Globally the prevalence of chronic non-communicable diseases is increasing at an alarming rate. About 18 million people die every year from cardiovascular disease, for which diabetes and hypertension are major predisposing factors. Propelling the upsurge in cases of diabetes and hypertension, is the growing prevalence of overweight and obesity, which have during the past decade joined underweight, malnutrition and infectious diseases as major health problems, threatening the developing world. Today more than 1.1 billion adults worldwide are overweight and 312 million of them are obese Parvez H. et al. (2007).

Hypertension is a chronic medical condition, in which blood pressure is elevated. It normally refers to systemic arterial hypertension Maton A. et al. (1993) which is becoming an important contributor to cardiovascular diseases.

The world health organization attributes hypertension as the leading cause of mortality. The world hypertension league umbrella organization of 85 national hypertension societies recognized that more than 50% of the hypertensive population worldwide are unaware of their condition Chokalingam A (2007). It is estimated that nearly one billion people are affected by hypertension worldwide and this figure is predicted to increase to 1.5 million by 2025 Kearney P. M. et al. (2005). In India, it is predicted to assume epidemic proportions by the year 2015. W.H.O. predicts that 100 million or 60% of the world’s heart patient will be Indians by the year 2210. Without widespread dietary improvement Indian heart disease toll will double by 2015 Esselstyn et al. (2001).

1.1 COMPLICATIONS:-

Hypertension increases the workload of heart, causing the heart to
thicken and become stiffer. It is a risk factor for atherosclerosis, cardiovascular morbidity, cardiovascular and mortality in industrialized countries. The risk is increased for-

- Cerebrovascular accident or strokes Agabeti R. E. (2008)
- Hypertensive cardiomyopathy (heart attack due to chronically high blood pressure)
- Left ventricular hypertrophy (thickening of the myocardium of the left ventricle of the heart).
- Hypertensive retinopathy (damage to the retina)
- Hypertensive nephropathy (chronic renal failure)
- Hypertensive encephalopathy
- Confusion, headache and convulsion etc.

It is caused by severe small blood vessel congestion and brain swelling which is reversible if blood pressure is lowered Papadakis et al. (2008).

1.2 CLASSIFICATION:

Blood pressure is usually classified based on the systolic and diastolic blood pressure. Systolic blood pressure is the pressure in the vessels during a heart beat. Diastolic blood pressure is the pressure between heart beats.

A systolic or the diastolic blood pressure measurement higher than the accepted normal values for the age of the individual is classified as pre-hypertension or hypertension.

Hypertension is classified as either primary (essential) or secondary. Primary hypertension refers to high blood pressure for which no medical cause can be found Correntero O. A. et al. (2000). It is most prevalent hypertension type affecting 90-95% of hypertensive patient. Mild to moderate hypertension is usually asymptomatic Pitts S R et.al. (1998).
Effect of Spirulina Supplementation on Blood Glucose and Blood Pressure Levels of Selected Diabetics and Hypertensives of Bhilai Township

<table>
<thead>
<tr>
<th>Classification</th>
<th>Systolic pressure mm of Hg</th>
<th>Diastolic pressure mm of Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>90-119</td>
<td>60-79</td>
</tr>
<tr>
<td>Pre-hypertension</td>
<td>120-139</td>
<td>80-89</td>
</tr>
<tr>
<td>Stage I</td>
<td>140-159</td>
<td>90-99</td>
</tr>
<tr>
<td>Stage II</td>
<td>≥ 160</td>
<td>≥ 100</td>
</tr>
</tbody>
</table>


There are many factors responsible such as sedentary lifestyle, stress, visceral obesity, hypokalemia, salt sensitivity, obesity Wofford M.R. et al. (2004), alcohol intake Djousse L. et al. (2009) and vitamin D deficiency. Risk also increases with aging, having a family history of hypertension, consuming foods that contain high fructose corn syrup Science Daily (2009) Recent studies have implicated low birth weight as a risk factor for adult essential hypertension Uchiyama M (2008).

5-10% of cases are of secondary hypertension that results from identifiable cause. It may occur due to adrenal cortical abnormalities, kidney disorders some medicines like steroids etc.

Essential hypertension may be considered as the result of interaction between genes & environment. The environmental effects are powerful and explain most of the blood pressure differences between population Harrap S. B. (2003).

1.3 CAUSES:

Causes of increase in hypertension in Indians are speculative Gupta R. (2004). In addition to increasing age, sex & heredity, other factors include:

- Tobacco & smoke:

Smoking raises blood pressure, which increases the risk of stroke in people who already have high blood pressure. It also increases heart rate, tightens major arteries and creates irregularities in the timing of
heart beat. According to American Heart Association 2007, more than 4,00,000 Americans die each year of smoking related illnesses because of the effect of smoking on the heart and blood vessels American Heart Association (2007).

- **Hyperlipidemia**: 
  Food derived from animal fats like red meat and butter are high in saturated fat, which introduces bad cholesterol or LDL into the blood stream. This type of cholesterol is considered bad because it sticks to arterial walls, which can clog them.
  Foods derived from plant material such as green leafy vegetables and vegetable oil are high in unsaturated fat i.e. 'good fat'. This keeps cholesterol moving through the blood stream and into the liver to be disposed off. Diet rich in unsaturated fats can help to reduce LDL cholesterol.

- **Physical inactivity**: 
  An inactive life style is a risk factor for coronary heart disease. Exercise burns calories, helps to control cholesterol levels and lowers blood pressure. Exercise also strengthens the heart and makes the arteries more flexible.

- **Overweight and Obesity**: 
  Excess weight increases heart work. It also raises blood pressure blood cholesterol and triglyceride levels.

**Body Mass Index (BMI)**

BMI a relative parameter of body weight in relation to height –

\[
\text{B.M.I.} = \frac{\text{Wt (kg)}}{\text{Ht (m)}^2}
\]

85% cases of essential Hypertension occur with a body mass index greater than 25 Haslam D W et al. (2005).
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Introduction

- Alcohol:
  Too much alcohol raises blood pressure, causes heart failure and leads to stroke.

- Stress:
  Stressful situations raise heart rate and blood pressure, increase hearts need for oxygen which may cause angina pectoris or chest pain. During stressful condition nervous system releases extra hormones (most often adrenaline). This hormone raises blood pressure, which can injure the lining of arteries. When the arteries heal, the walls may harden. It also increases the amount of blood clotting factor which may then block the arteries. Urban population who are being exposed to stress of acculturation and modernization, the hypertension prevalence rates have more than doubled in the last few years and are now similar to the developed countries Kearney P et al. (2005).

Similarly Diabetes ranks third among the chronic diseases and is one of the leading causes of deaths. As of 2000 at least 171 million people worldwide or 2.8% of the population suffer from diabetes. Wild S. et al. (2004).

It is the bitter sweet problem of India. The 20th World Diabetes Congress of the International Diabetic Federation has said that India leads the

<table>
<thead>
<tr>
<th>Range</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 18.50</td>
<td>Underweight</td>
</tr>
<tr>
<td>18.50-24.99</td>
<td>Healthy weight</td>
</tr>
<tr>
<td>25-29.99</td>
<td>Overweight</td>
</tr>
<tr>
<td>30-39</td>
<td>Obese</td>
</tr>
<tr>
<td>≥ 40</td>
<td>Morbidly Obese</td>
</tr>
</tbody>
</table>

WHO2004
world in the looming epidemic of diabetes. The country currently has 50.8 million people suffering from diabetes followed by China (43.2 million) and the U.S. (26.8 million) By 2010 almost 7% of India’s adult population will have this disease www.zeenews (2009).

According to the International Journal of Diabetes there is an alarming rise in prevalence of this disease and India is the ‘diabetes capital of the world’. Now this disease has gone beyond epidemic to a pandemic one www.hindustantimes.com.

Currently 11% of India’s urban population and 3% of rural population above the age of 15 have diabetes. The world health organization estimates that mortality from diabetes and heart disease cost India about $ 210 billion every year and is expected to increase to $ 3.35 billion in the next 10 years Neogi S (2010).

India is sitting on a diabetes time bomb and it is tickling very fast www.indiaserver.com (2009). Sonia Anand who is leading an international study on diabetes said that India faces a prominent threat from type 2 diabetes and heart problems arising from it.

1.4 TYPES OF DIABETES

Diabetes is a condition in which a person has high blood sugar. There are three main types of Diabetes:

Type 1 Diabetes results from body’s failure to produce insulin and presently requires the person to inject insulin. It is immune mediated in nature and there is no preventive measure against it. It causes 10% of diabetes mellitus cases in North America & Europe.

Type 2 Diabetes results from insulin resistance, a condition in which cells fail to use insulin properly. It is also known as adult onset, obesity related and NIDDM (non insulin dependent diabetes mellitus) and is more common affecting 90 to 95% of U.S. diabetic population.
Both type 1 and type 2 are chronic conditions that usually cannot be cured.

Gestational diabetes occurs in about 2-5% of all pregnancies and may improve or disappear after delivery. It is fully treatable but about 20% to 50% of affected women develop type 2 diabetes later in life.

1.5 CLASSIFICATION

Pre diabetes indicates a condition that occurs when a person’s blood glucose levels are higher than normal but not high enough for diagnosis of type-2 diabetes.

<table>
<thead>
<tr>
<th>Condition</th>
<th>2 hours glucose mg/dl</th>
<th>Fasting glucose mg/dl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt; 140</td>
<td>&lt;110</td>
</tr>
<tr>
<td>Impaired fasting glycaemia</td>
<td>&lt; 140</td>
<td>&lt;126</td>
</tr>
<tr>
<td>Impaired glucose tolerance</td>
<td>≥140</td>
<td>&lt;126</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>≥200</td>
<td>≥126</td>
</tr>
</tbody>
</table>


1.6 SYMPTOMS

High blood sugar produces classical symptoms of polyuria, polydipsia, polyphagia, fatigue, rapid weight loss, poor wound healing, infections, disturbed mental status and hazy vision.

Uncontrolled diabetes leads to several neurological (numbness and tingling in feet and hands), Cardiovascular, ocular, renal complication and gangrene of lower extremity Greenburg R.E. (1995). Ketoacidosis, a state of metabolic dysregulation characterized by the smell of acetone, a deep breathing known as kussmaul breathing, nausea, vomiting and abdominal pain. A number of skin rashes can occur in diabetes that is collectively known as diabetic dermadromes. Diabetes doubles the risk of vascular problems including cardiovascular diseases The Lancet (2009).

Symptoms develop rapidly in type 1 diabetes while in type 2 slowly
and may be subtle or absent.

1.7 CAUSES-

Diabetes Mellitus is a multifactorial disease. The etiopathology of the disease include heredity, race, life style, age, nutritional status, stress, altered immune functions, altered physiological or metabolic status, drug and hormones etc. Ramchandran A. et al. (1992).

1.8 MEASUREMENT –

Blood sugar level can be measured in two ways

(1) By glucometer

(2) Glycolated Haemoglobin (Hb A1C) -

First system measures the blood glucose level in plasma which changes from time to time.

In normal 120 days life span of red blood cells glucose molecules react with haemoglobin forming glycated Hb. In individual with poorly controlled diabetes the quantity of these Hb’s are much higher than healthy people. Glycolated Haemoglobin is the average of blood sugar for the last 100 days. It is not affected by diet. In normal Indian the HbA1C is 4% to 5.9%.

1.9 MANAGEMENT –

Diabetes is a slow progressing non invasive disease, not at all life threatening unless one abuses one’s body.

Type 1 Diabetes is not preventable but 80% of type 2 diabetics can delay or prevent it, by modification in life style, proper medication, moderate exercise, avoiding excessive weight gain, intake of polished & processed food, trans oils, stress & smoking.

1.10 SPIRULINA

These degenerative disease are growing health problems Crews D. E. (2007) and leading causes of death all over the world. Thus it becomes important to prevent and control them. Now a day’s many foods are used as
health foods. ‘Spirulina’ a blue green algae is now becoming a health food worldwide. It is a multi cellular filamentous cyanobacterium of oscillatoriaceae family. It is characterized by spiral shaped chains of cells enclosed in a thin sheath.


It is a photosynthetic micro-organism that grows naturally in fresh water with minimal growth requirements i.e. water, inorganic salts and light. It needs a strongly alkaline growth medium that is unsuitable for other microorganisms. It grows in Africa, Asia, North & South America Ciferri O (1983).

It has been used as food additive because of high content of protein as well as essential nutrients like carotenoids, vitamins & minerals Khan Z et al. (2005). In terms of protein 1 kg of Spirulina is equivalent to 5 kg of meat or 9 litres of milk and proteins are 85 to 95% digestible.

It is highly rich in potassium which activates many enzymes that are essential for muscle contraction. Potassium also helps in the maintenance of normal blood pressure. It has 1.79% potassium which is ten times higher than in common vegetables Henrikson R (1989).

It is rich in iron and is the only vegetable source of vitamin B₁₂. It’s administration is useful for women with hypochromic anaemia Seshadri C V et al. (1999)

Spirulina proteins are used to supplement many cereals with tryptophan & lysine to make them complete.

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### Composition of Spirulina Siva Prasad Rao et al. (2005)

In human beings, it controls obesity Becker E W (1986). It has concentrated low calorie nourishment that enters the blood quickly and raises the blood sugar level and prevents the hypothalamus in the brain from sending out hunger signals. This is because, the protein of Spirulina contains an amino acid phenyl alanine, which is transformed into brain neurotransmitters which control appetite, alertness, energy level & mood.

It has highest linolenic acid content that can be converted to gamma linoleic acid in the presence of enzyme delta 6-desaturase. The enzyme is not active in some individuals and thus the deficiency of gamma linolenic acid in the system results in the thickening of arteries, high blood pressure and cholesterol accumulation. The direct availability of gamma linolenic acid is a

<table>
<thead>
<tr>
<th>Content</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (g)</td>
<td>7.0</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>9.0</td>
</tr>
<tr>
<td>Proteins (g)</td>
<td>71.0</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>15</td>
</tr>
<tr>
<td>Vitamin A (g)</td>
<td>0.75</td>
</tr>
<tr>
<td>Beta carotene (g)</td>
<td>0.20</td>
</tr>
<tr>
<td>Nicotinic acid (mg)</td>
<td>1.18</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>0.40</td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.55</td>
</tr>
<tr>
<td>Vitamin B12 (mg)</td>
<td>30.0</td>
</tr>
<tr>
<td>Iron (g)</td>
<td>0.16</td>
</tr>
<tr>
<td>Xanthophylls (g)</td>
<td>0.18</td>
</tr>
<tr>
<td>Chlorophyll (g)</td>
<td>0.19</td>
</tr>
<tr>
<td>Crude fibre (g)</td>
<td>0.90</td>
</tr>
</tbody>
</table>

*Content and quantity data from Siva Prasad Rao et al. (2005)*
unique property and compensates for the metabolic inability of the individual cholesterol control by Spirulina Siva Prasad Rao et al. (2005). Gamma linoleic acid also stimulates growth in some animals. Gamma linoleic acid also acts as an anti inflammatory sometimes alleviating symptoms of arthritic conditions.

It is gaining more attention from medical scientists as a nutraceutical and source of potential pharmaceuticals. It can prevent or inhibit cancer in human beings and animals. Some common forms of cancer are result of damaged D.N.A. causing uncontrolled cell growth. Cellular biologists have defined a system of special enzymes, called endonuclease which repair damaged D.N.A., to keep cells alive and healthy, when these enzymes are deactivated by radiation or toxins error in D.N.A. go unrepaired and cancer may develop.

In vitro studies suggest that the unique polysaccharides of Spirulina enhance cell nucleus enzyme activity and D.N.A. repair synthesis.

It also acts as a functional food, feeding beneficial intestinal flora especially lactobacillus and bifidus, maintaining a healthy population of these bacteria in the intestine reduces potential problems from opportunistic pathogens like E. Coli and candida albicans when spirulina is added to the diet, beneficial intestinal flora increase.

It is a powerful tonic for the immune system also. Feeding studies show that even small amounts of Spirulina build up both the humoral and cellular arms of the immune system Qureshi M.A. et al. (1996). The bone marrow stem cells, macrophages, T. cells and natural killer cells exhibit enhanced activity. Spleen and thymus glands also show enhanced functions. In addition to increase in the number of macrophages their activity and effectiveness in killing germs is also increased in presence of Spirulina.

Phycocyanin present in Spirulina affect the stem cells found in bone marrow and hence has direct effect in stimulating the production of new red
and white blood cells. White blood cells make up the cellular immune system and red blood cells oxygenate the body.

Scientists from the institute of human performance and rehabilitation in Greece found that supplementing the diet with Spirulina improved running capacity by 30% thus extending the time to exhaustion significantly Med. Sci. sports (2010).

It is approved in Russia as a ‘medicine food’ for treating radiation sickness. The children of Chernobyl suffer radiation poisoning from eating food grown on radioactive soil. Their bone marrow is damaged; rendering them immuno deficient. Radiation damaged bone marrow can not produce normal red and white blood cells. The children are anaemic and suffer from terrible allergic reactions. Children fed just 5 grams of Spirulina made dramatic recoveries within six weeks but children not given Spirulina remain ill.

1.11 NEED AND IMPORTANCE OF THE STUDY

Obesity, heart disease, diabetes and cancer are the major health problems of the modern society. these health problems have increased enormously in recent past. different aspects regarding their causes and remedies have been studied in current researches and now accepted facts are that one of the major causes of ailment is amount and type of diet.

Decline in overall health that took place in the last century was due to altered eating habits of country people coming to new industrial towns. The changes that were important -

(a) Decline in the consumption of milk

(b) The general use of refined sugar which had previously been an aristocratic delicacy and

(c) The introduction of roller milled white flour which was softer than the traditional whole meal stone ground wheat. Drummond J. C. etal (1959)
In today’s world the pace of life is fast and it has become virtually impossible to follow the three or four meal pattern that was traditionally accepted. Traditional Indian foods were very much balanced with lots of fibrous components. Industrialization has brought in increased consumption and availability of refined and carbohydrate rich foods. Biscuit, noodles, chips, burger, pizza and other readymade items are few examples.

Spirulina, the blue green algae known for its potential to bring about nutrition revolution in the developing countries, is an excellent food source, providing the highest amount of protein, ever known to man and it has been concluded that Spirulina Earths super food has a versatile role in controlling many imbalances that occur in the body. Hence, it should be within the reach of common layman as it has many therapeutic uses also. All the government programmes and health centres aimed at nutrition education and intervention can effectively use Spirulina in reaching the objectives of their programme.

A deeper awareness of Spirulina to the general public will thus pave the way to a healthy community, correcting the nutritional imbalances and chronic non-communicable diseases like hypertension and diabetes caused by today’s fast paced life.

This type of work has been carried out for the first time in Bhilai city which is an important centrally placed geographical area of the newly formed Chhattisgarh state. Over all it will be an important projectionable study to assess the effect of Spirulina in hypertensive & diabetic patients with the following objectives.

1.12 OBJECTIVES

1. To study the pattern, type of food consumption and food habits of selected diabetic and hypertensive subjects.

2. To record their height and weight in order to find out the imbalances of their body weight.
3. To have a general idea of their lifestyle.
4. To analyse the diet consumed by the subjects in terms of energy, protein, carbohydrates, fats and micronutrients.
5. To find out the effect of spirulina supplementation on the blood sugar and blood pressure levels of the selected subjects.

1.13 LIMITATION
1. The study will be limited only to patients of Bhilai township of Chhattisgarh.
2. Study will be limited to 120 diabetic and 120 hypertensive patients.
3. Supplementation will be limited only to a period of 3 months.
4. Nutrition education will only be limited to 02 sessions of awareness generation programme.
5. Diet survey will be carried out only for a period of one day.

* * * * *