



Review of Literature

II. REVIEW OF LITERATURE

The literature pertaining to the study entitled “EFFECT OF SUPPLEMENTATION OF SELECTED NEUTRACEUTICALS ON TYPE II DIABETICS” is discussed under the following headings.

- A. Prevalence of diabetes mellitus
- B. Classification of diabetes mellitus
- C. Etiological factors of diabetes mellitus
- D. Complications of diabetes mellitus
- E. Interrelationship between various nutrients and diabetes mellitus
- F. Role of exercise in the management of diabetes mellitus
- G. Prevention and treatment for diabetes mellitus
- H. An overview about selected neutraceuticals

A. PREVALENCE OF DIABETES MELLITUS

World Health Organization estimated that there were 135 million diabetic individuals in the year 1995 and it projected that this number would increase to 300 million by the year 2025. It also declared that diabetes had reached epidemic proportions and predicted that most of the increase would be contributed by developing countries particularly in India (Rajendra *et al.*, 2002).

It had been estimated that presently in India, about 33 million individuals are affected by diabetes and these numbers are expected to increase to 57.2 million by the year 2025 (Srinivasan, 2002). Chadha (2001) stated that India had now been declared by WHO as the “Diabetes capital of the world”. Studies done by Viswanathan *et al.* (2002) in the year 2001, revealed that prevalence in Kerala was 12.4 per cent in urban areas and 2.4 per cent in rural areas. King *et al.* (1998) estimated that Non-Insulin Dependent Diabetes Mellitus (NIDDM) also known as Type II diabetes accounted for more than 90 per cent of all subjects with diabetes.

Diabetes mellitus is recognized to be common in Indians of the Asian subcontinent. It was estimated that 25 million Indians currently have diabetes and (Kochupillai 2000) the projections indicate Indians would be the largest group by the year 2025 AD. The majority of them who present for medical treatment have adult onset diabetes (Sridhar and Nagamani, 2002).

Park (2000) predicted that diabetes mellitus is one of the leading causes of death and it ranks third among chronic diseases. The incidence of diabetes is increasing at an alarming rate.

According to various studies and statistics diabetes has become the 4th leading cause of death in most developed countries and will be one of the most challenging health problems worldwide in the 21st century (Konno, 2001).

Reports from the World Health Organization indicates that diabetes mellitus is one of the major killers of our time, with people in south East Asia and western pacific being most at risk (Firshein, 2001).

The National surveys shows that the prevalence of diabetes is high in all parts of urban India and the potential for further increase is high in view of the high prevalence of Impaired Glucose Tolerance (IGT) (Ramachandran, 2002).

There is rising prevalence of what is known as Type II diabetes mellitus among younger age groups notably in poor countries. Previously this disease has been traditionally associated with being more than 40 years of age and over weight (Ko, 2001).

India has largest number of persons with diabetes with 23 million cases in 2000 rising to 57 million by the year 2025". Diabetes prevalence rates are 2-6 times higher in Latin African native and Asian American groups than among Anglo Americans (US department of health and human services 2000).

China and USA followed India with 17 and 15 million diabetes in the year 2000. India, china and USA are likely to remain in the top in the year 2025. Worldwide the number of persons with diabetes was estimated as 150 million in 2000 rising to 300 million by the year2025. The major part of increase will take place in developing countries in which 76 per cent of diabetes will occur by the year 2025 (King, 2001).

Largely accounted for the marked increase in obesity (up to 60per cent since 1990 in adults) the incidence of Type II diabetes has risen by 1/3 rd in the same time period there are now 15 million Americans including at least 300,000 children, with Type II diabetes (Harris 1998).

Studies done in migrant Indian population settled in UK, USA, South Africa, South East Asia showed distinct similarities in terms of a very high prevalence of diabetes among them ranging between 15 and 20 per cent (Ramaiya, 1990).

Diabetes affects 8 per cent of the US population, with 90 per cent having the Type II variety. The increased percentage of children who are over weight (up 50 per cent since 1970) and the lack of physical activity account for the increased incidence of Type II diabetes in children (Strauss, 2001).

Peters (2004) stated that the prevalence of Type II diabetes has increased at an alarming rate in the past 20 years. The increasing prevalence of Type II diabetes in both children and adults is strongly associated with the increasing prevalence of obesity.

Type II diabetes is an enormous public health problem affecting an estimated 18.2 million Americans. The prevalence is increasing, particularly among youth and young adults, in parallels with the continuing rise in obesity. It is relatively a common disease with major public health implications. The

prevalence, incidence, mortality, morbidity, cost to society, and the effectiveness of treatment and prevention involving weight management, exercise and glycemic control which can reduce micro vascular complications in diabetic subjects.(Power, 2001).

B. CLASSIFICATION OF DIABETES MELLITUS

Classification of diabetes by WHO (2002)

Type – I

(β Cell destruction usually leading to absolute insulin deficiency)

- Auto immune
- Idiopathic

Type – II

May range from predominantly insulin resistance with relative insulin deficiency to a predominantly secretory defect with or without insulin resistance) other specific type.

- Genetic defects of β cell function
- Genetic defects in insulin action
- Disease of the exocrine / pancreas
- Drug – or chemical induced Infections

Classification of diabetes by Raptis and Tomita (2003)

Diabetes mellitus can be divided into two major categories depending on whether endogenous insulin secretion is sufficient to prevent diabetes is shown below

IDDM	Low level of insulin including endogenous insulin, dependent on injected insulin to prevent ketosis and sustain life onset predominantly in youth but can occur at any age.
NIDDM	Insulin level may be normal, elevated or depressed; hyperinsulinemia and insulin resistance may characterize in most subjects. NIDDM prone under normal circumstance of hyperglycemia and onset predominantly occurs after age 40 years but can occur at any age.
Gestational diabetes	Glucose intolerance that has its onset or recognition during pregnancy associated with older age, obesity, family history of diabetes.

Classification of diabetes by Foster (2000)

Diabetes is broadly classified into two types Type I and Type II.

Type I- (Insulin dependent) diabetes is characterized by an absolute deficiency in insulin is typically diagnosed in the first to third decade of life and accounts approximately 10 per cent of all cases of diabetes.

- a) Type I- A diabetes mellitus results from autoimmune β cell destruction; which usually leads to insulin deficiency.

Type I B diabetes mellitus is also characterized by insulin deficiency as well as a tendency to develop ketosis. They lack immunologic markers indicative of an autoimmune destructive process of the β cell.

- b) Type II -(Non – insulin dependent) diabetes is a heterogeneous group of disorders usually characterized by variable degrees of insulin resistance impaired insulin secretion and increased glucose production and diagnosed after the fourth decade of life and accounts for roughly 90 per cent of diabetes diagnosed.

Classification of diabetes by Zimmet (1997)

- ◆ Insulin Dependent Diabetes Mellitus (IDDM)
- ◆ Non insulin Dependent Diabetes Mellitus (NIDDM)
- ◆ Malnutrition Related Diabetes Mellitus
- ◆ Impaired Glucose Tolerance Test (IGT)

i) Insulin Dependent Diabetes Mellitus (IDDM)

IDDM (Type I diabetes) results from a cellular mediated autoimmune destruction of the β -cells of pancreas and it may also be triggered by viral infection or other infections. This type of diabetes generally affects younger children; both sexes were found to be affected equally.

ii) Non-Insulin Dependent Diabetes Mellitus (NIDDM)

NIDDM (Type II diabetes) represented the most common form of carbohydrate disorder affecting at least five per cent of the population in the industrial world (Hauner and Scherbaum, 2002). In addition to genetic predisposition, obesity and sedentary life style were also considered as the main promoters. Recent data given by Manson *et al.* (2001) suggested that life style intervention in people at increased risk could potentially reduce the incidence of the disease.

Milton (2002) had mentioned about the increase in the number of adolescents with Type II diabetes. Arslanian (2002) had reported increasing cases of Type II diabetes in obese children. The risk factors laid down by the author for pediatric Type II diabetes were

- ◆ Obesity and increased body mass
- ◆ Family history of Type II diabetes
- ◆ Puberty at a mean age of 13-15 years

- ◆ Female gender

iii) Malnutrition Related Diabetes Mellitus

Malnutrition related diabetes mellitus was previously known as tropical diabetes. It is classified as,

- ◆ Fibrocalculous diabetes
- ◆ Protein - deficient pancreatic diabetes.

In both subclasses, the individuals were inhabitants of relatively poor tropical countries and were characteristically under weight, had clinical signs of present or past malnutrition and other dietary deficiency status.

iv) Gestational Diabetes Mellitus

Sean *et al.* (2002) defined gestational diabetes mellitus as glucose intolerance that was first detected during pregnancy. Yeoleskar and Borade (2002) predicted that a person with gestational diabetes may continue to be hyperglycemic after delivery and may have chances of Type I diabetes.

Yang and Hage (2002) discovered some independent predictors for gestational diabetes from their study, which includes maternal age, stature, pre-pregnancy, basal metabolic rate, weight gain in pregnancy before screening, diabetes in first degree relatives and habitual cigarette smoking during pregnancy. Melzger *et al.* (2004) also defined Gestational Diabetes Mellitus (GDM) as any degree of glucose intolerance with onset or first recognition during pregnancy.

v) Impaired Glucose Tolerance (IGT)

Nordisk (2001) explained glucose tolerance as a condition when blood glucose is higher than normal but not high enough for diagnosis as diabetes. He also added that IGT can be confirmed when the glucose level was 141 to

199mg/dl, two hours after a person was given a drink containing 75 grams of glucose.

In 1979, national diabetes data group recommended that diabetes mellitus be classified into 1 or 2 types according to dependence on exogenous insulin. Type I is Insulin Dependent Diabetes Mellitus due to the destruction of β islets cell, leading to the absence or decreased insulin secretion. Type II diabetes is a Non Insulin Dependent Diabetes Mellitus due to the imbalance between the two factors that control glucose metabolism namely insulin production and insulin sensitivity (Yuen *et al.*, 2001).

Yeh (2002) explained the two clinical group of diabetes are juvenile – onset, maturity onset. The juvenile occur in less than 25 year old, they are underweight and deficient in insulin in their blood plasma and show no insulin response when fed large amounts of glucose. They are liable to ketosis an accumulation of ketone bodies in the blood which in excess amount can lead to coma and death.

According to Mann *et al.*, (2001) Non – Insulin Dependent Diabetes Mellitus also known as Type II it is a very common form of diabetes and constitutes about 80-90 per cent of diabetes. Unlike IDDM subjects which do not secrete enough insulin problem with NIDDM subjects is that they are resistant to action of insulin secreted.

Ashal *et al.* (2002) reported that Type II diabetes pathophysiology involves a relatively selective defect in the glucose ability to provoke secretion of insulin from pancreatic islet β cells. This defect accounts for the β cells failure to compensate for insulin resistance and for the ultimate development of hyperglycemia.

Malnutrition Modulated Diabetes Mellitus (MMDM) is a clinical syndrome that occurs in young malnourished individuals in developing countries. This form of diabetes mellitus is characterized by early onset and requires insulin administration (Usha awasthi and Awasthi,2001). Mohan *et al.* (2002) revealed that malnutrition related diabetes include two forms of NIDDM that, although quite rare are well described in developing tropical countries.

C. ETIOLOGICAL FACTORS FOR DIABETES MELLITUS

1. Lack of insulin

Srinivasan (2002) expressed diabetes mellitus as a condition in which the amount of glucose in the blood is too high. Normally insulin enabled the body to turn blood glucose into immediate energy or to store it in cells. But if insufficient insulin was produced or if it did not work properly, the glucose remained trapped in the blood, causing the damage to blood vessels, nerves and tissues. He also stated that less than 5 per cent of Indian diabetes, mostly in children and teenagers, the insulin producing cells in the pancreas were destroyed resulting in the Type I diabetes.

Ganda *et al.* (2002) opined that the risk of diabetes increase with age especially after forty years mainly because the number of beta cells in the pancreas that produce insulin decrease as age advance. After thirty years women are at higher risk of diabetes as compared to men. Women who develop diabetes during pregnancy are at high risk of developing Type II diabetes in later life.

2. Genetic factor

In less than five per cent of Indian diabetics, mostly children and teenagers, the insulin producing cells in the pancreas were destroyed result in Type I diabetes and believed that genetic factors, environmental factors and infections were the causes of IDDM (Zarich,2003).

In all types of diabetes there is a balance between genetic and environmental factors, but as in other diseases, genes play a greater role in subjects with a younger onset for their diabetes. This is clearly seen in Type II diabetes. There is a considerable evidence that genes, as well as major environmental influences like obesity, are important in the etiology of Type II diabetes (Hattersely 2002).

Marianne *et al.*,(2001) explained that individuals with a family history of diabetes had a higher BMI and higher concentrations of glucose, cholesterol, triglyceride and uric acid and their risk of obesity and diabetes was increased.

3. Age

Atkins (2002) emphasized ageing as a main cause for the increasing prevalence of diabetes and he also reported that ageing as one of the factor that lead to a dramatic increase in prevalence of diabetes in developing countries.

4. Obesity

Henderson (2000) opines that obesity is a well known risk factor for diabetes mellitus but curiously the complete absence of adipose tissue is not prospective but actually causes diabetes. Recent research has often focused on the predisposition towards Type II diabetes after displayed by children with a low birth weight found to be less than 35per cent and the majority of more than half of all Type II diabetes cases result from obesity (Boyko, 2000).

Women who are obese and diabetic have a much greater risk than other women of giving birth to children with congenital birth defects (Moore *et al.*, 2000). Women who develop gestational diabetes are at a higher risk of developing diabetes later in life than other women. Their infants have a higher risk of developing diabetes later in life as well (Chasen and Taber, 2001).

Anderson *et al.*, (2003) found that obesity is a major risk factor for the development of diabetes. Williams (1999) reported that obesity is a major risk factor for the development of Type II diabetes and is an important obstacle to the management of this disease.

Bray (2001) explained the relationship between diabetes and obesity, pointing out that many diseases attributable to obesity including hepatic disease, diabetes and cardiovascular disease.

Alder (2002) found that obesity is an important risk factor for the development of Type II diabetes. The increasing incidence of obesity accounts for the emergence of Type II diabetes.

Helmrich *et al.* (2001) said that the most marked benefit of exercise in diabetes prevention has been observed in people with obesity or a family history of diabetes. So, obvious target populations for training programs would be people at increased risk of Type II diabetes (eg) first degree relatives, women with gestational diabetes people with low birth weight (or) visceral obesity and certain ethnic groups.

Ryan *et al.* (2001) suggested that blood relatives of people with diabetes are more likely to develop diabetes than those who do not have it in their families. The risk depends upon the number of family members who have diabetes. Higher the number of relatives with diabetes greater is the risk. There is five per cent risk of your developing diabetes if your parents or siblings have diabetes. This risk may increase to fifty per cent if you are over weight.

Haffnersm (2001) found that obesity and weight gain have constantly been shown to be the strongest modifiable risk factors for diabetes. In representative sample of the US population, each unit increase in each unit of BMI is associated with a 12 per cent increased risk of the Type II diabetes – compared to people with

BMI less than 22Kg/m² those with BMI of 25-27Kg/m² had 2.75 times the greater risk of diabetes and each kg increase in body weight is associated with a 4.5 per cent increase in diabetes risk.

Swaminathan (2001) said that age obesity is the main factors of diabetes. The diseases occur at all ages but a greater percentage of the cases occur in persons over 45 years of age. The incidence of diabetes is greater among obese persons than in person of normal weight.

Gagliano *et al.* (2003) had found that the following factors may increase you chance of getting diabetes.

- ☞ Family history of diabetes
- ☞ Obesity < being 20per cent or more your desired body weight>
- ☞ Physical stress (such as surgery or illness)
- ☞ Hypertension
- ☞ Abnormal blood cholesterol (or) triglyceride level
- ☞ Age
- ☞ Pregnancy

5. Lack of exercise

Boule and Hadded *et al.* (2001) reported that exercise training reduce glycosylated hemoglobin (HbA1c) which in turn decreases the risk of diabetic complications.

Karin *et al.*, (2004) confirmed that lack of exercise as an important risk factor for the development of Type II diabetes. According to Leitzmann (2001) television watching a major sedentary behavior in the Unites States, has been associated with obesity. Time spent on watching TV was significantly associated with higher risk for diabetes.

Storfen *et al.* (1996) emphasized lack of exercise as an important risk factor for the development of Type II diabetes. High levels of physical activity are correlated with lower levels of plasma insulin resistance.

Stein (2002) reported that some recent studies have indicated that people with sedentary life style are more likely to have diabetes as compared to those who lead an active life. It is believed that exercise and physical activity increases the effect of insulin in the cells.

Kriska *et al.* (2001) said that physical activity has been consistently reported to be inversely related to future risk of diabetes in most population. Higher level of physical activity is associated with a lower risk of diabetes in observational studies.

6. Smoking

Culloh *et al.* (2002) and Haire and Josher (2004) mentioned that smoking is associated with a decrease in body weight and an increase in insulin resistance and glycosylated hemoglobin levels in subjects with Type I diabetes.

Smoking has been found to be an independent risk factor for the development of Type II diabetes mellitus. Data from the Osaka Health survey have shown that the risk for development of Type II diabetes mellitus in current smoker is higher than in non smoker and that the number of cigarettes smoked and the number of packs per year are positively related to the development of Type II diabetes mellitus in a dose dependent manner (Sahay *et al.*, 2002).

Individuals who habitually chew betel – but a common practice for more than 2000 million Asian may be at risk for developing Type II diabetes mellitus (Mannan 2000).

A lower socio-economic class categorized either by occupational or educational level, was an additional risk factor for diabetes in Hong Kong Chinese who had known risk factor for glucose intolerance (Ko *et al.*, 2001).

D. COMPLICATIONS OF DIABETES MELLITUS

Long term complication of diabetes by WHO (2002)

Organs	Complications
Blood vessels	Poor circulation causes wounds to heal poorly and can lead to heart disease, stroke, gangrene of the feet and hands, impotence and infections.
Eye	Decreased vision and ultimately blindness.
Kidney	Poor kidney function and kidney failure.
Nerves	Sudden or gradual weakness of a leg: reduced sensations tingling, and pain in the hands and feet, chronic damage to nerves.

Aqueel Khan (2002) explained that complications occur in all diabetics. They are

- Diabetic retinopathy (70 per cent)
- Diabetic cataract
- Diabetic nephropathy (50 per cent)
- Peripheral neuritis
- Diabetic gangrene
- Skin lesions
- Pulmonary tuberculosis
- Atherosclerosis involves coronary and peripheral arteries

Cardiovascular complication

Macrovascular complications associated with chronic hyperglycemia in Type II diabetes mellitus is a major global health problem that is currently on the rise (Khamaisi *et al.*, 2003). Cardiovascular disease is the most prevalent complication and primarily accounts for the excess morbidity and mortality in diabetic subjects, but microrvascular complications, such as kidney disease and retinopathy are frequent and contribute to the total disease burden (Battisti *et al.*, 2003).

Giles (2003) pointed out that the risk for cardiovascular disease, particularly congestive heart failure, is significantly higher in subjects with Type II diabetes mellitus than in individuals without diabetes. Furthermore, insulin resistance may be associated with cardiomyopathy, even in the absence of hyperglycemia and has been linked with cardiovascular remodeling.

Diabetes, a leading cause of morbidity and mortality in the United States, is associated with a two to four fold increase in the risk of coronary artery disease. Strict glycemic control, pharmacologic therapy, and life style modifications are parts of a comprehensive strategy to prevent both microvascular and macrovascular events in subjects with Type II diabetes (Zarich, 2003).

Macrovascular complications like ischemic cardiopathy, Cerebro vascular injury, will contribute a large measure to the seriousness of Type II diabetes, being responsible for more than 50 per cent of deaths. The prevention of complication implies a multifactorial approach with the follow up and management of vascular risk factors associated with diabetes (Cairou *et al.*, 2001).

Coronary Artery Disease (CAD) mortality and the incidence on non-fatal CAD events are two to four times higher in Type II diabetic subjects compared to age-matched non diabetic subjects and it is also stated that at every age point,

diabetic subjects had a higher prevalence of CAD and also increased carotid intimal media thickening compared to their non-diabetic counter-parts (Pradeepa *et al.*, 2002).

Though a contentious issue for several decades there is now direct evidence linking blood glucose levels with cardiovascular out come. CVD is the leading cause of death among persons with diabetes. Recent evidence from U.K. Prospective Diabetic study, Clinical trial sample suggest that glycemic control is associated with increased risk of heart failure among subjects with Type II diabetes (Anonymous, 2000)

People with Type II diabetes mellitus are at high risk of cardiovascular disease and micro vascular complications. A number of epidemiological studies have shown a strong relationship between the prevalence of vascular complications and raised levels of plasma glucose and glycosylated hemoglobin (Home 2005).

Type II diabetes mellitus is a disease with a high incidence and prevalence in the world. The main cause of death in these subjects is myocardial stroke and a high incidence of general cardiovascular complications (Leiva and Mujica 2005).

According to Mohan *et al.*, (2001) the prevalence of coronary heart disease among diabetic subjects was 21.4 per cent and 9.1 per cent suffered with normal glucose tolerance. He also suggested that carotid arteriosclerosis is present in 20 per cent of diabetic subjects compared to 1 per cent of non-diabetic subjects.

Aravind *et al.*, (2002) suggested that diabetic subjects are at increased risk of arteriosclerosis and particularly coronary artery disease (CAD). According to Raman (2001) and Furnay *et al.*, (2003) the coronary heart disease is the most prevalent in diabetes and is principle cause of mortality.

Retinopathy complication

Diabetic retinopathy is one of the common complications of diabetes and is the leading cause for subject's visual dysfunction and sight loss (Ning *et al.*, 2003).

Retinal vascularization and muscular edema are central features of diabetic retinopathy, the major cause of blindness in the developed world (Coldwell *et al.*, 2003).

Klein *et al.*, (2002) discovered that retinopathy occurred in either Type I or Type II diabetes a decade or so after the onset of diabetes and is one of the leading causes of blindness in the Western world. They also stated that the prevalence of retinopathy was related to the duration of diabetes.

Diabetic retinopathy is the most specific of all diabetic complications and in one of the leading cause of blindness in the western world. A recent study in Hyderabad performed on known diabetic subjects using ophthalmoscopy reported 22.4 per cent prevalence of diabetic retinopathy. In the Chennai based Urban population study, retinopathy was 19 per cent which included 17.5 per cent with non proliferate diabetic retinopathy and 1.5per cent with proliferate diabetic retinopathy (Pradeepa *et al.*, 2002).

Diabetic retinopathy is progressive damage to the eye's retina caused by long term diabetes. It can cause blindness people with both Type I diabetes and Type II diabetes are at risk for this condition. Diabetic retinopathy is caused by damage to blood vessels at the retina (Park *et al.*, 2000)

Neuropathy complications

Obrosova (2003) indicated that Peripheral Diabetic Neuropathy (PDN) affects up to per cent to 70 per cent of diabetic subjects and is the leading cause of foot amputation.

Moulika *et al.* (2000) observed that diabetic neuropathy occurred in approximately 50 per cent of individuals with long standing Type I and Type II diabetes.

Vinik *et al.* (2000) found that the risk of developing neuropathy is directly linked to the education of diabetes mellitus; after 20 years of diabetes mellitus, around 40 per cent of subjects will have neuropathy. In subjects attending a diabetic clinic 25 per cent reported symptoms, 50 per cent were found to have neuropathy using a simple clinical test and almost 90 per cent tested positive to more sophisticated test. Neuropathy may be present at the time of diagnosis of Type II diabetes mellitus, but neurological complications occur equally in Type I and Type II diabetes mellitus.

Diabetic neuropathy occurs in approximately 50 per cent of individual with Type I diabetes subjects. It may manifest as polyneuropathy, mononeuropathy and autonomic neuropathy. As with other diabetes mellitus, the development of neuropathy correlates with the duration of diabetes and glycemic control (Grodner *et al.*, 2001)

Nephropathy complications

Rajendra *et al.* (2002) represented diabetic nephropathy as the leading cause of end stage renal disease worldwide. He also stated that microalbuminuria was considered to be an early stage of nephropathy. Moulika *et al.* (2000) noticed that diabetic nephropathy manifested primarily by thickening of the capillary basement membrane in the glomeruli which lead to diminished filtration ability.

Estacio and Schrier (2001) reported that nephropathy is commonly seen in Type I diabetes mellitus. Around 35 per cent of the diabetic subjects will develop nephropathy.

Diabetic nephropathy is the leading cause of diabetes mellitus related morbidity and mortality. Proteinuria in diabetes mellitus is associated with markedly reduced survival and increased risk of cardiovascular disease. Individuals with diabetic nephropathy almost always have diabetic retinopathy (Guyton, 2000).

E. INTERRELATIONSHIP BETWEEN VARIOUS NUTRIENTS AND DIABETES MELLITUS

Nutrition is a key environmental factor that is particularly involved in the pathogenesis and progression of several polygenic, diet-related diseases (Roche 2004).

Diet was able to improve glycemic control, glucose utilization, some lipid profiles, and the capacity for fibrinolysis in Type II diabetes. Even if changes in glycemic control were modest during the 4-week period, the use of an Low Glycemic Index diet in a longer-term period might play an important role in the treatment and prevention of diabetes and related disorders (Rizkalla *et al.*, 2004).

Carbohydrates

Sahay and Sahay (2002) recommended intake of 50-60 per cent of calories from carbohydrates of high fibre content and low glycemic index as it allows insulin to work more effectively. Willette and Manson (2002) suggested that high, long term intake of simple carbohydrate like glucose may increase the risk of Type II diabetes.

Elkins (2002) technically referred fiber as a complex carbohydrate consisting of a polysaccharide and a lignin substance that remains undigested as it

is processed through the gastro-intestinal tract. The American Diabetic Association had recommended 20 to 35 grams dietary fiber per day for diabetics.

Viswanathan *et al.* (2000) evolved high carbohydrate diet, which provided about 60 per cent of calories in the form of the complex carbohydrate. The diet was modified around by increasing the protein content to 20 per cent and reduces the fat content to 13 per cent. As the traditional Indian diet is vegetarian, increasing the content of pulses and legumes increased the protein content of the diabetic diet. This change further increased the fiber content of the diet.

Snehalatha *et al.* (2000) opined that Type II diabetic subjects who have been consuming high carbohydrate high fiber diet for long period did not have post prandial hypertriglyceridemia.

Increasing evidence suggests an important role of carbohydrate quality in the development of Type II diabetes. A diet with rapidly absorbed carbohydrates and low in cereal fiber is associated with an increased risk of Type II diabetes (Schulze *et al.*, 2004).

Proteins

Boctor and Jenkins (2004) reported that a high protein diet may accelerate the progression of diabetic nephropathy currently, a protein in takes of 0.6 - 0.8 g/kg body weight / day is recommended for the diabetic subject.

Fats

Recent research had highlighted the importance of diets containing optimum proportions of omega-3 fatty acids, particularly n-3 and n-6.PUFA content of less than 10 per cent of the total calories, n6/n3 ratio less than 10 and an ECF content of atleast 3 per cent of the total calories was advised (Klein *et al.*, 2002).

ECF content of atleast 3 per cent of the total calories was advised (Klein *et al.*, 2002).

Mohan *et al.* (2002) explain about the effect of insulin on lipid metabolism as it is to reduce the release of fatty acid from the stored fat and decrease the production and mobilization of fatty acid from liver. Insulin is required for the utilization of VLDL which is elevated in diabetes.

Evidence-based nutrition principles for the treatment of Type II diabetes mellitus recommend that 10 per cent of energy should be derived from saturated fats (A level evidence) and the polyunsaturated fat (PUFA) intake should be about 10 per cent of energy intake, with 30 per cent total fat when weight loss is required (Tapsell *et al.*, 2004).

Grylls *et al.*, (2003) reported that reduced dietary saturated fat and excess body weight may be useful means of improving glycemic control in older adults with diabetes. Dam (2003) described that changes in diet can protect against Type II diabetes. Higher consumption of whole grain products and exchanging unsaturated fat for saturated fat may lower risk of Type II diabetes.

Vitamins

Bhoraskar (2002) referred vitamin D as an immune suppressive agent with a protective effect on the beta cells. Vitamin D deficiency progressively reduced insulin secretion until the glucose intolerance became irreversible. Thiamine, (B₁), riboflavin (B₂), nicotinic acid (B₃), pyridoxine (B₆), and B₁₂ also had an important role in glucose metabolism. Hagen (2001) stressed the role of vitamin C as an aldose reductase inhibitor and an antioxidant and stated its importance in the management of diabetes.

Gary and Bansal (2000) said that Vitamin C and vitamin E, helps get sugar out of the blood stream and into the cells. Gaedep *et al.* (2001) found that both the vitamins will keep the blood vessels and kidneys healthy in the diabetic subjects.

Ambrosch *et al.*, (2001) said that vitamins prevent the diabetic blindness vision loss. Folic acid and B₁₂ helps to prevent stroke and loss of limbs due to diabetic complications. Biotin helps insulin work well, keeps the pancreas working well, and lowers the blood sugar levels.

Stene (2000) found that cod liver oil taken during pregnancy was associated with reduced risk of Type I-diabetes, suggesting that vitamin D and or the omega 3 fatty acid in the cod liver oil have protective effect against diabetes.

Trace minerals

Bhoraskar (2002) mentioned that deficiency of chromium could lead to glucose intolerance. Deficiency of zinc had been shown to be associated with reduced insulin secretion and increased insulin resistance. He also emphasized that magnesium was also equally important in maintaining the electrical potential in nerve and muscle membrane and also in glucose homeostasis.

Law *et al.* (2003) reported that there is an association between hypertension and both Type-I and Type-II diabetes especially for people with Type II diabetes who are obese. There is also evidence that people with Type II diabetes are more salt sensitive than general population. Sodium intake recommendation for people with diabetes is the same as for the general population less than 5 g/day. For person with hypertension and diabetes, the intake should be reduced to less than 3g/day. In hypertensive subject with nephropathy sodium restriction is required and sodium intake should not exceed 2g/ day.

Stapleton (2000) said that selenium is called “insulin mimic”. Selenium helps to take blood sugar into the cells. Selenium also protects blood vessels and nerve damage due to elevated blood sugars.

Importance of fibre

Chandalia *et al.* (2001) mentioned that diabetes was one of the first diseases to be classed as fiber-deficiency disorder. In his study, it was also shown that high intake of dietary fiber, particularly of the soluble type, improved glycemic control, decreased hyperinsulinemia and lowered plasma lipid concentrations in subjects with Type II diabetes mellitus.

Easwaran *et al.* (2001) mentioned that wheat along with the bran exhibited larger amount of dietary fiber which proved to be helpful to diabetic subjects. Research studies have been done with fiber added to meals in the form of guar gum, pectin and wheat bran and an improvement in glucose control was observed.

Sharma (2003) stated that the WHO recommendation for dietary fiber intake for persons with coronary artery disease and diabetes are approximately 27-40g / day from a variety of food sources. Although selected soluble fibers are capable of delaying glucose absorption the effect of dietary fiber on glycaemia is probably insignificant.

F. ROLE OF EXERCISE IN THE MANAGEMENT OF DIABETES MELLITUS

Boule *et al* (2001) concluded that exercise constituted the first step in the treatment of Type II diabetes along with diet as it was perceived to be beneficial for glycolic control and weight loss in subjects with Type II diabetes and induced improvement in insulin sensitivity.

Berson and yalow (2000) said that exercise improves metabolism and increases well-being in the subject and has been shown to enhance insulin action on target tissue. For people with IDDM, the major benefits of exercise are cardiovascular conditions, weight maintenance, and lowering the lipid levels and for NIDDM light exercise is important to control blood glucose and lipid level. Aerobic exercises such jogging, swimming, taking long walks is recommended.

Skerret and Manson (2002) opined that the physical activity increase insulin sensitivity and improves glucose tolerance in both healthy subjects and in people with obesity, gestational diabetes, and impaired glucose tolerance as well as in first degree relatives of subject with Type II diabetes.

Knowler *et al.* (2002) explained that the risk of getting Type II diabetes can be reduced upto 40 per cent with an active life style compared with a sedentary life style. Weight loss is not necessary for a beneficial effect of exercise, and an effect can be obtained by mild or moderate exercise and the exercise effect depend on overall energy expenditure rather than on intensity of exercise.

Rao (2003) said that exercise play a very important role in controlling diabetes as it helps to burn excess sugar, improves function of various organs of the body and improves blood supply to all parts of the body. Brisk walking, Jogging and yoga are very effective. Deep breathing increases the amount of oxygen inhaled by the body and therefore increases utilisation of sugar.

Sahay *et al.* (2002) revealed that moderate exercise such brisk walking for 3 or 4 miles a day will help to increase the calorie needs and avoid the development of obesity. Exercise is very useful measure in the management of diabetes because during exercise, carbohydrate is utilized by the muscles for energy; there fore it reduces the requirement of insulin.

G. PREVENTION AND TREATMENT OF DIABETES MELLITUS

Sato *et al.*, (2003) suggest that disease prevention has been considered at three levels; Primary (avoiding the occurrence of disease), Secondary (early detection and reverse) and tertiary (prevention or delay of complications). The major purpose of physical exercise for primary prevention and treatment of lifestyle related disease to improve insulin sensitivity. It is known that during physical exercise, glucose uptake by the working muscles rises seven to twenty times over the blood level depending on the intensity of the work performed.

There is several possible realizations of the so-called artificial or bio-artificial pancreas systems which should automatically and efficiently substitute for the lost function of the cells (Wojcicki and Ladyznski, 2003).

Clement *et al.* (2004) said that an effective orally administered insulin product would be of substantial benefit in the treatment of subjects with diabetes mellitus.

Fonseca (2003) pointed out that a weight management program combining a low caloric, low sodium diet with education and behaviour has shown to be effective in subjects with Type II diabetes.

Katiyar (2003) suggested that possible palatable composition of protein, fat and carbohydrate has been proposed which can be incorporated in diet for the significant regulation of blood glucose and insulin level in diabetic subjects. Dietary changes and other management approaches may be best modified through family and community influence instead of the individual dietary modifications strategies (Valenzuela *et al.*, 2003).

Recently several well planned studies have demonstrated the beneficial effects of yogic practices in subjects with diabetes with a significant fall in fasting

and post prandial blood sugar values and Hb A_{1c} with reduction in the requirements of oral hypoglycemic agents and insulin (Sahay *et al.*, 2002).

Regular exercise helps to keep weight down and therefore can work to control Type II diabetes (Reader's Digest 2000). Naturally occurring adult onset obesity associated diabetes could be prevented by maintaining normal lean body composition through careful long term management of Calorie intake (Badkin 1993).

Weight control is of fundamental importance in the population strate the prevention of glucose intolerance, especially in high risk individual purpose with IGT or with genetic predisposition to diabetes (WHO 1990).

Epidemiological evidence in non diabetic subjects suggests that light moderate alcohol intake in adults is associated with increased insulin sensitive and decreased risk of Type II diabetes, CHD and stroke (JADA-2002).

According to Tiwari and Rao (2002) phytochemicals identified from traditional medicinal plants are presenting an exciting opportunity for the development of new types of therapeutics in the prevention and treatment of diabetes mellitus.

In a recent study over weight subject with impaired glucose tolerance reduced their risk of getting Type II diabetes by 58per cent when they received individualized counseling on reducing their weight, improving their eating habits and increasing their levels of physical activity (Tuomilehto and Lindstrom *et al.*, 2001) and (Moore *et al.*, 2000).

H. AN OVERVIEW ABOUT SELECTED NEUTRACEUTICALS

1. Onion (*Allium cepa*)

Onions (*Allium cepa*) are extensively cultivated in India. The underground bulbs, which constitute the crop, vary in size, color, firmness and strength of flavors. The onion is a valuable and is used either as a salad or spice or for cooking with other vegetables. Its characteristic pungency is due to volatile sulphur compounds.

Kapoor (1990) showed that two sets of compounds make up the majority of onion's known active constituents sulfur compounds, such as Allyl Propyl Disulphide (APD) and flavonoids. This group of compounds has multiple medical actions. APD shown to block the breakdown of insulin by the liver and possibly to stimulate insulin production by pancreas, thus increasing the amount of insulin and reducing sugar levels in the blood. Fifty grams of raw or boiled onion prevented the rise in serum cholesterol.

Bailey (1989) reported that onions have been used in many cultures to treat diabetes, but are probably best utilized as adjuncts to other herbal and nutritional treatments. Onions contain disulfide bonded thiosulfinates and diallyldisulfides. Insulin has a similar disulfide bond, so allium disulfide chemicals are thought to compete with insulin for endogenous insulin-inactivation compounds. About 10g/kg onion extract lowered fasting blood glucose and improved glucose tolerance by 71.8 per cent.

Tu (1992) showed that onion bulb has been used therapeutically in the Ayurvedic, Siddha, and Unani systems of Indian medicine, in various dosage forms including the decoction, infusion and fresh juice as well as raw, cooked and /or roasted bulb.

According to Bruneton (1995) onions have appetizer and gastric tract stimulant actions. An animal study concluded that serum, liver and aorta triglyceride levels were decreased after use of an aqueous extract of onion. A study has shown an antimicrobial activity and hypoglycemic activity.

Babu *et al.* (1997) revealed that onion feeding improves the metabolic status in diabetic condition probably because of its hypoglycemic effect. Ahulwallia *et al.* (1989) explained that the effect of administration of onion showed hypoglycemic effect in blood.

2. Cinnamon (*Cinnamomum zeylanicum*)

Cinnamon is one of the oldest spices known. It was so highly treasured that it was considered more precious than gold. Cinnamon also received much attention in China, which is reflected in its mention in one of the earliest books on Chinese botanical medicine, dated around 2,700 B.C. Now a day it is produced in Srilanka, India and other countries.

Cinnamon has a long history both as a spice and as a medicine. It is the bark of the cinnamon tree which is available in its dried tubular form known as a quill or as ground power. It is commonly used as a beverage flavoring and medicinal agent (www.spice.com).

Cinnamaldehyde (so called cinnamic aldehyde) has been well researched for its effects on blood platelets. The cinnamaldehyde in cinnamon helps to prevent unwanted clumping of blood platelets. The way it accomplished this health protective act is by inhibiting the release of an informatory fatty acid called arachidonic acid from platelet membranes. Cinnamon's ability to lower the release of arachidonic acid from cell membranes also puts in an "anti-inflammatory" food (www.spices-essential.com).

Spices are an important group of agricultural commodities. In traditional medical systems, their ability to heal various physical, mental and emotional problems has widely been reported. HPLC analysis was performed to estimate phenolic acids in spices. In all spices ~~several~~ phenolic acids; viz., Tannic, Gallic, Caffeic, Cinnamic, Chlorogenic, Ferulic and Vanillic acids could be identified on the basis of their retention time with standard compounds and co-chromatography. The spices are known to significantly contribute to the flavor, taste, and medicinal properties of food because of phenolics (www.spices-properties.edu.com).

Anderson (2004) opines that cinnamon enhances the insulin activity. The insulin enhancing complexes in cinnamon is a collection of catechin/epicatechin oligomers that increases the body's insulin dependent ability to use glucose roughly 20-fold. The potentially toxic components in cinnamon are found primarily in the lipid (fat) soluble fractions.

According to Mucia (2004) cinnamon may significantly help people with Type II diabetes to improve their ability to respond to insulin, thus normalizing their blood sugar levels. Cinnamons not only stimulate insulin receptors, but also inhibit an enzyme increasing cell ability to use glucose. Less than half a teaspoon per day of cinnamon reduces blood sugar levels 40-60 per cent.

According to Diabetes care (2003) humans with Type II diabetes consuming as little as one gram of cinnamon per day was found to reduce blood sugar triglycerides, LDL (bad) cholesterol and total cholesterol. Cinnamon in the diet of people will reduce risk factors associated with diabetes and cardiovascular diseases.

Khan *et al.*, (2003) stated that cinnamon improves blood glucose, triglyceride, total cholesterol, HDL cholesterol, and LDL cholesterol levels in people with Type II diabetes. The levels of cinnamon reduced the mean fasting serum glucose (18-29 per cent), triglyceride (23-30 per cent), LDL cholesterol (seven

27 per cent), and total cholesterol (12-26 per cent) levels. Changes in HDL cholesterol were not significant. Intake of one to six g of cinnamon per day reduces serum glucose, triglyceride, LDL cholesterol, and total cholesterol in people with Type II diabetes and suggests that the inclusion of cinnamon in the diet of people with Type II diabetes will reduce risk factors associated with diabetes and cardiovascular diseases.

Cinnamon has an antiseptic power and also account for a couple of other medical applications. A Japanese study suggests that it cannot soothe the stomach; it may help to prevent ulcers. German research claims cinnamon “suppresses completely” the bacteria that causes urinary infection and the fungus associated with yeast infections as well (www.spices.com).

3. Cumin seed (*Cuminum cyminum*)

Many spices and herbs are known to be hypoglycemic. *Cuminum cyminum* belonging to the family Apiaceae is widely used in Ayurvedic medicine for the treatment of dyspepsia, diarrhoea and jaundice.

In vitro influence of 14 individual spices (curcumin, capsaicin, piperine, garlic, onion, ginger, mint, coriander, cumin, fenugreek, mustard, and asafoetida) on the activities of digestive enzymes of rat pancrea and small intestine was examined by including them in the reaction mixture at two different concentrations. A majority of spices enhanced the activity of pancreatic lipase and amylase when they are directly in contact with the enzyme. It is inferred that this positive influence on the activity of enzymes may have a supplementary role in the overall digestive stimulant action of spices, besides causing an enhancement of digestive enzymes in pancreatic tissue (Rao *et al.*, 2003)

The spices tested increased gastric acid secretion, in some by a cholinergic mechanism but by other mechanism(s) as well. Red pepper produced maximum

increase in acid secretion, but this was significantly reduced in injured stomach. Cumin and coriander increased gastric secretion in injured stomach (Vasudevan *et al.*, 2000).

4. Artichoke (*Cynara scolymus*)

“Eating an artichoke is like getting to know some are really well”

- *Stradely*

The artichoke, *cynara scolymus* is actually a member of the thistle family, although its leaves are bigger broader and soft rather than prickly. Artichoke plants are quite beautiful, like giant ferns- six feet in diameter and 3-4 feet high. It's the heart at the base of flower bud produced by the plant that's prize for its delicate flavor and its versatility.

Maros(1999) Stated that it belong to the

Family	Asteraceal
Genus	Cynara
Species	Scolymus
Synonymus	None
Common name	Globe Artichoke, alcachofra, alcachofera, artichout lyosen-azami.
Part used	Leaves & Flower.

Mist (2000) reported about the availability of artichoke in different season. Artichokes are available through out the year but peak seasons are spring.

Baroda (2004) found that artichoke is a member of the thistle family and predominantly cross-pollinated plant (Lanteir *et al.*, 2004). The globe artichoke is the authentic, leafy vegetable; It's also called the green artichoke or the French artichoke, although the word, “artichoke” is derived from the northern Halianword

“articiocco”. Globe artichoke represents an important component of the south European agricultural economy (Acquadro *et al.*, 2005).

Robert and Helinth (2000) defined that California artichokes are a delicious food for a healthy life style. One large artichoke contains only 25 calories, no fat, and 170 mg of potassium and is a good source of vitamin C, folate, magnesium and dietary fiber.

Emenderfer (2005) and English (2000) indicated that artichoke and edible vegetable from the Mediterranean area was a good source of natural antioxidants, hydroxy cinnamic acids and flavones.

Schutz (2004) said that artichoke is popular vegetable for its, pleasant bitter taste which is attributed to phytochemicals found in the green parts of the plants called cynarin and cynaropicrin, sesquiterpene lactones with documented medicinal action.

Mulinacci (2004) opined that artichoke leaf extract are widely used alone or in association with other herbs for embittering alcoholic and soft drinks and to prepare herbal teas or herbal medicine products.

Mist (2000) explained about current research is showing benefits to the liver. Silymarin is a compound found in artichokes that has powerful antioxidant properties and may help the liver to regenerate healthy tissue.

5. Amla (*Emblica officinalis*)

Amla fruit also known as Indian goosbery is one of the richest sources of bioflavonoids and vitamin C. Amla's traditional uses include as a laxative, eyewash, appetite, stimulant and to treat anorexia, indigestion, diarrhea, anaemia and jaundice. Amla is becoming increasingly well known for its usually high

levels of vitamin C which is resistant to storage and heat damage due to cooking. It is found natively in India.

Amla is highly nutritious and is an important dietary source of vitamin C, minerals and amino acids. The edible fruit tissue contains protein concentration 3 fold and ascorbic acid concentration 2 fold compared to that of apple.

The better hypolipidemic effects and correction of elevated levels of certain enzymes shown by garlic and amla may be due to the facts that they contain comparatively better active principles than that found in onions. The antioxidant activity of *Emblica officinalis* may reside in the tannoids of the fruits of the plant, which have vitamin C-like properties, rather than vitamin C itself (Periyanaagam *et al.*, 2004).

Effect of tannoid principles of *Emblica officinalis* was assessed on chronic unpredictable stress-induced perturbations in oxidative free radical scavenging enzymes. The results indicate that the reported anti-stress rasayana activity of *Emblica officinalis* may be due to its tendency to normalize stress-induced perturbations in oxidative free radical scavenging activity, in view of the postulate that several stress-induced diseases, including the process of aging, may be related to accumulation of oxidative free radicals in different tissues (Bhattacharya and Ghosal *et al.*, 2000).

The radio protective effect of the fruit pulp of *Emblica officinalis* was studied. Treatment with *Emblica* also lowered the elevated levels of lipid peroxides in the serum. *Emblica* extract may be useful in reducing the side effects produced during therapeutic radiation (Harikumar *et al.*, 2004).

It was shown that amla extracts had significant ulcer protective and healing effects and this might be due to its effects both on offensive and defensive mucosal factors (Rao *et al.*, 2002).

Oral administration of the extracts (100 mg/kg body weight) reduced the blood sugar level in normal and in alloxan (120 mg/kg) diabetic rats significantly within 4 h. Continued, daily administration of the drug produced a sustained effect (Sabu *et al.*, 2002).

The effect on total serum cholesterol and its lipoprotein fractions of supplementation of the diet with amla was studied in normal and hypercholesterolaemic men aged 35-55 years. The supplement was given for a period of 28 days in the raw form. Both normal and hypercholesterolaemic subjects showed a decrease in cholesterol levels. Two weeks after withdrawing the supplement, the total serum cholesterol levels of the hypercholesterolaemic subjects rose significantly almost to initial levels (Jacob *et al.*, 1988).

Embllica officinalis will reduce lipid levels. The mechanism of hypolipidemic action is due to the presence of flavanoids in them (Anila and Vijayalakshmi 2002).

6. Soyabeans (*Glycin max Merrr*)

Okara (pronounced as oh-KAR-uh) is a Japanese word and are the general or generic term for the product. Okara means "the honorable shell." A more old-fashioned term for okara is *kirazu*, which means "that which cannot be cut;" okara is potentially light, almost fluffy in nature, like grated coconut.

One cup of dried soybeans produces usually 2 cups of okara after the soy milk is extracted. One half cup of okara is about 60 grams.

Yoshii *et al.*, (2005) found that reuse of waste okara has the kinetic mechanism on hydrolysis and have the properties of water soluble polysaccharides extracted were investigated. Okara was hydrolyzed by being autoclaved at pH 4.5 in two volume of water with or without a catalyst.

Okara contains mostly crude fiber composed of cellulose, hemicelluloses and lignin about 25 per cent protein, 10-15 per cent oil, but little starch or simple carbohydrates. The high-quality protein fraction has good water holding and emulsifying qualities and contains a peptide with anti-hypertension effects (www.bhsnuff.edu.hk.com).

Jenkins (2004) showed that 3-hydroxy-3-methyl-glutryl-coenzyme A (HMG-CoA) reductase inhibitors reduce serum cholesterol and are increasingly advocated in primary prevention to achieve reduction in LDL cholesterol. Okara diet has the ability to reduce LDL cholesterol below 3.4 mmol/dl.

Okara of Japanese soy curd industry was once an important daily food, but modernization in life style has reduced its status to a normal industrial waste. The protein content of this waste is still high. The waste contains some amino acids (www.asabe.org).

A diet rich in soy protein may alleviate fatty liver, a disease which often accompanies diabetes. Soy protein prevents the accumulation of triglycerides and cholesterol in the liver. These changes are due to a reduction in the transcription factors that control the expression of genes involved in lipid production (www.jlr.org.com).

7. Bay leaves (*Laurus nobilis*)

The bay tree is native to the Mediterranean region and Asia Minor. Bay Leaf or Laurel Leaf is dried leaves or an evergreen shrub or more rarely a tree attaining a height of 15 to 20 meters. The aroma of the crushed leaves is delicate and fragrant and taste is aromatic and bitter. The size of the leaves is ranging from 2.5 to 7.5 cms in length and 1.6 to 2.5 cms in breadth. The shape is elliptical and tapering to a point at the base and tip of the leaves (www.spices-food.com).

Bay leaves are robust, strongly aromatic with a woody astringent flavor and a pleasant slightly minty aroma. They are used to flavor all kinds of meat and vegetable dishes, soups, and sauces.

According to Broadhurst (2004) bay leaves has a active phytochemicals are likely to be a phenolic in nature. Presence of active phytochemicals may improve glucose metabolism.

Shinn (2003) explained that Estragole is a naturally occurring food flavoring agent found in bay leaves. Its therapeutic activity is acting as a hepatocarcinogen.

According to Khan (2005) bay leaves has a potentiated insulin activity more than 3-fold. Chromium concentration of foods ranged from 1-145ng/g and spice ranged from 4-1818ng/g. Insulin potentiating activity of foods and spices did not correlate with total chromium and also have an additional role in glucose metabolism.

The leaves and the fruits of the Bay Laurel are used medicinally. When taken internally it aids in digestion. It is used for nervousness, paralysis and as an aid in urination after childbirth. When applied externally bay is a deodorant and soothing, and is used in salves for itching, sprains, bruises, skin irritation, and rheumatic pain (www.spices.com).

8. Flaxseed (*Linum usitatissimum*)

Flaxseed is the hard, tiny seeds of *Linum Usitatissimum*, the flax plant that has been widely used for thousands of years as a source of food and clothing (Tarpila *et al.*, 1997). Flaxseed was rich in phenolic compounds and also it contains substantial amounts of lignan, secoisolariciresinol diglucoside.

Flaxseed contains 32-45 per cent of its mass as oil, of which 51-55 per cent is α -linolenic acid (n-3 fatty acids, omega-3 fatty acids). The oil made from flaxseed has no appreciable amounts of lignans but it does contain α -linolenic acid (Rose, 1997).

Flaxseed with 51-55 per cent α -linolenic acid in its oil and richest source of plant lignans, has been shown to reduce hypercholesterolemic atherosclerosis by 46 per cent without lowering serum lipids (Prasad *et al.*, 1998).

Harris (1997) informed that oil from flaxseed has been suggested as an alternative to fish oil in prevention of heart disease and flaxseed oil does not affect triglyceride level.

Flaxseed regimen reduced serum levels of both low-density and high-density lipoprotein cholesterol by 4.7 per cent respectively (Lucas *et al.*, 2002). It is possible that besides the effects of its fiber, other components of flax such as its lignan or oil may help lower cholesterol and prevent atherosclerosis (Jenkins, 1999).

Prasad (1997) suggest that the secoisolariciresinol in flaxseed scavenges hydroxyl group and therefore has an antioxidant activity. Modest dietary flaxseed supplementation is effective in reducing hypercholesterolemic atherosclerosis markedly without lowering. Hence dietary flaxseed supplementation could therefore prevent hypercholesterolemia related heart attack and strokes.

Observational studies suggest that people who eat more lignan containing foods have a lower incidence of breast and perhaps colon cancer (Adlercrautz and Mazur, 1997 and Serraino and Thompson, 1992). Lignans may also fight cancer in other ways, perhaps by acting as antioxidants (Yuan, 1999). Flaxseed or one of its lignan inhibited the growth of human breast cancer cells (Sung *et al.*, 1998) and lignan enterolactone and enterodiol inhibited the growth of human colon tumor

cells (Thompson *et al.*, 1996). Flaxseed extract appears to protect liver cells against CCI (4) – induced necrosis (Endoh *et al.*, 2002).

Lignans similar in structure to endogenous sex steroid hormones may act *in vivo* to alter hormone metabolism and subsequent cancer risk. Hence the postmenopausal women, consuming flaxseed in addition to their habitual betaestradiol and estrone sulfate and increasing serum prolactin concentrations (Hutchins *et al.*, 2001).

Arjmandi (2001) indicated that phytoestrogens in plants play a role in maintaining or improving skeletal health. There is increasing evidence that dietary phytoestrogens will also have a beneficial role in chronic renal disease. Nutritional intervention studies have shown that consumption of flaxseed reduces proteinuria and various forms of chronic renal disease (Ranich *et al.*, 2001).

The natural action of fiber containing foods such as flaxseed can be particularly helpful when constipation is chronic (Tarpila *et al.*, 1997). The researcher concluded that flaxseed relieved constipation more effectively than psyllium (Fasicule, 1997).

9. Stevia leaves (*Stevia rebaudiana*)

Stevia is one of the most health restoring plant on earth. Stevia is a tropical plant from Brazil. It's a small shrub. Cocker (1966) stated that there are different varieties of stevia. A large number of species of stevia are employed medicinally.

Stevia rebaudiana is the species used for the treatment for diabetes mellitus. Paraguayan botanist, Bertoni in 1905 discovered the honey leaf *Stevia rebaudiana*. Apart from Brazil *Stevia rebaudiana* is also grown in Japan, Korea, Thailand and China widely. *Stevia rebaudiana* is the only species in the genus that has been investigated thoroughly in terms of botany, phytochemistry and

pharmacology and proved to be safe for human consumption which possesses numeric therapeutic effect (Rajalakshmi, 2004).

The best proof of stevia safety is its long history and use first by the Guarani people of South America. Giridher *et al.* (2004) stated that in 1994, under pressure of American Herbal product Association, the Food and Drug administration (FDA) approved the sale of stevia as a dietary supplement. Although anyone can benefit from using stevia instead of sugar or chemical sugar substitutes, there are certain people who are more likely to benefit from its remarkable sweetening potential. Some of these people include those with diabetes, those interested in decreasing calorie intake and children.

Stevia is the sweetener of the future with zero calories. It possesses numerous phytochemicals which have antioxidant property and are rich source of some nutrients and therapeutically beneficial.

Vedavathy (2003) stated that stevia contains a high concentration of eight phytochemicals called glycosides. The intensity of the sweetness and taste is directly proportional to the presence of four major steviol glycosides contained in the plant leaves, veins and stems. The normal proportion of these glycosides are stevioside (5-10 per cent), rebaudioside A (2-4 per cent), rebaudioside C (1-2 per cent) and dulcoside A (0.5-1 per cent). Steviol glycosides are water soluble. The result is a sweet, non bitter taste without undesirable aftertaste. In addition the leaf contains aluminium, ascorbic acid, auroinulin, betacarotene, calcium, chromium, potassium, cobalt, iron, magnesium, niacin, phosphorus, protein, riboflavin, selenium, silicon, sodium, steviol, thiamin, tin and zinc.

Kim and Dubois (1991) stated that the yield of stevioside from dried leaves of the *Stevia rebaudiana* can vary greatly from about (5-22 per cent) of the weight of dry leaves, depending upon the cultivation and growing conditions. The most abundant of these stevioside is up to 300 times sweeter than sugar. Miyata (1990)

mentioned that stevioside is one of the sweetest substances ever discovered and comprises up to eight per cent of *Stevia rebaudiana* leaf. The human body does not metabolize the sweet glycosides (they pass right through the normal elimination channels) from the leaf or any of its processed forms; the body obtains no calorie from stevia. Processed form of pure stevia can be 70-400 times sweeter than sugar.

Avery (1999) cited that stevia is used to sweeten a dish or drink. Similarly Kroyer (1999) added that two or three leaves are enough to sweeten a cup of coffee or tea. In addition to its incredible sweetness stevia leaf and extract have several traditional, medicinal and therapeutic benefits.

Stevia would seem quite obvious that even partially substitution a non calorie sweetener for sugar would help to reduce calorie intake and thus contribute to weight loss. Burn (1997) stated that a good possibility that even partially substituting these refined sugar calories with calorie free stevia can make a difference in weight.

Das *et al.* (1992) concluded that neither stevioside nor rebaudioside is cariogenic (cavity causing). It appears that the chemicals within the stevia plant that imparts its sweetness are not fermentable and thus does not cause tooth cavities.

Boeck (1981) and Melis (1991) explained the effect of stevioside on blood pressure and found that consumption of stevia showed a reduction in blood pressure as well as an increased elimination of sodium and possessed slight diuretic effect.

10. Jambolin seeds (*Syzygium cumini*)

The Jambolan (*Syzygium Cumini*) is native in India, Burma, Ceylon and the Andaman Islands. There are several types of fruits which differ in color and size. The ripe fruit is widely eaten in India. The leaf juice is used in the treatment of dysentery, either alone or in combination with the juice of mango or embolic leaves. Jambolan leaves may be helpful in the treatment of skin diseases.

Jambolans of good size and quality, having a sweet or sub acid flavor and a minimum of astringency, are eaten raw and may be made into tarts, sauces and jam. Good quality jambolan juice is excellent for sherbet, syrup and "squash". In India the latter is a bottled drink prepared by cooking the crushed fruits, pressing out the juice, combining it with sugar and water and adding citric acid and sodium benzoate as a preservative. The jambolan has received far more recognition in folk medicine and in the pharmaceutical trade than in any other field.

Grover *et al.*, (2002) studied that research conducted in last few decades on plants mentioned in ancient literature or used traditionally for diabetes have shown antidiabetic property. Among these they evaluated *Eugenia jambolana* have shown varying degree of hypoglycemic and antihyperglycemic activity. Sharma *et al.*, (2003) found that hypoglycemic activity was assessed by reduction in fasting blood glucose at 90 minutes and also in fasting blood glucose during Glucose Tolerance Test (GTT). There were significant fall in fasting blood glucose and increase in serum insulin levels.

A study conducted by Vikrant *et al.*, (2001) showed that herbal extracts of *Eugenia jambolana* have shown to reduce hyperglycemia in diabetic human subjects. Kurian (1999) determined that black jamun seeds are very effective in diabetes. Half to one gram of the seed powder can be taken twice or thrice a day.

Supriya (1998) showed that the jamun seeds powder about 15g is administered orally thrice a day for 3-4 months in diabetes without side effects as a hyperglycemic effect.