CHAPTER V
SUMMARY AND CONCLUSION

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.

The World Health organization attributes Hypertension as the leading cause of mortality. It is predicted to assume epidemic proportions by the year 2015, in India. According to W.H.O. 60% of the world’s heart patients will be Indians by the year 2210.

Similarly Diabetes ranks third among the chronic diseases. According to International journal of Diabetes, India is the Diabetic capital of world. Currently 11% of India’s urban population and 3% of rural population above the age of 15 have Diabetes. It is estimated that India which had 19.4 million diabetics in 1995 is expected to register a near three fold increase by 2025 (World Health report, 1999). 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.

Non communicable diseases are major health challenge of growing magnitude in the 21st century, thus it becomes important to prevent and control them.

Spirulina a food supplement with amazing nutritional and therapeutic qualities is now becoming a health food worldwide. World food conference of United Nations has declared it as the ‘best food for tomorrow’. It contains 65-71% complete proteins with all the essential amino acids, vitamin B12, Beta carotene, minerals including Calcium, Iron, magnesium, potassium Khan Z., Bhadouria P., Bisen P. S. (2005), hence beneficial in the maintenance of normal
blood pressure. It provides Gamma linolenic acid that helps to control cholesterol level Siva Prasad Rao, K. V. Radhika Sushma and Prabhakar G. (2005). It has significant properties as an antioxidant, antiviral, anticancer, anti allergic, immune enhancing, blood vessel relaxing, blood lipid lowering and liver protective properties, so it can be used for the therapeutic purposes for treatment of Diabetes, obesity, atherosclerosis, hyperacidity, Rheumatoid arthritis and kidney disorders etc. Thus it is an earth’s super food that has a versatile role in controlling many imbalances that occur in the body.

The present study is related with food habit, life style pattern, Body mass index, diet analysis and effect of Spirulina supplementation on selected Diabetic and Hypertensive subjects.

The present thesis entitled “EFFECT OF SPIRULINA SUPPLEMENTATION ON BLOOD GLUCOSE AND BLOOD PRESSURE LEVELS OF SELECTED DIABETICS AND HYPERTENSIVES OF BHILAI TOWNSHIP” deals the subject in the following chapters-

INTRODUCTION

REVIEW OF LITERATURE

METHODOLOGY

RESULTS AND DISCUSSION

CHAPTER 1 : INTRODUCTION

This chapter describes the meaning, classification, causes, symptoms, complications and management of Diabetes and Hypertension.

A study of relationship of non-communicable diseases with pattern and type of food consumption, life style, imbalances of body weight and calculation of dietary factors in terms of energy protein, carbohydrate and fat is mentioned. Since adequate nutrition is a prime prerequisite to vigorous health, emphasis is put on a diet capable of promoting best possible health with no ailment.
Spirulina, a blue green algae is now used as a food additive, a medicinal food and a food supplement for the reasons given below -

1. In terms of protein 1 Kg of spirulina is equivalent to 5 Kg of meat or 9 litres of milk and the proteins are 85-95% digestible.

2. It has 1.79 % potassium which is 10 times higher than common vegetables. It activates many enzymes that are essential for muscle contraction.

3. It is rich in Iron and only vegetable source of vitamin B\textsubscript{12} so it’s administration is useful in treatment of hypochromic anaemia .

4. It controls Obesity and has concentrated low calorie nourishment. It contains Phenyl alanine which is transformed into brain neurotransmitters which control appetite, alertness ,energy levels and mood.

5. It is a powerful tonic for immune system.

6. Spirulina provides Gamma linolenic acid ,deficiency of which results in thickening of arteries, high blood pressure and cholesterol accumulation.

**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.

Decline in overall health in the last century was due to altered eating habits. Traditional Indian foods were very much balanced with lots of fibrous components. Industrialisation has brought about an increased consumption and availability of refined and carbohydrate rich foods. Biscuit, noodles, chips, burger, pizza and other readymade items are few examples. Decreased consumption of milk and introduction of roller milled white flour are also some of the factors.
Spirulina, a blue green algae is known for its potential to bring about nutrition revolution in the developing countries is an excellent food source, so, this study is an attempt to find out the effect of spirulina supplementation on blood glucose and blood pressure levels of selected subjects.

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. It is an important projectionable study to assess the effect of spirulina on Diabetic and Hypertensive subjects with the following objectives.

**AIMS AND OBJECTIVES**

1. To provide insight into the pattern and type of food consumption and to study the dietary/food habits of the selected diabetic and hypertensive subjects.
2. To have a general idea of their lifestyle.
3. To record their height and weight in order to find out the imbalance of their body weight.
4. To analyze the diet consumed by the subjects in terms of energy, protein, carbohydrate and fat.
5. To find out the effect of spirulina supplementation on the blood sugar and blood pressure levels of the selected subjects.

**CHAPTER 2: REVIEW OF LITERATURE**

This chapter incorporates previous studies done on dietary habits, effect of age and sex, factors that control these diseases and effect of Spirulina Supplementation on Diabetic and Hypertensive subjects.

- Aldo Ferreira et al. (2010) studied hepatoprotective effects of Spirulina in patients with fatty liver. They considered Spirulina as an alternative treatment for patients with dislipidemic disorder. Their study revealed
that initial hypercholesteremia prevalence was 27.8% which was diminished to 13.9% after oral spirulina administration for 6 weeks.

- Nagoaka et. al (2005) have presumed that C. Phycocyanin content of spirulina inhibits pancreatic lipase activity and leads to decrease in jejunal cholesterol absorption and hence blood pressure.

- Chobanian A.V. et al. (2003) studied high blood pressure prevalence in 36 samples before and after treatment with spirulina (4.5 g/day for 6 weeks). Results showed that initial hypertension type II prevalence was 14% which was diminished after supplementation to 3% whereas hypertension type I prevalence dimished from 31% to 11%.

- Torres Duran P.V. et al. (2007) demonstrated anti hyperlipidemic and antihypertensive effects of spirulina.

- Parikh P. et al. (2001) studied the effect of spirulina supplementation at 2g/day dose for 2 months on blood glucose levels, glycosylated haemoglobin and lipid profile of 25 diabetic type I subjects. They found a reduction of fasting, post prandial blood glucose and HbA1C level. Change in lipid profile observed, demonstrated a reduction of total cholesterol.

- Anuradha. V. et al. (2001) studied the impact of administration of spirulina (4g/day) for 60 days on blood glucose levels of selected diabetic patients. The result proved that spirulina has hypoglycemic effect on Non insulin dependent diabetic patients. Significant decrease in body weight was also observed.

- Palta. A. et al. (2006) studied the effect of spirulina on weight and blood pressure levels of selected hypertensives in Raipur city. Study revealed significant reduction in blood pressure. Weight loss was also evident.

- Rammurti et al. (2002) tested spirulina on patients of high cholesterol and ischemic heart disease, they concluded that it plays a key role in
reducing blood cholesterol levels and improving lipid profiles.

The review of literature indicates that not much work has been carried out in Chhattisgarh state, hence the topic offers large scope for research work and has potential to serve the society.

CHAPTER – 3: METHODOLOGY

This chapter deals with the selection of samples and methodology used for collection of data.

1. **Description of study area** - Study is carried out in Bhilai township of Durg district of Chattisgarh state.

2. **Selection of samples** – Samples were selected by stratified random sampling. Out of 193 screened subjects 120 non insulin dependent diabetic patients with fasting blood sugar level between 120 to 160 mg/dl were selected for final study.

   Similarly out of 201 screened hypertensives 120 subjects between age group of 40-60 years, who were not taking any anti-hypertensive drug, and were either from prehypertension stage or hypertension stage I or II were selected for study.

   Out of 120 subjects 60 males and 60 females were selected for final study. They were then divided into two groups of 30 each. One served as experimental group and other as control group. Experimental group was given Spirulina supplementation (2 gms/ day) alongwith nutrition education for a period of 90 days. The control group was given only nutrition education specially related to disease. Similar categorization was done for Hypertensive patients.

3. **Tools & techniques for data collection**

   i. **Life Style Assessment** - Information about occupational status, physical activity, type of exercise, faulty food addictions, and dietary
habits (vegetarian/non vegetarian) frequency of meals per day was collected.

ii. **Dietary Survey**— The questionnaire was designed according to the set specifications and specific goals. Daily consumption of different food items such as milk, green leafy vegetables, fruits, salad, sprouts, dry fruits, fried foods, sweets, salt, tea/coffee and quantity and type of cooking oil used was taken into consideration. Diet survey was carried out using 24 hour recall method for 1 day. Quantity of cooked food taken was converted into raw equivalent in terms of grams or milliliters. Nutrient content was then estimated using food composition table (Gopalan C. et al.).

iii. **Anthropometric Measurements**— Anthropometric measurements like height in meter and weight in kg were recorded for calculation of body mass index.

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

Following classification of B. M. I. was considered for evaluating the status of the subjects. (W.H.O 2004)

- $<18.50$ = Underweight
- $18.50-24.99$ = Healthy weight
- $25-29.99$ = Overweight
- $30-39$ = Obese (class I and II)
- $\geq 40$ = Morbidly obese (class III)

iv. **Biochemical Assessment**— Blood sugar of diabetic patients and blood pressure of selected hypertensives was measured initially before starting supplementation and then after supplementation was over.

Four categories of blood sugar level as per 1999 WHO criteria include-
Blood glucose level in plasma changes from time to time therefore for diabetic patients Glycated haemoglobin (HbA1C) test was done twice in the entire study period, initially before starting supplementation and finally after supplementation was over.

HbA1C is the average of blood sugar for the last 100 days and it is not affected by diet. In normal 120 days lifespan of red blood cells glucose molecules react with haemoglobin forming Glycolated haemoglobin. In individual with poorly controlled diabetes the quantity of HbA1C is much higher. In normal Indian the HbA1C range should be as follows:-

- A non diabetic should have an HbA1C result between 4% to 6%.
- In diabetics HbA1C level should be 6.5% or higher.
- In pre diabetics HbA1C is 5.7% to 6.4%.

Four categories of blood pressure as per the recommendation of American heart association include-

<table>
<thead>
<tr>
<th>Category</th>
<th>Systolic Pressure (mm of Hg)</th>
<th>Diastolic Pressure (mm of Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;120</td>
<td>&lt;80</td>
</tr>
<tr>
<td>Pre hypertensive stage</td>
<td>120-139</td>
<td>80-89</td>
</tr>
<tr>
<td>Hypertension stage-I</td>
<td>140-159</td>
<td>90-99</td>
</tr>
<tr>
<td>Hypertension stage-II</td>
<td>&gt;160</td>
<td>&gt;100</td>
</tr>
</tbody>
</table>
v. **Supplementation with Spirulina** - The experimental diabetic and hypertensive male and female subjects were given supplementation with 2 gm of Spirulina per day in the form of Hellorina tablets. The supplementation was carried out for 90 days. After every month weight of the subjects, blood sugar and blood pressure level were measured.

vi **Diet-counseling** - A systematic diet counseling was developed for experimental purpose. Control group was given nutrition education whereas experimental group was given spirulina supplementation along with diet counseling.

**CHAPTER 4 : RESULT & DISCUSSION**

This chapter deals with the results of the study and their presentation in the form of graphs and tables. In addition elaborate discussion of the results was done based on the tabulated data. Results of the study have been discussed under following sub headings.

1. **Life style pattern**
   
   • **Occupational Status**
     
     **Diabetic** - 47% males and 13% females from experimental group and 33% males and 20% females from control group are involved in some kind of business whereas 53% of males and 53% of females were in service. 33% females were housewives.
     
     **Hypertensive** - Among experimental males 27% were businessmen and 73% were in service. In control group 47% had their business and 53% were in service. In females 6% from experimental group were in business and 47% in service and 47% were housewives. In control group 13% females were in business, 60% in service and 27% were housewives.
• **Physical Activity**

**Diabetic**- 60% of males and 80% of females lead a sedentary life whereas 33% male and 20% females carried moderate activities. 7% of males were of heavy worker category in experimental group. In control group 67% males were sedentary and 33% were moderate worker. Among females 87% were sedentary worker and 13% were moderate worker.

**Hypertensive**- 80% of males from experimental group and 60% from control group are sedentary workers. 20% from experimental group and 40% from control group were moderate workers. Among females 87% were sedentary workers 13% moderate workers in experimental group. In control group 73% were sedentary workers and 27% were moderate workers.

• **Type of exercise**

**Diabetic**- 33% males from experimental group and 53% from control group were not involved in any kind of physical exercise. 53% males from experimental group and 47% from control group regularly practiced walking. 13% of experimental male practiced yoga daily. 50% females from experimental group and 40% from control group did not do any kind of physical exercise. 43% from experimental group and 50% from control group walked regularly.

**Hypertensive**- 47% of males from experimental group and 57% from control group perform no physical exercise. 43% and 40% from experimental group and control group respectively walked regularly. Only 10% from experimental group and 3% from control group practiced yoga. Among females 23% from experimental group and 20% from control group walked regularly. 70% from the
experimental group and 63% from the control group carried on no physical exercise.

- **Faulty Food addictions**
  
  **Diabetic** - 50% of males from experimental group had the habit of eating pan, 33% took tobacco, 40% were smokers, 50% took alcohol whereas 50% males had no faulty food addiction.
  
  In females about 40% from experimental group and 17% from control group had the habit of eating pan and tobacco.
  
  **Hypertensive** - 56% males from experimental group and 60% from control group had the habit of eating tobacco. 47% males from experimental group and 53% from control group had the habit of eating pan. 40% experimental male and 43% control male were smokers.

- **Dietary Habit**
  
  - 67% of males from experimental group and 53% from control group were nonvegetarian. 33% female of experimental group and 27% from control group were nonvegetarian.
  
  - 80% male hypertensives from experimental group and 60% from control group were nonvegetarian. 20% females from experimental group and 13% from control group were nonvegetarian.

- **Frequency of meals per day**
  
  **Diabetic** - 53% males and 40% of females from experimental group took 3 meals per day whereas 13.3% males and 20% females had more than 3 meals per day. 33% males and 40% females took only 2 meals per day. 47% males and females from control group had the habit of taking 3 meals per day. 20% males and 27% females took
more than 3 meals per day, 33% males and 27% females had only 2 meals per day.

**Hypertensive**- 40% males from experimental group and 20% from control group adopted a 3 meal pattern, 53% from experimental group and 60% from control group had 2 meals per day. 7% from experimental group and 20% from control group took more than 3 meals per day.

Among females 33% from experimental group and 40% from control group had adopted a 2 meal pattern. 40% from experimental group and 33% from control group had their meal twice a day and 27% had more than 3 meals per day.

2. **Dietary survey**

Mean calorie intake of hypertensive and Diabetic subjects was between 1900 to 2100 calories/day. Of the total calories about 11-12% were obtained from protein, 63-67% from carbohydrate and 22-24% from fat. Further analysis indicates that calorie intake was mainly through refined carbohydrate and excess fat. Subjects were advised to modify their diet by taking a hypocaloric, low fat, high fiber and antioxidant rich diet with moderate physical activity.

3. **Anthropometric measurements**

After measurement of height and weight B.M.I.(Body Mass Index) was calculated. The subjects were then categorized according to the classification of World Health Organization. Pretest 100% of experimental male and female diabetic patients were overweight (B.M.I between 25 to 29.9). 60% of male experimental hypertensives were in overweight category and 13.34% were in obese (B.M.I > 30) category, 20% were of normal weight. Among male control hypertensives, 60% were overweight, 6.6% were of normal weight, 20% underweight and 13.34% were obese. Among female
experimental hypertensives, 73% were overweight, 13.3% underweight, 13.3% obese and 6.6% underweight. Among control female hypertensives, 66.6% were overweight, 26.6% had healthy weight and 6.6% were obese.

4. **Biochemical assessment**

Initial blood sugar level of diabetic patients and blood pressure of hypertensive patients was recorded before supplementation.

- **Diabetic experimental male** - Pretest mean fasting blood glucose level was 139.60 mg/dl (S.D ± 10.01) post prandial was 202.20 mg/dl (S.D ± 13.93) and random sugar level was 186.20 mg/dl (S.D ± 9.92).

- **Diabetic experimental female** - Pretest mean fasting blood sugar level recorded was 140.20 mg/dl (S.D ± 9.39) , post prandial 202.20 mg/dl (S.D ± 12.83) and random level was 185.60 mg/dl (S.D ± 11.18).

- **Diabetic control male** - Pretest mean fasting blood sugar level was 144.8 mg/dl (S.D ± 8.89) post prandial level was 207.20 mg/dl (S.D ± 14.03) and random blood sugar level was 186 mg/dl (S.D ± 8.36).

- **Diabetic control female** - Pretest mean fasting blood sugar level was 140.80 mg/dl (S.D ± 7.15) post prandial 199.60 mg/dl (S.D ± 13.44) and random blood sugar recorded was 188.8 mg/dl (S.D ± 11.05).

- **Hypertensive experimental male** - Pretest mean Systolic blood pressure was 148.9 mm of Hg (S.D ± 16.27) and Diastolic blood pressure was 94 mm of Hg (S.D ± 5.71)

- **Hypertensive experimental female** - Pretest mean Systolic blood pressure was 142.1 mm of Hg (S.D ± 10.95) and Diastolic blood pressure was 92.40 mm of Hg (S.D ± 5.61)

- **Hypertensive control male** - Pretest mean Systolic blood pressure was 149.7 mm of Hg (S.D ± 17.13) and mean Diastolic blood pressure recorded was 98.9 mm of Hg (S.D ± 7.08).
Hypertensive control female- Mean Systolic blood pressure before supplementation was 144.5 mm of Hg (S.D ± 14.14) and Diastolic blood pressure was 90.5 mm of Hg (S.D ± 4.36).

5. Supplementation with Spirulina

- Effect on B.M.I

Diabetic experimental male- Mean B.M.I was 26.19 (S.D ± 0.51) before supplementation which was reduced to 25.06 (S.D ± 1.09) after supplementation.

Diabetic experimental female- Mean B.M.I 26.77 (S.D ± 0.69) was reduced to 25.41 (S.D ± 0.95).

Hypertensive experimental male- Pretest mean B.M.I was 26.08 (S.D ± 2.99) which was reduced to 24.89 (S.D ± 2.04).

Hypertensive experimental female- Pretest B.M.I of 25.94 (S.D ± 3.62) was dropped to 24.30 (S.D ± 2.54).

- Effect on blood sugar level

Diabetic experimental male-Pretest mean fasting blood sugar level 139.60 mg/dl (S.D ± 10.01) was reduced to 139.1 mg/dl (S.D ± 9.61) after 30 days, to 132.40 mg/dl (S.D ± 7.29) after 60 days and 120.70 mg/dl (S.D ± 4.63) after 90 days. Post prandial blood sugar level of 202.2 mg/dl (S.D ± 13.93 reduced to 202 mg/dl (S.D ± 4.26) after 30 days, 191.80 mg/dl (S.D ± 15.13) after 60 days and 181.60 mg/dl (S.D ± 18.88) .Random blood sugar level of 186.20 mg/dl (S.D ±9.92) became 184.5 mg/dl (S.D ± 9.93) after 60 days and 163.20 (S.D ± 12.30) after 90 days.

Diabetic experimental female-Fasting blood sugar level of 140.20 mg/dl (S.D ± 9.39) was dropped to 139.60 (S.D ± 9.22) after 30 days and then to 134.4 mg/dl (S.D ± 7.96) after 60 days and finally to 123.3 mg/dl (S.D ± 9.45) after 90 days. Post prandial blood sugar
Effect of Spirulina Supplementation on Blood Glucose and Blood Pressure Levels of Selected Diabetics and Hypertensives of Bhilai Township

202.2 mg/dl (S.D ± 12.83) was dropped to 201.4 mg/dl (S.D ± 12.82) after 30 days to 196.5 mg/dl (S.D ± 12.31) after 60 days and finally to 187.3 mg/dl (S.D ± 13.63) after 90 days. Random blood glucose of 185.60 mg/dl (S.D ± 11.18) was dropped to 185 mg/dl (S.D ± 11.30) after 30 days, 180 mg/dl (S.D ± 9.38) after 60 days and 171.4 mg/dl (S.D ± 8.73) after 90 days.

- **Effect on HbA1c level**

Change in HbA1c level was observed in diabetic experimental males after supplementation. In 22 subjects it was reduced and in 8 subjects it remained unchanged. Pretest HbA1c level was 7.46% (S.D ± 0.31) which was reduced to 7.23% (S.D ± 0.28) which is significant at .01 level.

In 18 experimental females HbA1c level was reduced whereas it remained unchanged in 12 subjects. Pretest HbA1c level was 7.28% (S.D ± 0.24) which was reduced to 7.26% (S.D ± 0.24) which is significant at .05 level.

- **Effect on Blood Pressure level**

**Hypertensive experimental male**—Pretest mean Systolic blood pressure was 148.9 mm of Hg (S.D ± 16.27) which was reduced to 148.3 mm of Hg (S.D ± 16.4) after 30 days and then to 142.4 mm of Hg (S.D ± 15.96) after 60 days and finally 134 mm of Hg (S.D ± 18.99) after 90 days of supplementation. Pretest Diastolic pressure was 94 mm of Hg (S.D ± 5.71) which became 93.9 mm of Hg (S.D ± 5.78) after 30 days it further dropped to 91.8 mm of Hg (S.D ± 5.47) after 60 days and 88.6 mm of Hg (S.D ± 6.05) after 90 days of supplementation.

**Hypertensive experimental female**—Pretest Systolic pressure 142.1 mm of Hg (S.D ± 10.95) was dropped to 142.3 mm of Hg (S.D ±
Effect of Spirulina Supplementation on Blood Glucose and Blood Pressure Levels of Selected Diabetics and Hypertensives of Bhilai Township

9.92) after 30 days, 138.9 (S.D ± 8.87) after 60 days, 133.8 mm of Hg (S.D ± 9.46) after 90 days. Pretest Diastolic pressure of 92.40 mm of Hg (S.D ± 5.61) became 92.60 (S.D ± 5.75) after 30 days, after 60 days it was reduced to 90 mm of Hg (S.D ± 4.67) and then 87.3 mm of Hg (S.D ± 5.19) after 90 days.

6. Diet Counseling

Effect of diet counseling on control and experimental group was observed.

- **Effect on B.M.I**

  **Diabetic control male** - Pretest B.M.I was 26.92 (S.D ± 0.52) which was reduced to 26.42 (S.D ± 0.32).

  **Diabetic control female** - Pretest B.M.I 26.20 (S.D ± 0.72) was reduced to 25.89 (S.D ± 0.72).

  **Hypertensive control male** - Pretest B.M.I was 25.84 which was reduced to 25.44.

  **Hypertensive control female** - Pretest B.M.I 26.01 was reduced to 25.60.

- **Effect on blood sugar level**

  **Diabetic control male** - Pretest mean fasting blood sugar level was 144.8 mg/dl (S.D ± 8.89) which was reduced to 144.4 mg/dl (S.D ± 8.62) after 30 days, then to 143.3 mg/dl (S.D ± 8.35) after 60 days and 142.3 mg/dl (S.D ± 8.84) after 90 days of supplementation.

  Similarly post prandial blood sugar level was 207.2 mg/dl (S.D ± 14.03) which remained 207.2 mg/dl (S.D ± 14.00) after 30 days, then to 206.3 mg/dl (S.D ± 14.05) after 60 days and 205.9 mg/dl (S.D ± 13.85) after 90 days of supplementation. Pretest random blood sugar level was 186 mg/dl (S.D ± 8.36) which was reduced to 185 mg/dl (S.D ± 7.57) after 30 days, then to 184.3 mg/dl (S.D ± 8.44)
Effect of Spirulina Supplementation on Blood Glucose and Blood Pressure Levels of Selected Diabetics and Hypertensives of Bhilai Township

Summary and Conclusion

Diabetic control female- Pretest mean fasting blood sugar level was 140.8 mg/dl (S.D ± 7.15) which was reduced to 140.9 mg/dl (S.D ± 7.14) after 30 days, then to 139.2 mg/dl (S.D ± 7.79) after 60 days and 139 mg/dl (S.D ± 7.89) after 90 days of supplementation. Similarly post prandial blood sugar level was 199.6 mg/dl (S.D ± 13.44) which was reduced to 199.4 mg/dl (S.D ± 13.61) after 30 days, then to 198.9 mg/dl (S.D ± 14.87) after 60 days and 198.2 mg/dl (S.D ± 15.78) after 90 days of supplementation. Pretest random blood sugar level was 188.8 mg/dl (S.D ± 11.05) which was increased to 189.6 mg/dl (S.D ± 11.90) after 30 days, then reduced to 187.8 mg/dl (S.D ± 10.75) after 60 days and 187.6 mg/dl (S.D ± 9.56) after 90 days of supplementation.

- Effect on HbA1C level

In control females HbA1C level of 26 remained unchanged whereas loss was observed in 4 subjects. Pretest HbA1C level was 6.97% (S.D ± 0.28) which was not changed significantly after nutrition education.

In control male HbA1C level of 25 remained unchanged whereas loss was observed in 5 subjects. Pretest HbA1C level was 7.32% (S.D ± 0.20) which was reduced to 7.30% (S.D ± 0.18) which is statistically insignificant.

- Effect on Blood Pressure level

Hypertensive control male- Pretest mean Systolic blood pressure was 149.7 mm of Hg (S.D ± 17.13) which was reduced to 149.6 mm of Hg (S.D ± 17.37) after 30 days and then to 148.5 mm of Hg (S.D ± 18.27) after 60 days and finally 145.6 mm of Hg (S.D ± 18.47) after
90 days of supplementation. Pretest Diastolic pressure was 98.9 mm of Hg (S.D ± 7.08) which became 98.6 mm of Hg (S.D ± 7.07) after 30 days it further dropped to 97.6 mm of Hg (S.D ± 6.42) after 60 days and 96.4 mm of Hg (S.D ± 5.45) after 90 days of supplementation.

**Hypertensive control female** - Pretest mean Systolic pressure 144.5 mm of Hg (S.D ±14.14) which was reduced to 147.3 mm of Hg (S.D± 15.30) after 30 days, then to 144.7 mm of Hg (S.D ±13.95) after 60 days and finally to 144 mm of Hg (S.D ±13.80).
Pretest mean diastolic pressure of 90.5 mm of Hg (S.D ±4.36) remained same after 30 days, reduced to 90.1 mm of Hg (S.D ±4.34) after 60 days and finally to 89.40 mm of Hg (S.D ±4.26) after 90 days of supplementation.

Impact of dietary counseling was also observed in lifestyle profile and food consumption pattern. A positive correlation was observed with lifestyle modification, reduction in the quantitative intake of sweets, salt, fried foods, alcohol, smoking and tobacco chewing and increase in the quantitative intake of milk, green leafy vegetables, fruits, salad and sprouts was observed.

To compare the overall impact of Spirulina supplementation and nutrition education, gain score i.e. post test – pre test mean scores of B.M.I., blood sugar and blood pressure after 30, 60 and 90 days were compared. Gain scores clearly indicate that spirulina supplementation along with nutrition education was proved to be much more beneficial than nutrition education alone.

**RECOMMENDATIONS:**

1. A deeper awareness of Spirulina to the general public will pave the way to a healthy community correcting the nutritional imbalances and chronic non-communicable diseases.
2. Spirulina, an excellent food source that has a versatile role in controlling many imbalances should be within the reach of common man.

3. All the government programmes and health centres aimed at nutrition education and intervention can effectively use Spirulina in reaching the objectives of their programme.

4. Weight reduction through diet control and regular aerobic exercise is helpful. Moreover, reduced sugar and sodium intake and increased calcium and potassium intake is advised.

5. Consumption of tobacco, alcohol and cigarette smoking is contraindicated.

6. Last but not the least, stress being the root cause of several disorders and ailments, needs to be controlled through various relaxation therapies like yoga, meditation, keeping oneself occupied with hobbies and various social activities.

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