement in phytochemistry has shown that it is a cinnamtannin B1 isolated from *C. zeylanicum*, which is of therapeutic effect on type 2 diabetes (Verspohl *et al.*, 2005) with the exception for the postmenopausal patients studied on *C. cassia*.

Cao *et al.*, (2007) demonstrated that cinnamon exhibits the potential to increase the amount of proteins involved in insulin signaling, glucose transport and anti-inflammatory / anti-angiogenesis response thus improving the glucose and lipid profiles of people with type 2 diabetes. Kim *et al.,* (2006) suggested that cinnamon extract has a regulatory role in blood glucose level and lipids and it may also exert a blood glucose suppressing effect by improving insulin sensitivity or slowing absorption of carbohydrates in the small intestine of rats.

According to a recent U.S. study, just half a teaspoon of cinnamon a day could help in controlling type 2 diabetes. Solomon and Blannin (2007) showed that cinnamon and its phenolic extracts exhibited insulin potentiating activity. *In vitro* and *in vivo* studies showed that cinnamon had beneficial effects on glucose homeostasis in humans.

Naturally occurring compounds like chromium and polyphenols found in cinnamon have been shown to improve insulin sensitivity i.e. insulin signaling and glucose control in patients with type 2 diabetes. Three grams of cinnamon reduced mean fasting blood glucose (18 – 20 %), total cholesterol (12 – 26%), LDL cholesterol (7 – 27%) after 40 days of supplementation (Vincent, 2007).

2. Cloves (*Syzygium aromaticum)*

Cloves are used in Ayurveda called Lavang in India, Chinese medicine and western herbalism and dentistry where the essential oil is used as an anodyne (painkiller) for dental emergencies. The important constituents of cloves include essential oils acetyl eugenol, beta caryophylline and vanillin, crategolic acid, tannins, gallotannic acid, methyl salicylate, the flavanoids eugenin, kaempferol, ohamnetin and eugenitin, triterpenoids like oleanolic acid, stigmasterol and campesterol and several sesquiterpenes (Chinese herbal medicine, 2004).

Cloves are also a key ingredient in tea along with green cardamoms. In the North Indian cuisine, it is used in almost every sauce or side dish made, mostly ground up along with other spices. In the South Indian cuisine, it finds extensive use in the biriyani dish and is normally added whole to enhance the

presentation and flavour of rice. The compound responsible for the cloves aroma is eugenol and it comprises about 72 to 90 per cent (Chami *et al.,* 2005). Eugenol has pronounced antiseptic and anaesthetic properties.

In Tibetan medicine, cloves are used internally as a tea and topically as oil for hypotonic muscles, including multiple sclerosis (Fu *et al*., 2007). In West Africa, the Yosubas use clove infused in water as a treatment for stomach upsets, vomitting and diarrhoea. The infusion is called ogun jedi-jedi (Darshan and Doreswamy, 2004). Clove is used in the form of a paste or mixture as dental cement, filler or restorative material (Almas *et al.,* 2000). Clove is sometimes added to tobacco in cigarettes and clove cigarettes (kreteks) typically contain 60 per cent tobacco and 40 per cent ground cloves (Stanfill *et al*., 2006).

Cloves are used as a carminative, to increase hydrochloric acid in the stomach and to improve peristalsis. Cloves are also said to be a natural antihelmintic (Phyllis and James, 2000). The essential oil is used in aromatherapy when stimulation and warming is needed, especially for digestive problems. Topical application over the stomach or abdomen will warm the digestive tract (Andrew and Karen, 2003).

Since the herb is so warming it is contraindicated in persons with fire symptoms and according to classical sources should not be used for anything except cold from yang deficiency. As such it is used in formulas for impotence or clear vaginal discharge from yang deficiency, for morning sickness together with ginseng and patchouli, or for vomitting and diarrhoea due to spleen and stomach coldness (Chinese Herbal Medicine, 2004). This would translate to hypochlorhydria. Clove oil is used in various skin disorders like acne, pimples etc. It is also used in severe burns, skin irritations and to reduce the sensitiveness of skin (Dragland *et al*., 2003).

Western studies have supported the use of cloves and clove oil for dental pain and to a lesser extent for fever reduction, as a mosquito repellent

and to prevent premature ejaculation (Trongtokit *et al.,* 2005). Cloves may reduce blood sugar levels (Turner, 2004). Cloves, a commonly used spice could prevent lung cancer, claims a research team at Chittaranjan and at National Cancer Institute, Kolkata. Cloves may inhibit abnormal cell growth in lungs, reduce the abnormal crowding of cells in particular regions of lung tissue and check the growth of pre malignant cells by more than 85 per cent. According to this study cloves could be a potential herbal remedy for lung cancer (Insight, 2007).

Cloves, Hyperlipidemia and Diabetes Mellitus

Dietary management is a starting point for the treatment of diabetes. It is important to recognize the effect of plant based compounds on tissues that regulate glucose metabolism, such as the liver. Several herbs and spices were found to increase glucose uptake into adipocytes, insulin like effect. Prasad *et al.*, (2005) highlighted that clove extracts acted like insulin in hepatocytes and hepatoma cells by reducing phospho enol pyruvate carboxykinase and glucose 6 phosphate gene expressions thus clove extract acted as an insulin mimetic agent.

Consumption of capsules containing 1, 2 or 3 grams of cloves/day for 30 days decreased risk factors of diabetes including glucose, triglycerides, total and LDL cholesterol with no changes in HDL concentrations. This study suggested that intake of 1 to 3 grams of cloves per day is beneficial for people with type 2 diabetes (Ken, 2006). Wood (2006) pointed out intake of an equivalent of one to two cloves per day improved cardiovascular and diabetes risk factors in type 2 diabetics.

3. Garlic (*Allium sativum L.*)

Garlic has been regarded as a force for both good and evil. A Christian myth considered that after Satan left the Garden of Eden, garlic grew in his left footprint and onion in the right (David, 2003) Garlic's close relatives included

onion, shallot, leek and chive. Garlic has been used throughout recorded history for both culinary and medicinal purposes. It has a characteristic pungent, spicy flavour that mellows and sweetens considerably with cooking (Zohary and Hopf, 2004). Garlic is widely used around the world for its pungent flavour, as a seasoning or condiment. It is a fundamental component in many dishes. It is often paired with onion, tomato or ginger (Maud, 2006). To maximize health benefits from consuming cooked garlic, it has been suggested to allow the crushed or chopped garlic to rest for 15 minutes before use to allow the enzymatic reactions to occur. However allicin is deactivated during cooking due to its instability and may be more beneficial if consumed raw (Pope, 2007).

Garlic is claimed to help prevent heart disease including atherosclerosis, high cholesterol, high blood pressure and cancer (Sovova and Sova, 2004). Supplementation with garlic extract inhibited vascular calcification in human patients with high blood cholesterol (Durak *et al.,* 2004). The known vasodilative effect of garlic is possibly caused by catabolism of garlic-derived polysulfides to hydrogen sulfide in red blood cells, a reaction that is dependent on reduced thiols in or on the RBC membrane. Hydrogen sulfide is an endogenous cardio-protective vascular cell signaling molecule (Durak *et al.*, 2002).

In 2007 a BBC news story reported that *Allium sativum* may have beneficial properties, in preventing and fighting common cold (Borrelli *et al.*, 2007). This assertion has the backing of long tradition in herbal medicine, which has used garlic for hoarseness and coughs. The Cherokee also used it as an

expectorant for coughs and croup (a group of conditions involving inflammation of the upper airway that leads to a cough that sounds like a bark, particularly when a child is crying) (Groppo *et al.*, 2007). *Allium sativum* has been found to reduce platelet aggregation (Rahman, 2007) and hyperlipidemia (Kojuri *et al.*, 2007).

Garlic is also alleged to help in regulating blood sugar levels. Regular and prolonged use of therapeutic amounts of aged garlic extracts lower blood homocysteine levels and has shown to prevent some complications of diabetes mellitus (Crutchfield and Diane, 2003). A mouthwash containing 2.5 per cent fresh garlic showed good antimicrobial activity, although the majority of the participants reported an unpleasant taste and halitosis (bad breath) (Anderson, 1996).

In modern naturopathy, garlic is used for treatment for intestinal worms and other intestinal parasites, both orally and as an anal suppository. Garlic pods are used as a remedy for infections (especially chest problems), digestive disorders and fungal infections such as thrush (infection of the mouth) (Daniel and Maria, 2000). Garlic has been reasonably successfully used in AIDS patients to treat cryptosporidium in an uncontrolled study in China. It has also been used by atleast one AIDS patient to treat toxoplasmosis and another for protozoal disease (Oi *et al.*, 2001).

Allium species such as onions and garlic are used as foodstuff, condiment, flavouring and folk medicine. In fact, these common food plants are a rich source of several phytonutrients but are also used in the treatment and prevention of a number of diseases including cancer, coronary heart disease, obesity, hypercholesterolemia, type 2 diabetes, hypertension, cataract and disturbances of gastro intestinal tract. These activities are related to the thiosulfinates, volatile sulfur compounds which are also responsible for the pungency of these vegetables (Lanzotti, 2006). Garlic has been shown to prevent excessive platelet adhesion in humans. Garlic inhibits platelet

stickiness (aggregation) and increases fibrinolysis, which results in slowing of blood coagulation (Legnani *et al.,* 1993).

Garlic contains substances now being studied for their anticancer effects, including allicin, allixin, allyl sulfides, quercetin and organo sulfur compounds. There is some evidence that consuming one half to one full pod of garlic daily may have a cholesterol-lowering effect of up to 9 per cent. Also, 7.2 grams of aged garlic extract has been associated with anticlotting (*in vivo* studies), as well as modest reductions in blood pressure (Shan *et al.*, 2005).

Garlic, Hyperlipidemia and Diabetes Mellitus

Garlic and garlic preparations are used as agents for prevention and treatment of atherosclerosis and its related diseases. Garlic indirectly effects atherosclerosis by reduction of hyperlipidemia, hypertension and probably diabetes mellitus and prevents thrombus formation. Garlic has a direct effect on atherosclerosis which may be explained by its capacity to reduce lipid content in arterial cells and to prevent intracellular lipid accumulation (Orekhov and Grunwald, 1997).

Garlic juice when administered one ml per kg body weight exerted antioxidant and anti-hyperglycemic effects and consequently alleviated liver and renal damage caused by alloxan induced diabetes in rats (El-Demerdash *et al.*, 2005). Lau and Lam (1987) proved that odor modified liquid garlic extract lowered cholesterol, triglycerides, LDL and VLDL with rise of HDL and can be used in conjunction with dietary modification for control of hyperlipidemia in humans over a six month period.

Aged garlic extract significantly increased the activities of super oxide dismutase, catalase and glutathione peroxidase, the antioxidant enzymes which play an important role in scavenging oxidants and preventing cell injury thus treating disorders related to endothelial cell injury associated with free radicals

such as those found in ischemia, inflammatory diseases, diabetes and atherosclerosis (Wei and Lau, 1998).

As reported by Ali *et al.*, (2000) it was seen that fresh garlic powder reduced blood pressure. A significant reduction was also seen in serum total cholesterol, triglycerides, LDL and VLDL and an elevated level of HDL cholesterol. No change was seen in serum glucose and protein levels.

The antioxidant properties of herbs and spices are of particular interest in view of the impact of oxidative modification of LDL cholesterol in the development of atherosclerosis. There is level III evidence (National Health and Medical Research Council (NHMRC)) that consuming a half to one pod of garlic (or equivalent) daily may have a cholesterol lowering effect of up to nine per cent (Tapsell *et al.*, 2006).

S – allyl cysteine sulfoxide isolated from garlic, is more or less as active as gugulipid in controlling hypercholesterolemia, obesity and derangement of enzyme activities in cholesterol fed rats (Sheela and Augusti, 1995). Oral administration of petroleum ether extract of *Allium sativum* significantly prevented the rise in serum cholesterol and serum triglyceride level caused by atherogenic diet (Lata *et al.*, 1991) in hypercholesterolemic patients.

4. Turmeric (*Curcuma longa)*

Turmeric "the golden spice of life" is one of the most essential spice used as an important ingredient in culinary all over the world. Turmeric, derived from the plant *Curcuma longa* is a gold coloured spice commonly

used in the Indian subcontinent, not only for health care but also for the preservation of food and as a yellow dye for textiles. Curcumin, which gives the yellow colour to turmeric, was first isolated almost two centuries ago and its structure as diferuloylmethane was determined by 1910. Since the time of Ayurveda (1900 BC) numerous therapeutic activities have been assigned to turmeric for a wide variety of diseases and conditions, including those of skin, pulmonary and gastrointestinal systems, aches, pains, wounds, sprains and liver disorders (Aggarwal *et al.,* 2005).

Turmeric (coded as E100 when used as a food additive) is used to protect food products from sunlight (Leong *et al.*, 2008). Turmeric is widely used as a spice in Indian and other South Asian cooking. Curcumin is a potent anti-oxidant, anti-carcinogenic, anti-hepatotoxic agent, anti-proliferative, anti-invasive, anti-angiogenic agent and as a mediator of chemoresistance and radioresistance, as a chemopreventive agent and as an agent in wound healing, diabetes, Alzheimer's disease, Parkinson's disease, cardiovascular disease, pulmonary disease and arthritis (Goel *et al.*, 2008). Thus curcumin a spice once regulated to the kitchen shelf has moved into the clinic and may prove to be "curecumin".

During boiling, broiling, frying and baking, food proteins and carbohydrates pyrolyses to form Maillard reaction products, some of which are mutagenic / carcinogenic. These mutagenic / carcinogenics play an important role in the development and progression of diabetes and age related degenerative diseases and also destroy important essential amino acids. Turmeric, an important ingredient in food preparation, blocks the formation of hazardous Maillard reaction products and its mutagenic activity (Kolpe *et al.*, 2002).

Curcumin, a potent polyphenolic antioxidant and a Non Steroidal Anti-Inflammatory Drug (NSAID), when low doses are administered (160 ppm), the astrocytic marker Glial Fibrillary Acidic Protein (GFAP) was reduced and

insoluble beta amyloid, soluble abeta and plaque burden were significantly decreased by 43 to 50 per cent thus showing promising results for the prevention of Alzheimer's disease in mouse (Lim *et al.*, 2001 and Ono *et al.*, 2004).

Curcumin, the yellow colouring agent in the spice turmeric exhibited anti-mutagenic activity and has an anti-carcinogenic activity inhibiting chemically induced preneoplastic lesions in breast and colon and neoplastic lesions in the skin, forestomach, duodenum and colon of rodents (Aggarwal *et al.,* 2003). Also curcumin inhibits TPA induced skin tumour promotion in mice. Curcumin enhanced glutathione content and glutathione - S - transferase activity in liver and it inhibits lipid peroxidation and arachidonic acid metabolism in mouse skin, protein kinase C activity in TPA treated NIH3T3 cells, chemically induced ornithine decarboxylase and tyrosine protein kinase activities in rat colon (Stoner and Mukhtar, 1995).

The components of turmeric and curcumin and related compounds called curcuminoids appear to have antioxidant, anti-inflammatory, antiviral, antibacterial and antifungal properties, with potential activity against cancer, diabetes, arthritis, Alzheimer's disease and other chronic diseases. Curcumin seems to be a very good anticarcinogen. It is linked to reduced susceptibility to cancer with a decreased occurrence of leukemia and cancers of the prostate, breast and colon. Curcumin appears to be very helpful in preventing the process of inflammation in the diseases of aging, including emphysema, diseases of the cardiovascular system, congestive heart failure, gastrointestinal problems such as colon cancer and irritants and Alzheimer's disease (Stix, 2007).

Srivatsava *et al.*, (1995) opined that curcumin, a major component of turmeric inhibited platelet aggregation induced by arachidonate, adrenaline and collagen. Curcumins anti-inflammatory property may, in part, be explained by its effects on eicosanoid biosynthesis. Ruby *et al.*, (1995) stated that curcumin

III was found to be more active than curcumin I and II as a cytotoxic agent and in the inhibition of Ehrlich ascites tumour in mice.

Padmaja and Raju (2005) reported that curcumin prevented oxidative damage mediated through selenium and protected the dehydrogenases possibly through its anti-oxidative property. Wessler *et al.*, (2005) opined that Neisseria gonorrhoeae (Ngo) is a gram negative pathogenic bacterium responsible for an array of diseases ranging from urethritis to disseminated gonococcal infections.

Curcumin inhibited the Ngo induced signaling and completely abolished the adherence of bacteria to cells in late infection, underlining the high potential of curcumin as an anti-microbial compound without cytotoxic side effects. Suryanarayana *et al.*, (2005) established that turmeric ingestion delayed the progression and maturation of cataract (anticataractogenic agent); countered the hyperglycemia induced oxidative stress and minimized osmotic stress.

Turmeric, Hyperlipidemia and Diabetes Mellitus

Bapu and Srinivasan (1995) explored that curcumin feeding improved the metabolic status in diabetic condition, despite no effect on hyperglycemic status or the body weights. The mechanism by which curcumin improves this situation was probably by virtue of its hypocholesterolemic influence, antioxidant nature and free radical scavenging property.

Dietary curcumin showed significant countering of renal cholesterol and triglycerides elevated in streptozotocin induced diabetic rats. In order to understand the mechanism of hypocholesterolemic action of dietary curcumin, activities of hepatic cholesterol-7a-hydroxylase and HMG CoA reductase were measured which suggested a higher rate of cholesterol catabolism (Bapu and Srinivasan, 1997).

The anti-diabetic effects of curcumin are partly due to the reduction in 3hepatic glucose production caused by the activation of AMP kinase and inhibition of glucose-6-phosphatase activity and phosphoenol pyruvate carboxykinase activity (Fujiwara *et al.*, 2008).