Effect of Spirulina on Blood Pressure Levels of Selected Hypertensives in Coimbatore City

BY

K. N. GAYATHRI

A THESIS SUBMITTED TO THE AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN (DEEMED UNIVERSITY) COIMBATORE-43 IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN FOOD SERVICE MANAGEMENT AND DIETETICS

APRIL 1998

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APRIL – 1998

CERTIFIED AS BONAFIDE RESEARCH WORK

Signature of the Dean

Signature of the Head of the Department

Signature of the Guide

Tribute
To
My Nation

Acknowledgement

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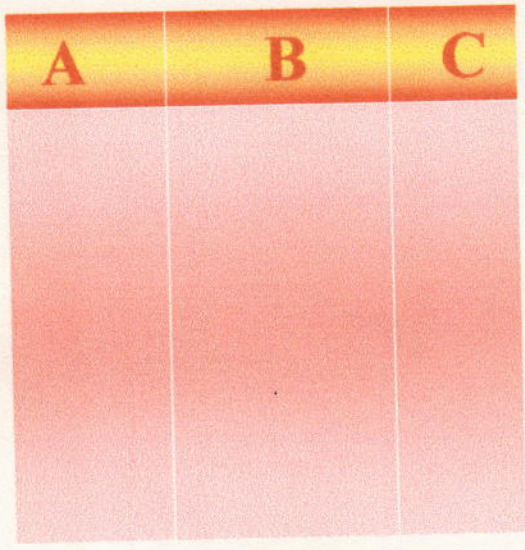

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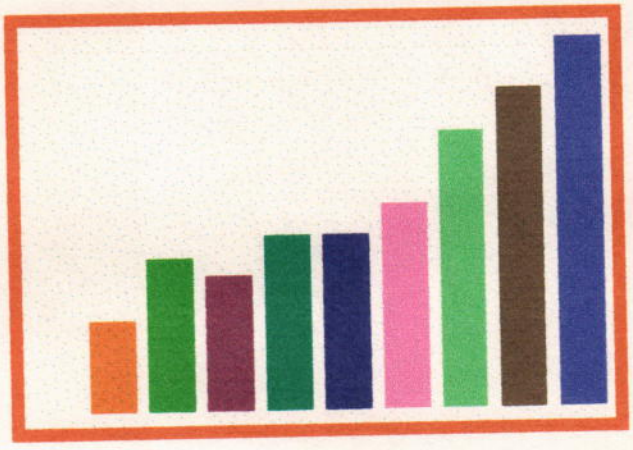

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INTRODUCTION

I. INTRODUCTION

Mechanization in today's world has resulted in making man's life more comfortable and thus reducing physical activity. In recent times, hence the health situations of the community on the whole is deteriorating .The changes in the life style, sedentary activity, inadequate nutrition has made him prone to many diseases. Many developing countries including India, face a universal problem of adult morbidity and mortality due to cardiovascular diseases like coronary heart disease and hypertension.

Hypertension is recognised as a serious health problem. It has been clearly shown that hypertension increases the risk of developing stroke, cardiovascular disease, diabetes mellitus, retinopathy, nephropathy and even causing glomerulopathy. **(Nillson, 1996 and Navalesi et al., 1995).**

According to **American heart Association (1997),** as many as 50 million Americans aged six and above have high blood pressure. **(Kuller (1994)** reported the prevalence in Americans as 36 percent in women and 38.7 percent in men. **Kumar and Klark (1994),** stated that in the western hemisphere 50 percent of the deaths are related to hypertension. According to **American Heart Association (1997),** hypertension killed 38,130 Americans in 1994, and contributed to the deaths of more than 1,80,000 Americans. **Butcait et al (1995),** stated that hypertension is the leading cause of mortality in Americans.

Hameed et al (1995), established that there was high frequency of hypertension among the people of South Asia. **Sayeed et al (1995),** validated that in Bangladesh, the prevalence of systolic pressure was more (10.5 percent) than that of the diastolic pressure (9 percent).

Voukiklaris et al (1996), reported that the prevalence of hypertension has increased from 0.7 percent in 1960 to 9.5 percent in 1991 in Greece.

In the developing Carribean community, the incidence of hypertension was 33 to 41 percent in men and 27 to 32 percent in women **(Miller et al., 1996)**. According to **Mugamer et al (1995)**, in the United Arab Emirates, male gender was associated with raised diastolic blood pressure.

Dash et al(1994), stated that the prevalence of hypertension in India was found to be 4.8 per 1000 males and 4.3 per 1000 females in rural tribal group giving an overall rate of 4.6 per 1000. In contrast the same were 27.1 per 1000 males and 21.4 per 1000 females. Urban tribal group, overall rate being 25.6 per 1000.

Gupta et al (1994), stated that in rural Rajasthan, hypertension rate is 46.4 per 1000 and 30.8 per 1000 in **Punjab (Wander,1994)**.

According to **Singh (1992)**, in the rural areas of Haryana, the incidence of hypertension was more in females than in males and was more prevalent in higher age groups.

In India, hypertension is becoming an important contributor to cardiovascular diseases and mortality **(Reddy, 1993)** and by 2000 A.D, nearly five crore people would be affected by hypertension **(Sharma, 1997)** and the incidence has particularly increased in large towns **(Sinha et al, 1990)**.

No single risk factor is the cause of hypertension various risk factors are **"controllable risk factors"**- smoking **(Challappa 1996, Feldman 1992, cunnane 1995, Becgom et al., 1995)**; alcohol **(Potter 1984, Ascherio et al., 1996, Rupp et al., 1996, Manson et al., 1990)**; Obesity **(Licata et al 1993, Martinez et al., 1993, Guagrano et al., 1996, Rotimi et al., 1995)**; Sedentary life style **(Duncan et al., 1993, Kebede et al., 1993, Steptoe et al., 1994)**; Stress **(Hinnen et al., 1993, Hayward., 1995)**; high salt

diet **(Lai 1992, Mtabaji 1990, Tobian 1991)**; deficient calcium and potassium intake **(Jeffrey 1984, Karppenen 1993).**

"Uncontrollable risk factors" are age **(Hatama et al., 1993, Leuitt et al., 1993)**; genetics **(Vardan 1995)**; sex **(Mugamer et al., 1995)**; hypercholesterolemia, diabetes and syndrome – X.

Age and cigarette smoking are important contributors to the risk of hypertension in both obese and non-obese people, but obesity increases the risk **(Manson et al., 1990)**.

There is no doubt that obesity and excessive alcohol intake are related to blood pressure, and weight reduction and alcohol restriclion can lower blood pressure levels **(Cox et al., 1990)**.

Cassano et al., (1990), reported that abdominal accumulation of body fat, apart from overall level of adiposity was associated with an increased risk of hypertension.

Vegetarian diets lower pressure **(Margetts et al., 1986)**; Many studies have found that calcium supplementation lowers blood pressure **(Bucher et al., 1996). Motoyama et al.(1989)**, stated that magnesium supplementation350-500 mg per day lower blood pressure.

Garlic has a blood pressure lowering effect. Garlic's positive effect on the heart includes reduction of platelet stickiness and lowering of blood pressure levels. **(Silagy and Neil., 1994).**

Consumption of SFA and unsaturated fattyacids lowers blood pressure opined **Cohen (1987)**.

Vitamin C lowers blood pressure **(Trout, 1991)**. Many people take one to two grams per day to help support healthy blood pressure levels.

According to **Law et al., (1991)**, reduction in the amount of salt added to processed foods would lower blood pressure by twice as much and could prevent as many as 70,000 deaths per year in Britain.

Cappucio and Mac Gregor (1991), suggested that potassium supplementation reduces blood pressure in normotensive and hypertensive subjects by an average of 5.9 to 3.4 mm Hg.

Recent evidence indicates that a high potassium diet reduces the rise of blood pressure caused by high Nacl diet, whereas a low , normal potassium intake encourages an Nacl-induced blood pressure rise **(Tobian, 1997).**

Coenzyme Q10 is frequently deficient in people with hypertension. Supplementation of 50 mg Q10 twice per day lowers the blood pressure levels **(Digiesi et al., 1992).**

Omega-3 fatty acids in fish oil may lower blood pressure **(Morris et al., 1993)**. Taurine, an aminoacid, has been used to lower blood pressure by reducing levels of hormone epinephrine **(Fujita et al., 1987).**

Spirulina is a multicellular, filamentous cyanobaterium, belonging to an algae of class cyanophyta which has been established as a highly nutritious food **(Jassby, 1988)**. The recent applications of spirulina in the food and pharmaceutical field have been exciting.

Spirulina is a compact well balanced source of nutrition unsurpassed to any other food known to mankind.

It is superior to meat, milk, egg and soyabeans. It has the highest protein content of 60-70 percent and the digestibility is about 80 percent and the net protein utilisation is about 60 percent. It has all eight essential aminoacids in it and ten non-essential aminoacids and is the richest known source of γ-linoleic acid.

It has the highest known vitamin B12 and the only vegetarian source. It contains the minerals like magnesium, manganese, zinc, calcium, potassium and sodium **(Robert Henrikson, 1989)**. The iron content is about 5.4 mg. No wonder, the **World Food Congress** of the United Nations declared spirulina as **"THE BEST FOOD FOR TOMORROW"** .Research has established that 1 kg of spirulina is equivalent to 1000 kgs of assorted vegetables. Spirulina has the approval of **FDA of USA** and **JHFA of Japan**.

Spirulina is highly rich in potassium **(Robert Henrikson, 1989)** and is highly beneficial to hypertensives. Spirulina contains 350 percent more potassium than rice. Potassium activates many enzymes that are essential for muscle contration. Potassium helps in the maintenance of normal blood pressure. Spirulina contains 1.79 percent potassium which is ten times higher than that in common vegetables. Therefore spirulina is highly beneficial to hypertensives.

There is dearth of study on the effect of spirulina on blood pressure levels. So this study is an attempt to study the effect with the following objectives.

OBJECTIVES

- **To study the dietary pattern of the selected hypertensives in Coimbatore city.**
- **To supplement the diets of the hypertensives with spirulina capsules (Recolina).**
- **To study the impact of supplementation of spirulina on the blood pressure levels of the selected hypertensives.**

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The available literature pertaining to the research study on " **Effect of spirulina on blood pressure levels of selected hypertensives in Coimbatore city**" was reviewed and is presented under the following headings.

A. **Incidence of hypertension**

B. **Risk factors associated with hypertension**

1. **Controllable risk factors**
2. **Uncontrollable risk factors**

C. **Effect of hypotensive agents on blood pressure**

D. **Management of hypertension**

A. INCIDENCE OF HYPERTENSION

Hypertension is a serious health problem which occurs worldwide.

Lord (1997) gave the prevalence rate of hypertension in the African - American population to be 27 percent for women and 32 percent for men.

Ghannem et al. (1997) reported that hypertension was an important public health problem in Tunisia, where there was a high prevalence as 18.8 percent with an adjusted rate of 15.6 percent (> 160 / 95 mm Hg).

The prevalence of hypertension (defined as systolic blood pressure of atleast 160 mm Hg, diastolic blood pressure of 95 mm Hg or use of antihypertensive medication according to **WHO** criteria) was 47 % and 43 % for women and men respectively in Barbados. **(Foster et al., 1990)**.

Vander sande et al., (1997) in his study on the Nationwide prevalence of hypertension in Gambia proved that 9.5 percent of the subjects were hypertensive. By less conservative criteria 24.2 percent of subjects were hypertensive.

Hypertension appears to be very prevalent in Gambia, with a substantial population at risk of developing target organ damage.

Bunnag et al., (1990) reported that there was high prevalence of hypertension in Thailand as 17.3 percent in men and 14 percent in women.

Garcia et al., (1990) studied the prevalence of arterial hypertension in Barcelona and stated that arterial hypertension prevalence was 19.8 percent. **Saunders (1991)** established that the major differences recognized between black and white hypertensives were primarily epidemiologic, with hypertension being more prevalent, having an earlier onset, and having more severe sequelae in the black population.

Beegom et al. (1995) in the study on the prevalence of hypertension in the urban population gave the prevalence rates between 25 and 64 years as 189/1000 and between 45 and 64 years as 335/1000, which is higher than in western populations.

The overall prevalence of hypertension in the rural community of Varanasi district was 7.19 %. Prevalence rates among males and females were found as 5.57 % and 8.82% respectively. **Goel et al. (1996)**

Blood pressure profile in the **Oraon tribal community** of India living in rural and urban areas were studied by **Dash et al.,(1994)** and prevalence rates was found to be 4.6/1000 & 25.6 /1000 in the rural & urban tribal group.

A. **RISK FACTORS ASSOCIATED WITH HYPERTENSION**

No single risk factor is the cause of hypertension. A number of risk factors contribute to the aetiology of hypertension. The various risk factors are

"controllable risk factors" and "uncontrollable risk factors"

Ghannem et al. (1997) stated the risk factors of hypertension as diabetes, obesity and smoking, to be 10.2 %, 27.7 % and 21.5 % respectively.

Confirming with the above, **Duncan et al, Kebede et al. (1993), Haffner (1992)**, gave the prevalence of risk factors for hypertension like smoking, obesity, sedentary life style to be 4%, 18 %, 47 % and 7 % respectively.

Gupta (1994) and Beegom (1997) brings out the prevalence of various risk factors like smoking, alcohol intake, sedentary life style, stressful life events and obesity to be 42.4, 12.7, 69.3, 4.2 and 20.8 percent respectively in rural Rajasthan.

Hypertension is not an isolated phenomenon, but occurs as a part of a complex syndrome together with metabollic risk factors like obesity, dislipaemia, hyperlipaemia and glucose intolerance **(Rett et al., 1993).**

1. CONTROLLABLE RISK FACTORS

a) Obesity

Obesity is considered as the number one public health problem by **Atkinson et al., (1994)** and by **Mc Donough (1987)** due to the morbidity and mortality from obesity and from complications including diabetes mellitus, hypertension, hyperlipidemia, hypercholesterolemia, cancers, mycocardial infarction, gout, osteoarthritis and gall bladder disease. Obese persons experienced a 2.6 times greater risk of hypertension compared to those with body mass indices below 25, says **Foster et al.(1993).**

Macedo et al. (1997), opines that obesity is associated with blood pressure, mainly in adults and suggested that body fat patterning plays a role in the etiology of hypertension.

Body fat distribution is recognized by **Sunyer (1991), Gerber (1990), Egg stein (1989), Krieger et al. (1998),** as an important predictor of metabolic complications of obesity. Body fat distribution is said to be directly related to health risk. Abdominal obesity of the android type (upper body or central type) is

considered more dangerous than gluteal - femoral obesity because abdominal obesity is strongly linked with risk factors of hypertension.

According to **Rodriguez – ojea Menedez, et al.(1993)**, among obese women, greater distribution of fat in the upper part of the body had greater blood pressure than had women with greater body fat in the lower body.

Becgom et al.(1994), in his study on urban population of South India point out the prevalence of central obesity to be significantly higher among male (77.2 Vs 48.9 percent) and female (84 Vs 51.4 percent) hypertensives compared to non hypertensive subjects.

Singh (1995) indicates the overall prevalence of central obesity in the urban population of North India to be 593/1000 adults including 56.2 percent in males and 51.3 percent in females. The prevalence of hypertension was found to be significantly higher among subjects with central obesity than in non-obese subjects (21.5 Vs 3.2 percent).

Sunyer (1991) points out that health risks of obesity increase with its severity and reach significance at a weight more than 20 % above optimal.

According to **witt et al. (1992)**, obese persons had high caloric intakes which were proportional to the degree of obesity and maintained their high caloric intake by consuming mostly foods of high caloric density, with occassional binge eating, largely avoiding low caloric foods.

Increased consumption of sweets and egg were prospectively related to increase in body weight, while increased walking and high intensity activity were related to decreased body weight **(French et al. 1995).**

b) Stress

Hayward (1995) states that phobic anxiety in man is associated with increased risk to hypertension and brings out strong evidence that psychiatric illness

in general is associated with elevated rates of cigarette smoking and also high rates of hypertension and physical inactivity.

Relating socio-economic status to healthy life style, **Hinnen et al.(1993)** bring out that unknown occupational factors while adversely affecting blood pressure in physicians manages and executives indicate the coronary beneficial effects in drivers and brick layers.

c) Smoking

Parish et al. (1995), pointed out that smoking is an independent risk factor of hypertension due to dietary habits of smokers who consumed fewer vegetables and high fibre foods and more of meat and alcohol.

Smoking increases the blood pressure levels. Chain smoking has deleterious effect on blood pressure **(Dewan Rowlands, 1982)** and smoking alone increases the incidence of hypertension two fold **(Challappa., 1996)**. Smoking a cigarette raises the blood pressure by 5 – 10 mm Hg for about 30minutes **(AHA, 1996).**

Compared to North Indians, smoking is reported high among South Indians (44.6 %). The rate of hypertension among South Indian women is the cause of prevalence of passive smoking (45.3%) by **Becgom et al., 1995**.

Smokers had high risk of hypertension than nonsmokers **(Kujala., 1994).**

d)Alcohol Intake

Ozawa (1990) contradicts by stating alcohol as a risk factor in stroke and points out that the incidence of hypertension is higher in those who drank alcohol than in non-drinkers which is endorsed by **Friedman (1990)**.

Altura and Altura (1989) stated that the alcohol induced increase in blood pressure has direct link with stroke.

Rupp et al. (1996) evidented that alcohol initiates central as well as peripheral reactions which in a synergistic manner have a hypertensive action and

Potter et al. (1984), explains that alcohol and blood pressure are positively related **(Narkiewicz et al. 1995)**.

Alcohol consumption was held responsible for 5% to 11% of all cases of hypertension seen in western societies. Alcohol infusion increased mean arterial pressure by roughly 10mm Hg. **(Urs Scherrer, 1995).**

As per **Facchini et al. (1994), Tulokar et al. (1994) and Goto (1990)** consumption of alcohol up to 30 ml daily lowers the risk of hypertension.

According to **American Heart Association (1997)**, people who have three or more drinks per day have a systolic pressure that is 3 - 4 mm Hg higher than non drinkers and a diastolic pressure 1 -2 mm Hg higher, with five or more drinks perday the systolic presssure is typically 5 -6 mmHg higher than non drinkers, and the diastolic 2 - 4 mm Hg higher.

e) Coffee

Drinking coffee is positively associated with lifestyle factors that promote hypertension; **(Schwarz, 1994). Tina (1987)** opines that 99 percent of ingested caffeine increases blood pressure level.

Leviton et al. (1995), Jeoung et al. (1990), opined that coffee drinkers are less likely than others to feel the need for health promoting behaviour. Drinking one or two cups of coffee raises the blood pressure by about 5 mm Hg. Regular coffee drinking may raise blood pressure a little, but not more than 2 mm Hg, but when taken with cigarette the blood pressure may increase more than 10 mm Hg **(American Heart Assoication ., 1996)**.

f) Sodium

All the hormones and ions involved in sodium conservation are inducers of hypertension; these include aldosterone, angiotensin 11, glucocorticoids, catecholamine and vasopression, plus, potassium waste, induced under the

influence of aldosterone excess, participates in the development of hypertension **(Huang, 1997)**.

Tobian et al. (1991) opined that the high sodium chloride diet can cause premature mortality by raising blood pressure in susceptible people.

Lai (1992), stated that high level of sodium in a diet is a serious risk factor of hypertension. **Kodama et al. (1997)**, suggested that a high salt content diet and the renin-angiotensin system are important to improve the survival rate in hypertensives.

g) Magnesium

Some rural populations of India have a higher prevalence of hypertension and dietary intake of magnesium and serum magnesium levels were inversely associated with the risk of hypertension **(Singh et al., 1996)**. Dietary deficiency of magnesium is one of the aetiology of hypertension **(Ma et al., 1995)**.

2. UNCONTROLLABLE RISK FACTORS

a) Urbanisation and age

Urban residence was associated with higher blood pressure levels and with higher Body Mass Index **(Mugamer et al., 1995)**.

Pavan et al(1997), validated that transition from rural to urbanized lifestyle is accompanied by a rise in the hypertension.

Urban populations have higher prevalence of hypertension than rural, high altitude dwellers usually have lower prevalence **(Liu., 1990)**.

Russell et al. (1990), opined that urban living is associated with obesity, higher systolic blood pressure and increased risk factors for cardiovascular disease.

Urbanisation is attributed as a significant risk factor for hypertension. The risk increases with age in both men and women. The prevalence in

women was after 45 years of age, where as in men, the rise was greater than 35 years of age as given by **Levitt et al. (1993).**

b. Familial aggregation

Dash etal. (1994) proved that the role of genetic factor is the causation of increased blood pressure.

Liu (1990), opined that genetic differences start to affect blood pressure from early childhood. Children from higher blood pressure parents are found more sensitive.

C.EFFECT OF HYPOTENSIVE AGENTS ON BLOOD PRESSURE

Carron and Morris(1985) established that dietary calcium supplements decreased blood pressure. However other trials of calcium supplementation cast doubt on the long term effectiveness of this therapy for lowering blood pressure **(Thomson et al., 1987)**. Recent findings relating dietay calcium to blood pressure were reviewed by **Weinsier and Norris (1985)**

Motoyama et al.(1989),and Patkieta I. (1990), showed that magnesium supplementation 300-500 mg per day lower blood pressure. The results were particularly effective in people who are taking a form of medication called depleting diuretics. **(Dyckner et al. 1983)**.

Tobian et al. (1991), suggested that a high potassium diet reduces the rise of blood pressure caused by a high Nacl diet, encourages an Nacl induced rise of blood pressure.

Fewer studies documented an effect of dietary potassium on blood pressure but where an effect was observed, lower blood pressure usually correlated with higher potassium intakes **(Reed, 1984, ; Bulpitt et al., 1986)**.

Garlic has mild blood pressure lowering effect **(Silagy et al.,1994)**. Garlic has positive effect on the heart and includes reduction of platelet stickiness and lowering the blood pressure levels.

Hawthorm has a mild blood pressure lowering effect **(Blersken., 1992)**.

Many studies have shown that blood pressure is lower in individuals who regularly drinks green tea. **Reishi**, a type of mushroom contains several constituents which seems to lower high blood pressure.

Dietary **MAXEPA** (a major source of eicosapentaenoic acid in fish oil) had good effects in lowering blood pressure. MAXEPA diminished the blood pressure elevation and prevented the high salt –induced mortality. Thus, results suggest that **MAXEPA** can attenuate salt-induced hypertension, reducing salt-induced mortality and protect the integrity of kidney NBMPR binding sites in salt-induced hypertension **(Bayorh et al., 1996)**.

Kenny et al. (1994), indicated that fish oil, as a dietary supplement or fish products represents a relatively simple and comparitively inexpensive dietary intervention which may lower blood pressure, especially in combination with a low salt diet, and favourably alter multiple risk factors in the cluster.

Cristofori et al., (1994), presented the beneficial effects of **Lacidipine** which is a second- generation 1,4-dihydropyridine calcium antagonist having long lasting anti hypertensive properties.

Lee and Tobian (1991) stated mild post-deoxycorticosterone acetate **(DOCA)** as an antihypertensive agent.

Captopril is an angiotensin I converting enzyme inhibitor and protects the hypertensives against stroke **(Stier et al., 1991)**.

19-acetylenic-deoxycorticosterone(hypertensinogenic,Mineralocorticoid) & decreased the blood pressure levels. (Azar et al., 1992)

Omega-3 fatty acids in fish oil may lower blood pressure **(Morris et al.,1993)**, (Three grams per day of EPA and DHA combined).

Taurine, an aminoacid, has been used to lower blood pressure at six grams per day **(Abe et al., 1987)**, probably by reducing levels of the hormone epinephrine **(Fujita et al., 1987)**.

Losartan is a drug which blocks the critical actions of the renin-angiotensin system and 50 mg dose of Losartan can provide effective 24-hours blood pressure control **(Michael., 1995).**

D. MANAGEMENT OF HYPERTENSION

1.Education programmes

Roca et al. (1991), suggested that education in hypertension clinics should play a supportive role rather than a primary one in the control of rather than a primary one in the control of high blood pressure.

Lewis (1988) opines that public education should be directed to maximise compliance with recommendations for dietary change. Food industry should also be encouraged to make available products that confirm with the dietary guidelines.

Gregory and clark (1992) consider the individual in the context of ethnicity and culture, which express themselves in the prevalence and magnitude of risk factors while formulating preventive strategies.

2.Diet

Diggin et al. (1990) pointed out that management with hypertension involves paying attention to life style factors, especially alcohol, smoking and obesity. Modification of salt intake in the diet is a simple measure. Drug therapy will need to be long term therapy and ease of treatment is important, which means that drugs given once a day or most to a day should be used. Diuretics and beta-blocker are

inexpensive and well proven but have many side effects. Newer agents may have fewer side effects but are more expensive. The choice will be an individual one.

Hatama et al.(1993), opined that controlled diet, salt intake, physical exercise and isolation from the social stimuli achieved by long term hospitalisation may prevent increased blood pressure.

People consuming a vegetarian diet as pointed out by **Whitten (1995)** may have a **" healthy effect "** compared to ominvore counterparts. Vegetarians are said to have lower blood pressure, less tendency to obesity and more intake of protective nutrients such as mono and PUFA, complex carbohydrates, dietary fibre, protein and antioxidants.

An epidemiological study suggested a protective effect of green vegetables and fruit **(Acheson and Williams(1983), Belin (1994)** are in view of the importance of hypertension, dietary factors influencing this risk factor warrant attention.

According to **Appel et al. (1997)**, a diet rich in fruits, vegetables and low fat milk products and with reduced saturated and total fat can substantially lower blood pressure.

American Heart Association (1996) suggested that drinking decaffeinated coffee may lower blood pressure, but only by a marginal amount. It was found that men who drink a lot of tea are at a reduced risk of hypertension.

Consumption of a varied diet containing fruits, vegetables and whole grain cereals, maintenance of appropriate body weight : consumption of a low-salt diet: use of fresh or minimally processed foods rather than cured, pickles or smoked foods; and consumption of alcohol in moderation **(Cohen (1987), Joossen.**

Hallfrisch et al. (1990) feels that intake of a diet confirming to dietary recommendations can result in substantial decrease in blood pressure. Not only sodium reduction, but increased potassium fibre P:S ratio and

completed **CHO** may contribute to their reduction.

Nara et al. (1994) suggested that, for lowering blood pressure, weight control, alcohol moderation, salt restriction and exercise appear the most effective. Smoking cessation, and diets low in total and saturated fats and rich in fish, fruit and vegetables are also likely to be substantially reduce hypertension.

Mtabaji et al. (1990) pointed out that reduced intake of salt and increased intake of potassium, protein and PUFA will lower the blood pressure levels.

Levey et al. (1996), suggests that in the dietary management of hypertension it may be more important to focus on specific change in a person's diet by decreasing the sodium intake by 1000 mg/ day and increasing the calcium intake by 400 mg / day.

Very low energy diets were found useful in breaking the circle of severe non-responsive hypertension to medication **(Eliahou et al.1993)**.

Variyam et al. (1996) indicate the attitudes about eating high fibre foods and awareness of the linkage between dietary fibre intake and some diseases are important determinants of an individual fibre intake.

Ascherio et al. (1996), proved that there was a tendency for fibre to reduce blood pressure. Serum phospholipid, n-3 PUFA, PUFA, SFA and taurine excretion rate were beneficial to hypertension **(Yamori et al. 1994)**

A low fat/ high fibre diet reduces blood pressure and a combination of the two regimes has the greater potential for reducing cardiovascular risk in hypertensives. According to the **National Research Council of United States,** guidelines for reducing blood pressure a include reductions in the consumption both SFA and unsaturated fatty acids.

Dietary fibre may be useful in the management of hypertension and obesity through its effects on energy density of food and the extent of interference with nutrient bioavailability **(George et al., 1982)**.

Geleijonse et al.(1996), stated that replacing common sodium salt by a low sodium, high potassium, high magnesium mineral salt could offer a valuable non-pharmacological treatment.

Reduction in cooking salt, sodium rich condiments and processed foods and an increase in potassium intake will be required in a programme aimed at controlling hypertension in the community **(Ttan Huiguang, 1996)**.

Costa et al.(1990), suggested that the adoption of salt restriction by populations could help them in reducing blood pressure.

Lai (1992), opined that intervention of salt intake had considerable effect of depression of blood pressure and morbidity rate of hypertension in a population.

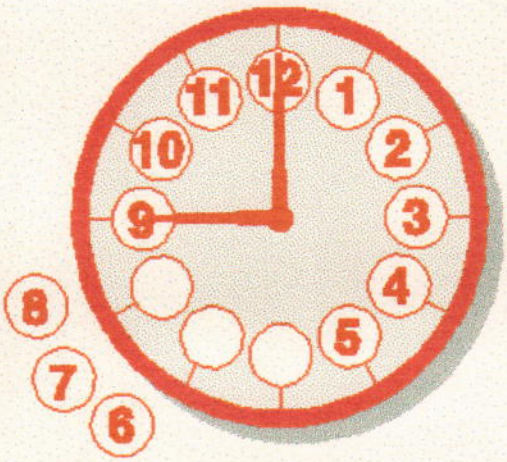
3.EXERCISE

Johnson (1994) opines that lack of physical exercise is more often the cause of overweight than in the over eating and becomes one of the cause of hypertension. **Kukkonen(1982)** stated that daily exercise can lower blood pressure significantly.

Swift et al.(1997) pointed out that BMI was lower in the exercise group than in the non-exercise group. Exercisers were more likely to respond that their fat intake needed to be "slightly decreased " or was "about right" than non-exercisers. **Wirth (1990)** recommends sports building up stamina such as running, swimming and cycling for reducing hypertension. The benefits of exercise stated by **Franz (1987)** are, Exercise improves physical fitness and psychological state assists in coping with stress as well as building self confidence and improving decreasing body fat and

proportionally increasing lean body tissue thus initiating weight control and improved physical work activity.

World health Organisation in its 1994 report gives the following prevention activities for preventing hypertension, as primary prevention covers activities aimed at preventing hypertension from occurring in susceptible individuals through modifications in environmental and behavioral risk factors, secondary prevention covering activities such as screening which aims at early detection of disease and prompt and effective management of the condition and tertiary prevention, which is any measure undertaken to prevent complication and disability due to hypertension



METHODOLOGY

III. METHODOLOGY

The procedure followed for the study entitled " **Effect of Spirulina on blood pressure levels of selected hypertensives in Coimbatore City**", is discussed under the following headings.

A. Selection of the sample.

B. Survey of the background information of the selected samples (hypertensives).

C. Measurement of the body dimensions (height and weight) and calculation of the Body Mass Index.

D. Quantification of days food intake and calculation of nutrients of the selected hypertensives.

E. Recording the initial blood pressure of the selected hypertensives.

F. Supplementation of the diets of the selected hypertensives with spirulina capsules.

G. Study of the impact of spirulina on blood pressure levels.

A. Selection of the sample

The investigator visited the various areas of Coimbatore city. The total number of samples selected were 40. The age group of the samples selected were between 40 – 55, since hypertension **"the silent killer"** occurs generally after 40 years **(Hatama et al., 1993)**. The selected samples were divided in to two groups as control and experimental groups. Twenty were chosen as control (10 men and 10 women) and twenty were chosen to be the experimentals (10 men and 10 women).

Only persons who were not consuming any drugs (antihypertensive drugs) were selected for the study.

B. Survey of the background information of the selected hypertensives

Background information was collected from the hypertensive selected with the help of a well framed questionnaire **(Appendix I)**. The questionnaire included questions on the socio economic status **(Appendix IA)** like age, occupation, education, income, family type and size. Information on dietary pattern **(Appendix IB)** included questions like meal pattern, frequency of food intake, awareness of hypotensive foods, likes and dislikes, frequency of food intake with special reference to sodium rich foods, and amount spent on food per month. Questions on life style pattern **(Appendix IC)** included personal habits, exercising pattern etc. Clinical status **(Appendix ID)** was noted with the help of questions like weight, height, BMI, familial tendency and blood pressure values of the samples. Questions on age of onset, symptoms experienced, salt restriction pattern etc were helpful in eliciting information on diagnosis and salt management **(Appendix IE)**. The investigator, with the help of these questions noted the various aspects.

C. Measurement of body dimensions (height and weight) and calculation of the body mass index.

Anthropometric measurements like height and weight were recorded for all the selected hypertensives. The techniques involved in recording anthropometric measurements are discussed below.

Height of an individual is principally a measure of skeletal bony tissue – leg, pelvis, shoulders and of skull. The subjects were made to stand erect with heels, buttocks, shoulders and the back of head touching the wall. A scale was placed just touching the head of the individual and the wall. The height was marked where the tip of scale rested on the wall. An inch-tape with an accuracy of 0.1 cm

measurement was used to measure the height from floor up to marking on the wall. Height was recorded to the nearest of 0.1cm using an inch tape, the person barefoot with his heels against the wall. **(Jellife, 1989).**

Weight, a key anthropometric measurement was measured using a portable bathroom weighing scale. The scale was checked for accuracy before taking measurements. This was done by noting whether the indicator needle was in zero mark when no weight is placed on the scale. The subjects were made to stand erect with barefoot and without any luggages. The weight was then recorded. The weight was recorded initially, on the 30th day and on the 60th day of the study. The heights and weights were taken for all the subjects.

The Body Mass Indices were calculated from heights and weights of all the subjects using the formula

$$\frac{\textbf{Weight in kg}}{\textbf{Height in m}^2}$$ **(WHO, 1995)**

Based on BMI, the persons were graded normal and obese as per the classification given by **Garrow (1987).**

D. Quantification of days food intake and calculation of nutrients of the selected hypertensives.

Details regarding the food intake of the selected hypertensives was obtained using the twenty four hour recall method. The subjects were asked to indicate the quantity or number of food items consumed in the various meals of the day making use of household cups and vessels. From the days mean food intake, the nutrient intake was computed using the

"Nutritive Value of Indian Foods" of NIN (1995).

E. Recording the initial blood pressure of the selected hypertensives.

Blood Pressure is measured using sphygmomanometer (Procedure in Appendix II). Systolic and diastolic pressures were measured in sitting position. Everytime the pressure is measured, it is done thrice for accuracy. Initially, before supplementation blood pressure values were recorded.

F. Supplementation of the spirulina capsules

Out of the forty samples selected, twenty were chosen as control (10 men and 10 women) and twenty were chosen to be experimentals (10 men and 10 women). The initial blood pressure values were recorded for all the forty samples. All the selected samples were not under the prescription of any antihypertensive drugs. Spirulina capsules **(Recolina)** were supplemented to the diets of the experimental group. About six spirulina capsule (each capsule is 500 mg) was given to the hypertensives in the experimental group for a period of sixty days (who were taking daily three grams of spirulina).

G. Study of the impact of spirulina on blood pressure levels.

The supplementation was carried out for a period of sixty days. Blood pressure was measured and weight was also recorded initially and after every fifteen days so that these were recorded four times during the period of the study. The difference in the values were noted to study the impact of spirulina.

The collected data were statistically analysed and the results and discussion are presented in chapter IV.

RESULTS AND DISCUSSION

IV.RESULTS AND DISCUSSION

The results and discussion of the study on **"Effect of spirulina on blood pressure levels of selected hypertensives in coimbatore city"**, is presented under the following headings.

A. **Background information of the selected Hypertensives.**

B. **Dietary practices of the selected hypertensives.**

C. **Life style pattern of the selected hypertensives.**

D. **Familial tendency .**

E. **Diagnosis of blood pressure and dietary salt management.**

F. **Intake of selected nutrients by selected hypertensives before and during supplementation.**

G. **Impact of supplementation of spirulina on weight reduction of selected hypertensives.**

H. **Impact of supplementaion of spirulina on Body Mass Index of selected hypertensives.**

I. **Impact of supplementation of spirulina on blood pressure Levels of selected hypertensives.**

A. *BACKGROUND INFORMATION OF THE SELECTED HYPERTENSIVES.*

A well framed questionnaire was used to elicit information regarding the age, sex, family, size, education, income, occupational status etc.

1. *Age and sexwise distribution:*

The age group of the selected hypertensives was between 40-55 years. Hypertension is considered as the **"Silent Killer"** which generally occurs after 40 years (**Hatama etal., 1993**) Out of the 40 samples selected, 20 were chosen as control and 20 were chosen as experimental group. In each of the groups, there were 10 men and 10 women. **Kuch et al.(1990)**, found that the prevalence of hypertension was related to age.

2. *Family size:*

Table I shows the distribution of the samples according to the size of the family.

TABLE – I

FAMILY SIZE

Family size	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
> 2	2	2	2	1
3 - 4	1	3	3	2
5 – 6	1	4	3	1
6 – 7	6	1	1	7

From the above table, it is clear that, out of 10 families (of 10 male hypertensives) in the control group, six families had a family size of 6 – 7 members. Also seven out of 10 families (of 10 female hypertensives) in the experimental group had a family size of 6 – 7 members. Hence the majority in both control and experimental groups had a family size of 6 – 7 members.

3. *Educational status:*

Educational status of the selected hypertensives is depicted in Table II.

TABLE – II

LEVEL OF EDUCATION OF SELECTED HYPERTENSIVES

Educational Qualification	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
Illiterates	2	5	3	7
Primary	4	2	5	1
Secondary	2	2	1	2
U.G	-	1	-	-
Diploma	2	-	1	-

From the above table, it can be deciphered that illiteracy was more prevalent in the females (five out of 10 in the control and seven out of 10 in

the experimental group).

Bennett(1995), opined that a steady increase in educational attainment may be reducing the risk of mortality related to hypertension.

4. Occupation status:

Occupational status of the selected hypertensives is given in Table III.

TABLE III

OCCUPATIONAL STATUS AND ACTIVITY PATTERN OF THE SELECTED HYPERTENSIVES

Type of Occupation	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
SEDENTARY				
Housewife	2	5	3	7
Business	1	-	-	-
MODERATE				
Agriculture	4	2	5	1
HEAVY				
Manual	2	2	1	2

It is notable from the table that four out of the 10 males and five out of 10 females in both control and experimental groups did heavy work. None of the males in both control and experimental groups were sedentary except for one who was in business. According to the **"Indian council of Medical Research Classification (1991)**, heavy activity included manual workers like stone cutter, blacksmith, and wood cutter, moderate activity included agricultural labour, weaver and sedentary activity included house wife and businessman.

Sedentary activity is a risk factor of hypertension **Mitter (1991).** The prevalence of central obesity was greater among sedentary and mild activity group than moderate and heavy activity group**(Sing et al.1995)**.

5. *Income level*

Monthly income of the selected hypertensives was classified according to **Housing and Urban Development Corporation 1994, classification (HUDCO)** and presented in table IV.

TABLE – IV

MONTHLY INCOME OF THE SELECTED HYPERTENSIVES

Monthly In Rs.	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
300-600	1	-	-	1
600-900	1	2	2	1
900-1200	2	1	1	1
1200-1500	2	4	4	4
1500-2650	4	3	3	3

According to **HUDCO,** people falling is low income range is from Rs.300 to 2,650. All the subjects belonged to the low-income group. In the control group, four out of 10 males and in the experimental group five out of 10 females had an income range between rs.1,500 – 2,650. Only one male in the control and one female in the experimental had income below Rs.600.

B. DIETARY PRACTICES OF THE SELECTED HYPERTENSIVES

Beilin (1994) opines that certain complex dietary pattern have a blood pressure lowering effect and may protect against the development of hypertension. Current interest in reducing hypertensives risks by diet involves attention to total fat; SFA, MUFA, PUFA and transfatty acids, soluble fibre, salt, antioxidants, flavanoid compounds in some soy products **(Dwyer , 1995).**

1.Vegetarianism

In the control group, six out of 10 males and four out of 10 females were non-vegetarians. In the experimental group five males were vegetarians and five

females were non-vegetarians. **Beilin etal (1988)** reported that vegetarians have lower blood pressure than meat eaters. They have more fibre, less saturated fat, cholesterol, and more complex carbohydrates. According to**Whitten (1995)** people consuming a vegetarian diet have a **"healthy effect "** than omnivore counter parts.

2. **Meal Pattern**

From the data obtained it is clear that seven males in the control and seven males in the experimental had a three meal pattern. In the case of females different type of meal pattern existed. No one pattern dominated.

3.Frequency of food intake

Frequency of food intake was noted for all the hypertensives and is presented in **Appendix III**. Frequency indicated that rice was taken daily by all the subjects and it was irrespective of control or experimental. Two males in the control and one male in the experimental took ragi daily.

Red gram dhal was commonly taken daily by majority of the hypertensives. It was added in sambar, rasam and poriyal. **Nara et al.(1990),** opined that protein intake may beneficially influence blood pressure.

Among the green leafy vegetables, drumstick leaves was more commonly used by the hypertensives. The reason being that it is cheap and also easily available from their own trees. It was consumed in the form of poriyal, koottu, ord in adai. In the control group, four males and five females took drumstick.

Both big and small onions were consumed eveyday by majority of the hypertensives. One male and two females in the control and one female in the experimental consumed potato daily. It was used as chips, sambars, poriyals.

Almost all the vegetables were consumed by the hypertensives. Some of the vegetables like tomatoes, snake gourd, drumstick, ash gourd, brinjal etc, were grown in their own fields or in their houses. Tomatoes were used in rasams, sambars,

and was consumed by almost all the subjects. In the experimental group seven males and seven females took tomatoes daily. Two males in the control and two females in the experimental, took bittergourd daily .

In the control group, two males and three females and in the experimental group, one male and two females used coconut daily.Condiments and spices were used extensively by the hypertensives. Almost all the fruits were preferred by the hypertensives. Four males in the control and two females in the experimental took banana daily. Four males in the control and one male in the experimental took watermelon daily since it was in season.Fleshy foods were consumed more on a weekly basis by the hypertensives.Every body consumed milk daily in the form of curd, buttermilk etc.,Cooking oil was used by all the hypertensives. Sugar was used by all the hypertensives. .

5.Frequency of food in take with special reference to sodium rich foods

The foods rich in sodium (50-100mg) was noted and is given in table V

TABLE - V

FREQUENCY OF FOOD INTAKE WITH SPECIAL REFERENCE TO SODIUM RICH FOODS.

Foods	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
(50 – 100 Mg) Beet root	1	4	-	-	1	-	2	1	-	-	1	2	-	-	1	1
Beef	-	-	-	1	-	-	-	1	-	-	-	1	-	-	-	-
Cauliflower	-	-	-	5	2	-	4	-	-	-	-	2	3	-	4	-
Chicken	-	2	3	4	-	2	3	1	-	3	2	4	-	5	2	1
Liver	-	2	-	-	-	-	2	-	-	1	-	-	-	-	-	-
Prawn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Red gram dhal	6	-	1	3	7	-	-	-	8	-	2	-	6	1	1	2
Spinach	1	-	2	3	1	2	-	1	1	4	-	2	2	-	2	4
(above 100 mg) Amaranth	2	1	-	-	2	3	1	4	4	3	1	3	3	1	2	-
Biscuits	-	-	1	2	-	-	2	1	-	2	3	1	-	2	4	1
Bread	-	-	-	1	-	-	2	3	-	4	-	3	-	-	4	5
Butter	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2
Cake	-	-	-	4	-	-	-	3	-	-	-	-	-	-	-	-
Chips	-	-	2	1	-	-	2	4	-	-	1	2	-	-	-	3
Egg	1	3	2	-	-	-	1	2	-	2	1	1	-	1	-	1
Pasteries	-	-	-	2	-	-	-	2	-	-	3	1	-	-	-	-
Pickles	10	-	-	-	9	-	-	1	8	-	-	2	8	2	-	-

From the above table it was obviously seen that among the foods having sodium content of 50-100 mg, red gram dhal was more commonly used daily and this was due to the fact that it was used either in thick dhal or sambhar or rasam. Among the foods which have above 100 mg of sodium, pickles was taken by the majority of the hypertensives daily. **Lai (1992),** stated that high level of sodium in a diet is a serious risk factor of hypertension.

6. Hypotensive foods

Awareness of hypotensive foods was questioned to the hypertensives and the listed the same which is presented in table-VI.

TABLE-VI
AWARENESS OF HYPOTENSIVE FOODS

Hypotensive foods	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
Ragi	3	3	3	5
Rice flakes	1	1	2	1
Colocasia	2	2	1	1
Yam	2	3	4	-
Potato	1	-	1	1
Tapioca	1	-	-	-
Ladies finger	-	-	1	-
Brinjal	2	1	1	-
Drumstick	4	-	2	3
Plantain green	1	3	1	2
Plantain flower	2	4	1	2
Ridge gourd	1	-	-	1
Garlic	7	8	6	9
Orange	1	-	2	1
Mango	-	-	-	1
Sapota	3	1	1	2
Guava	3	2	4	2

From the above table, it was noted that, majority of the hypertensives viewed garlic as a hypotensive food. Seven out of 10 males in the control and six out of 10 males in the experimental considered garlic as a hypotensive food. Eight female in the control and nine female in the experimental also knew about that fact. **Silagi et al (1994)**, opines that garlic has a positive effect in reducing the blood pressure.

Garlic has been used for medicinal purposes since at least **1550 BC**. Garlic can favourably influence a whole range of hypertensive risk factors (**Mansell and Reckless 1991**).

6. Expenditure on food

Table VII shows the food expenditure pattern of the families of selected hypertensives.

TABLE-VII

FOOD EXPENDITURE PATTERN

Amount spent on food per month (Rs.)	CONTROL		EXPERIMENTAL	
	M N=10	F N=10	M N=10	F N=10
≤300	1	-	1	1
300-500	2	3	2	2
500-800	2	1	2	1
≥800	5	6	5	6

The above table reveals that five out of 10 males and six out of 10 females in both control and experimental groups spent above Rs.800 on food every month. This depends upon the size of the family and the total income of the family. The lower the income, the more money is spent on food. This follows **Engel's law of consumption.**

7.Food eaten outside

In the control, four out of 10 males and six out of 10 females took food from hotels and in the experimental group, five out of 10 males and six out of 10 females had the habit of eating outside the home. The frequency of taking food away from home is given in table.-VIII.

TABLE-VIII
FREQUENCY OF FOOD EATEN OUTSIDE

CONTROL								EXPERIMENTAL							
M				F				M				F			
D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
-	1	2	1	1	2	2	1	-	2	2	1	1	2	3	-

D – DAILY W – WEEKLY F – FORTNIGHTLY O – OCCASSIONALLY

From the above table, it is notable that frequency of eating outside daily is poor. None of the males in both control and experimental group had the habit of eating outside daily. One female in the control group and one female in the experimental group had the habit of eating outside the home daily, because, these two females were alone in their homes and had their food in the work area itself.

C. LIFE STYLE PATTERN OF THE SELECTED HYPERTENSIVES

Leaf (1991) proved that even advanced stages of hypertension can be reversed with suitable life style.The world congress of consensus on cardiology held in Delhi in December 1995 came to the conclusion that "Surgery has limited use and in many case useless" and the disease can be managed by changes in lifestyle (**"The Hindu", 1996**).

The common life style factor of hypertension are stated by **Lore (1994) and Raitakari etal. (1994)**, to be non prudent diet, smoking, obesity and physical inactivity, psychological stress and alcholism.

1.Intake of pan with tobacco

The intake of pan with tobacco was enquired and it was found that among the control more males (six out of ten) chewed pan with tobacco and three out of ten females chewed pan with tobacco. In the experimental group half the males and females chewed pan with tobacco. One male in the control and one male in the experimental chewed pan with tobacco in the earlier stages only (before the diagnosis of hypertension). **Srivastava etal. (1996)** graded the relationship between the prevalence of tobacco consumption and socio-economic status and observed that 25%, 36%, 45%, 62% and 74% of professional, clerical, skilled, semiskilled and unskilled workers respectively consumed tobacco. The findings of this study is in tune with that of **Srivastava's** findings.

2.Consumption of coffee

Coffee consumption pattern of the hypertensives is depicted in table IX

TABLE –IX
CONSUMPTION OF COFFEE *

• Number ofCups	CONTROL		EXPERIMENTAL	
	M N=3	F N=5	M N=6	F N=5
< 4	2	3	4	2
> 4	1	2	2	3

• 1 Cup = 100 ml. * With sugar

It is notable from the above table that in the control three out of 10 males took coffee and out of that one person consumed above four cups and five out of 10 females in the control consumed coffee and in that two females consumed above four cups. In the experimental group, two males and three females

consumed above four cups. Blood pressure levels decreases with decreased coffee consumptions.(< 5 cups) .(**SUPERKO,1991**)

3. Type of coffee consumed

Table X presents type of coffee consumed by the hypertensives

TABLE-X
TYPE OF COFFEE CONSUMED BY THE SELECTED HYPERTENSIVES

Type of Coffee	CONTROL		EXPERIMENTAL	
	M N = 3	F N = 5	M N = 6	F N = 5
Filter	1	1	2	1
Instant	2	3	3	2
Both	-	1	1	2

From the above table, it is clear that instant coffee was preferred more by the subjects in the control and experimental group.**Palmeretal. and Thorp (1995)** suggest the intake of percolated coffee instead of brewed coffee.

3. Intake of other beverages

Table XI shows the daily intake of beverages other than coffee.

TABLE -XI
DAILY INTAKE OF BEVERAGES

Beverages	CONTROL		EXPERIMENTAL	
	M N = 7	F N = 5	M N = 4	F N = 5
Tea	4	2	3	2
Milk	1	2	1	3
Nil	2	1	-	-

The above table indicates that some hot beverage or other was taken daily by the subjects. Only two out of the ten males and one female in the control group did not consume any hot beverage.

5. Smoking Pattern

Among the male hypertensives, six men in the control and five men in the experimental smoked. None of the females smoked, **Rickenbach etal. (1993)** states that smoking is a prevailing risk factor for hypertension.

The number of cigarettes smoked by the smokers are given in table XII.

TABLE-XII
NUMBER OF CIGARETTES SMOKED BY THE SELECTED HYPERTENSIVES

Number of Cigarettes per day	CONTROL	EXPERIMENTAL
	M N = 6	M N = 5
< 5	-	1
6 - 10	3	1
11 - 20	2	3
> 20	1	-

It can be observed from the above table that in the control group, out of the six who smoked, three smoked above six cigarettes, and in the experimental group, out of the five who smoked, three smoked above 10 cigarettes, **Durairaj (1997)** ,**Victor(1996)** validated that smoking contributes to be a major risk factor of hypertension .

6. Alcohol Consumption

It was noticed that four out of 10 males in the control and three males in the experimental took alcoholic beverage. None of females consumed alcohol. Amount of alcohol consumed by the subjects is given in table XIII .

TABLE-XIII
ALCOHOL CONSUMPTION PATTERN IN MALE HYPERTENSIVES

Amount of alcohol consumed per day in ml.	CONTROL N = 4	EXPERIMENTAL N = 3
< 30	1	-
30 - 60	2	1
60 - 120	1	1
> 120	-	1

It is evident from the above table that none of the control took above 120 ml and only on male in the experimental took above 120 ml.

Alcohol stimulates the development of high blood pressure in previously normotensive adults and seems to play an important part in the early stages of hypertension **(Puddey et al., 1985).** Also alcohol intake up to 20g daily does not increase the risk of hypertension ,but beyond this level ,the risk increases progressively **(Witlemanetal .,1993).**

7. Type of Exercise

The type of exercise performed by the hypertensives is shown in table-XIV

TABLE-XIV
TYPE OF EXERCISE PERFORMED BY THE SELECTED HYPERTENSIVES

Type of exercise	CONTROL		EXPERIMENTAL	
	M N = 10	F N = 10	M N = 10	F N = 10
Walking	2	1	1	1
Jogging	1	-	-	-
Yoga	2	-	2	-
N - P	5	9	7	9

N – P – Non – Performers.

It is clear from the above table that in the control group five outof 10 males did no exercise and only one female did exercise walking). In the experimental group, three out of 10 moles did exercise, and nine out of 10 females did no exercise. Thus majority of the hypertensives (control and experimental) did not perform any exercise.

SWIFT etal.(1997), pointed out that BMI was lower in the exercise group than in the non - exercise group. Exercises was more likely to respond that their fat intake needed to be slightly decreased or was about right than non exercises.

D.FAMILIAL TENDENCY

Familial tendency of the selected hypertensives is presented in Table XV

TABLE –XV
FAMILIAL TENDENCY

Familial Tendency	CONTROL		EXPERIMENTAL	
	M N = 8	F N = 6	M N = 6	F N = 7
Father	2	1	1	2
Mother	2	-	-	2
Grandfather (P)	3	-	3	2
Grandmother (P)	-	2	2	-
Grandfather (M)	-	3	-	1
Grandmother (M)	1	-	-	-

P – Paternal **M – Maternal**

It is authenticated from the above table that only eight males and six females in the control and six males and seven females in the experimental had familial aggregation of hypertension. A positive family history is said to be an independent risk factor with blood pressure. **(Vardan, 1995).**

E.DIAGNOSIS OF BLOOD PRESSURE & DIETARY SALT MANAGEMENT

The hypertensives were interviewed about their age of onset of hypertension, symptoms experienced and about their dietary salt pattern.

1. Age of Onset

The pattern of age of onset of hypertension is presented in Table XVI

TABLE –XVI
AGE OF ONSET OF HYPERTENSION

Age	CONTROL		EXPERIMENTAL	
	M N = 10	F N = 10	M N = 10	F N = 10
< 30	2	2	1	2
30 - 35	4	2	4	3
35 – 40	3	5	3	2
> 40	1	1	2	3

From the above table it is noted that the age of onset of hypertension was between 30-35 years for four males each in the control and experimental group. Five females in the control had age of onset between 35 – 40 years.

2. Symptoms Experienced

The symptoms experienced by the hypertensives are presented in Table XVII

TABLE-XVII

SYMPTOMS EXPERIENCED BY THE SELECTED HYPERTENSIVES

Symptoms	CONTROL		EXPERIMENTAL	
	M N = 10	F N = 10	M N = 10	F N = 10
Headache	2	4	2	1
Tiredness/Fatigue	5	6	3	4
Dizziness	1	-	1	1
G.I. distrubance	-	-	-	1
Impaired vision	1	-	-	-

Shortness of breath	1	2	-	1
Pain over heart	1	-	-	-

From the above table it can be inferred that five males and six females in the control experienced tiredness and this led them to visit the physician. Also three males in the control ands four females in the experimental experienced tiredness and felt like taking rest after performing any activity.

3. Dietary Salt Management

The hypertensives were interviewed about their salt consumption pattern like, type of salt used, salt added in cooking, salt added at the table, and their habit of adding salt in curd rice.

Four males and two females in the control and three males and four females in the experimental group added salt curd and rice. The remaining managed with the salt added in cooking.

The type of salt used by the selected hypertensives is given in the tableXVIII

TABLE-XVIII
TYPE OF SALT USED

Type of salt used	CONTROL		EXPERIMENTAL	
	M N = 10	F N = 10	M N = 10	F N = 10
Iodised	1	--	--	1
Non – iodised	3	2	2	2
Unrefinded crystal salt	6	8	8	7

It can be deciphered from the table that majority, that is six males and eight females in the control group and eight males and seven females in the experimental group used unrefined crystal salt in cooking.

F. INTAKE OF SELECTED NUTRIENTS BY SELECTED HYPERTENSIVES BEFORE AND DURING SUPPLEMENTATION

1. Intake of selected nutrients by selected male hypertensives

Table XIX depicts the mean nutrient intake of the male hypertensives before and during supplementation. Individual values are given in **Appendix IV**.

Spirulina capsules were supplemented to the selected hypertensives. Six capsules (each 500 mg) were given, thus three grams of spirulina was taken by the hypertensives daily. Three grams of spirulina provided 71% protein, 46.2 mg of potassium, 5.75 mg of magnesium, 3.95mg of calcium, 0.9% fibre, 6900 IU vitamin-A, 4.2mg Beta-carotene, 360 IU vitamin-D, 60 μg of Vitamin-K.

The nutrient intake of the hypertensives were taken before and during supplementation. Though no restriction was imposed, addition of spirulina added to the fibre, potassium, and protein content.

TABLE –XIX
MEAN NUTRIENT INTAKE OF THE HYPERTENSIVE MALES BEFORE AND DURING SUPPLEMENTATION WITH SPIRULINA CAPSULES

Nutrients	Mean ± SD		T – Value
	B	D	
Energy (K.cal)	2361.6 ± 412.039	2258 ± 442.484	3.14**
Carbohydrate (g)	389.384 ± 77.622	361.812 ± 77.994	4.88**
Protein (g)	46.633 ± 12.818	54.056 ± 11.247	-5.38**
Fat (g)	34.283 ± 5.921	31.317 ± 5.130	1.91 N.S
Fibre (g)	6.468 ± 1.451	8.795 ± 2.859	-4.01**
Sodium (mg)	480.14 ± 64.289	440.535 ± 57.013	7.67**
Potassium (mg)	967.09 ± 82.112	1030.391 ± 112.2	-4.14**

B – Before supplementation D – During supplementation
S.D. – Standard deviation N.S. – Not significant
*** * - Significant at one percent level**

It was noted from the above table that there was a significant difference at one % level in the intake of all the nutrients like energy, CHO, sodium, potassium, and fibre, except for fat where the difference was not significant perhaps it is due to the contribution of spirulina.

2.Intake of selected nutrients by selected female hypertensives

Table XX depicts the mean nutrient intake of the female hypertensives before and during supplementation. Individual values are given in **Appendix –V.**

TABLE - XX

MEAN NUTRIENT INTAKE OF THE HYPERTENSIVE FEMALES BEFORE AND DURING SUPPLEMENTATION WITH SPIRULINA CAPSULES.

NUTRIENTS	MEAN ± STANDARD DEVIATION		T. VALUE
	B	D	
.Energy(k.cal)	2609 ± 397.57	2477 ± 424.76	1.84
Carbohydrate(g)	37.721 ± 42.01	361.786 ± 46.67	1.20
Protein (g)	49.227 ± 7.49	52.207 ± 8.28	-2.77
Fat (g)	34.184 ± 5.95	32.97 ± 5.57	0.85
Fibre(g)	7.185 ± 1.680	7.296 ± 2.11	-2.43
Sodium (mg)	461.66 ±57.54	422.27 ±49.661	6.29
Potassium (mg)	951.285 ± 82.12	1046.38 ± 88.549	-6.42

B – Before supplementation **D – During supplementation**

**** -significant at one percent level** *** - significant at five percent level**

N.S – Not significant

It is clear from the above table that there was an increase in the intake of nutrients like potassium, fibre. The difference were not significant for energy, carbohydrate and fat. Protein and fibre had a significant difference at five percent level. Sodium & potassium were significant at one % level. This may be due to the less intake of food compared to males.

G. IMPACT OF SUPPLEMENTATION OF SPIRULINA ON WEIGHT REDUCTION OF SELECTED HYPERTENSIVES

Table XX1 shows the impact of supplementation of spirulina on weight of the selected hypertensives after 60 days.

Individual values are given in **Appendix –VI** - Fig - 1

The table on weight reduction showed that there was significant reduction in weight of the males and females in the experimental group. There was a significant difference at one percent level-males (1% level -t = 9.64), Females (1% level -t = 11.64).The difference was not significant in the control (who were not supplemented with spirulina capsules). Also there was a significant difference at one % level when

experimental and control group were compared. **Becker (1986)** stated that faster weight reduction might be possible with spirulina diet, with virually no side effects.

Eck et al (1996) concluded that reducing excess body weight and decreasing weight gain appear to be the most important factors in preventing the accumulation of upper body fat.

A 1987 review of several large studies concluded that on average a loss of 20 pounds (9.2 Kgs) decreased systolic pressure by 6.3 mm Hg. and diastolic by 3.1 mm Hg. **(Huang, 1998)**

TABLE –XX1

MEAN WEIGHT OF THE SELECTED HYPERTENSIVES (Experimental and control)

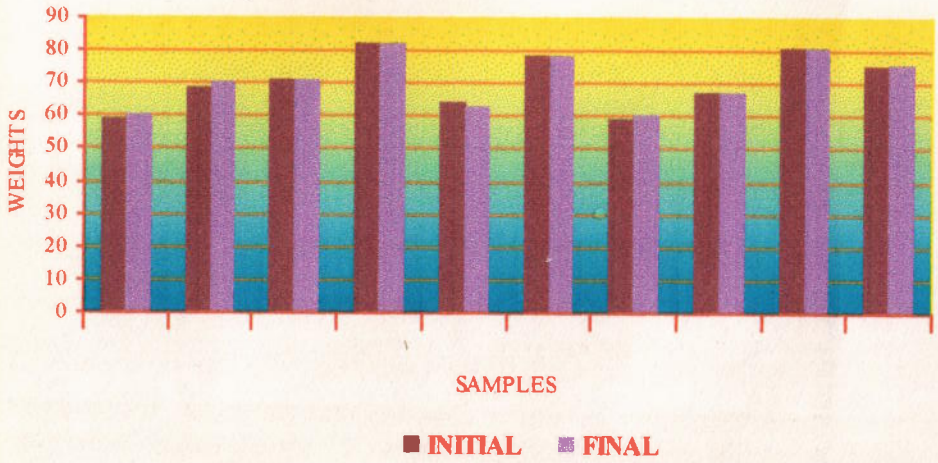
SEX	EXPERIMENTAL			CONTROL			EXPERIMENTAL VS CONTROL		
	MEAN WEIGHT			MEAN WEIGHT			MEAN WEIGHT		
	(B)	(D)	t- value	Inital	Final	t- Value	Experimental	Control	t- value
Male	66 ±8.64	64.6 ±8.64	9.64**	70.4 ± 8.46	70.9 ± 8.33	-1.63 **N.S.**	-1.4 ± .459	.5 ± .972	-5.59**
Female	66.5 ±5.56	64.6 ± 5.82	11.64**	65.4 ± 10.002	65.9 ± 10.37	- 1.25 **N.S.**	-1.9 ± .516	.5 ± 1.269	-5.54 **

B- Before supplementation **D- During supplementation** **N.S – Not significant * * - One percent signifinace**

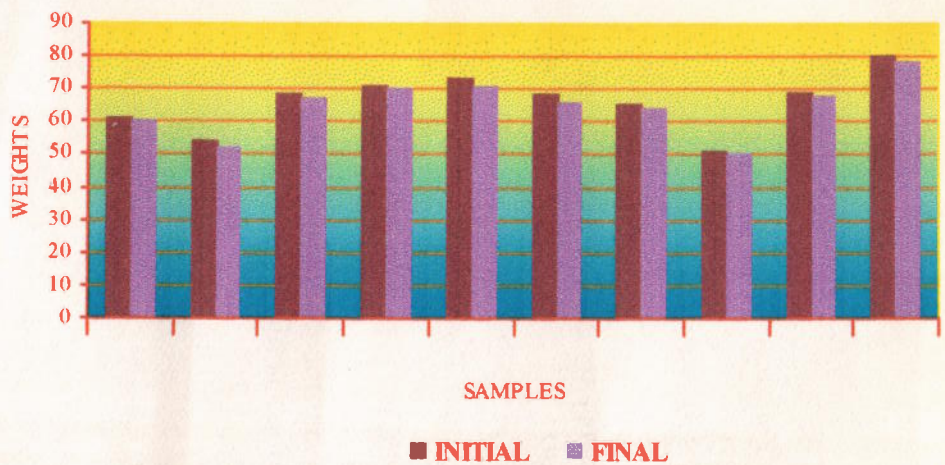
WEIGHT OF THE MALE HYPERTENSIVES

FIG - 1

CONTROL - MALES

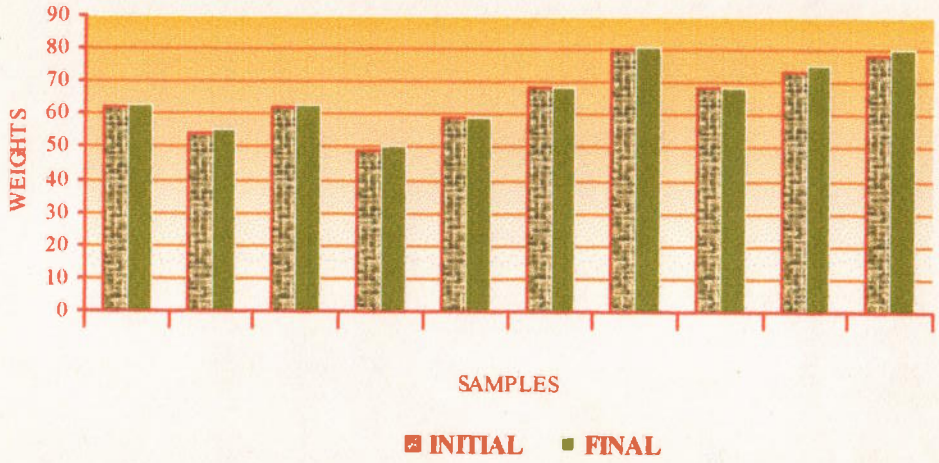


EXPERIMENTAL - MALES

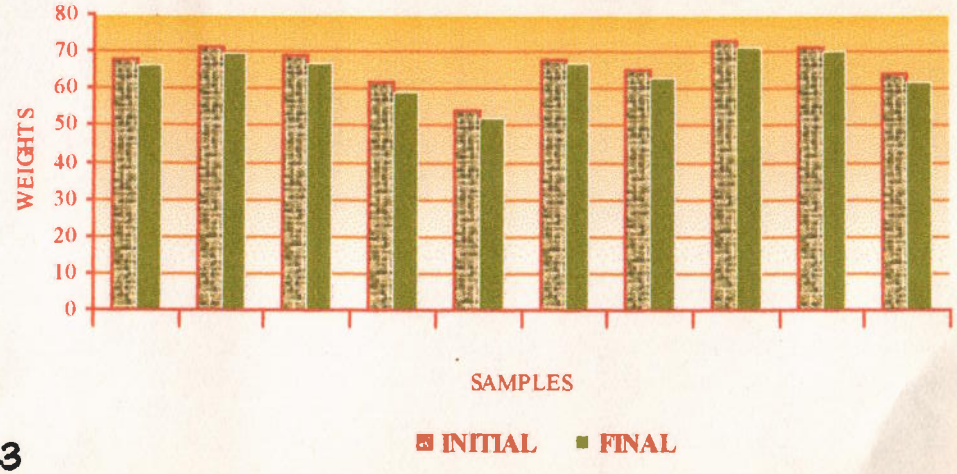


WEIGHTS OF THE FEMALE HYPERTENSIVES

CONTROL -FEMALES



EXPERIMENTAL - FEMALES



H. IMPACT OF SUPPLEMENTATION OF SPIRULINA ON BODY MASS INDEX OF THE SELECTED HYPERTENSIVES

Mean Body Mass Index of the selected hypertensives is given in Table XXII Individual values in **Appendix-VII**

TABLE XXII
BODY MASS INDEX OF THE HYPERTENSIVES (MALES AND FEMALES) BEFORE AND DURING SUPPLEMENTATION.

SEX	MEAN ± S.D		T – value
	B	D	
Male	24.389 ± 3.814	23.88 ± 3.83	11.33 **
Female	24.76 ± 4.3	24.05 ± 4.26	9.86 **

B – Before supplementation D – During supplementation
**** - One percent significance S.D – Standard deviation**

It is noticed from the above table that there was a significant reduction in BMI in both males (1% level –t = 11.33) and Females (1% level –t = 9.86). BMI has not reduced in the control since there was no weight reduction. **He et al. (1994)**, and **Pozzan et al. (1997)** stated that body mass is positively and independently associated with blood pressure, also **Spiegelman et al. (1991)** opined that BMI was a good predictor of blood pressure.

I.IMPACT OF SUPPLEMENTATION OF SPIRULINA ON BLOOD PRESSURE LEVELS OF THE SELECTED HYPERTENSIVES.

1.Systolic pressure

Mean systolic pressure of the selected hypertensives were noted and is presented in tableXXIII . Individual values are presented in **Appendix - .VIII** -Fig-2

The table depicted that spirulina has reduced the systolic pressure in the experimental. The difference was significant at one percent level - males (1% level –t = 9.49), Females (1% level –t = 7.80). There was no significant difference in the control group. Also there was a significant difference at one percent level when

the experimental and control groups were compared. Males (1% -t = -7.24). Females (1% -t = -6.60).

2. Diastolic pressure

Mean diastolic pressure of the selected hypertensives are presented in table - XXIV. Individual values are given in **Appendix – IX** - Fig - 3

The table showed that spirulina has reduced the diastolic pressure in the experimental at one percent level. Males (1% -t = 4.58), Females (1% -t = 6.33). The difference was not significant for the control group.Also there was a significant difference at one percent level when experimental andol groups were compared. Males (1% -t = 4.16), Females (1% -t = 6.02).

Weinsier et al. (1993) opines that weight loss has a blood pressure lowering effect that is related to changes in blood volume and cardiac output.

Spirulina is highly beneficial to hypertension. Usually diuretics are used to remove the extra water in blood so as to reduce the cardiac output and reduce the blood pressure. But diuretics do have side effects. Tests have shown that hypertension is intimately related to choline (one kind of B vitamin). Spirulina contain 3.23 % of serine and 1.95% of methionine totalling 5.18%. The content is very high provided there is adequate vitamin B6 in the system. To have vitaminB6 is not enough vitamin B6 is to be converted in to acti ve form of B6 P04 with the help of Mg 10g of spirulina contains 40 mg of magnesium. Spirulina contains a very high quantity of chlorophyll (mg). Some patients lack potassium (k) and eat much salt thus aggrevating hypertension. Spirulina contains 350% more potassium than rice. Potassium activates , many enzymes that are essential for muscle contraction. Potassium also maintains nerve functions, help in the maintenance of normal blood pressure, is necessary in the transfer of nutrients in and out of individual cells and helps to relax muscles.

Thus, spirulina, " **THE WORLD'S HEALTHIEST SUPERFOOD**", was **"remarkably active"**in reducing both the blood pressure levels and the weights of the selected hypertensives.

TABLE – XXIII

MEAN SYSTOLIC PRESSURE OF THE SELECTED HYPERTENSIVES

SEX	EXPERIMENTAL			CONTROL			EXPERIMENTAL VS CONTROL		
	MEAN WEIGHT		t- value	MEAN WEIGHT		t- Value	MEAN WEIGHT		t- value
	(B)	(D)		Initial	Final		Experimental	Control	
Male	169.5± 3.21	159.5 ± 11.89	9.49**	172 ± 13.16	178 ±17.03	-3.09**	-10±3.33	6±6.14	-7.24**
Female	160.5 ±13.28	146.5 ±13.95	7.80**	162 ± 11.59	170 ±15.45	-2.85*	-14 ± 5.67	8 ±8.88	-6.60**

B – Before supplementation
* - Five percent significance
D – During supplementation
N.S – Not significant
* * - One percent significance
S.D. – Standard deviation

TABLE –XXIV

MEAN DIASTOLIC PRESSURE OF THE SELECTED HYPERTENSIVES

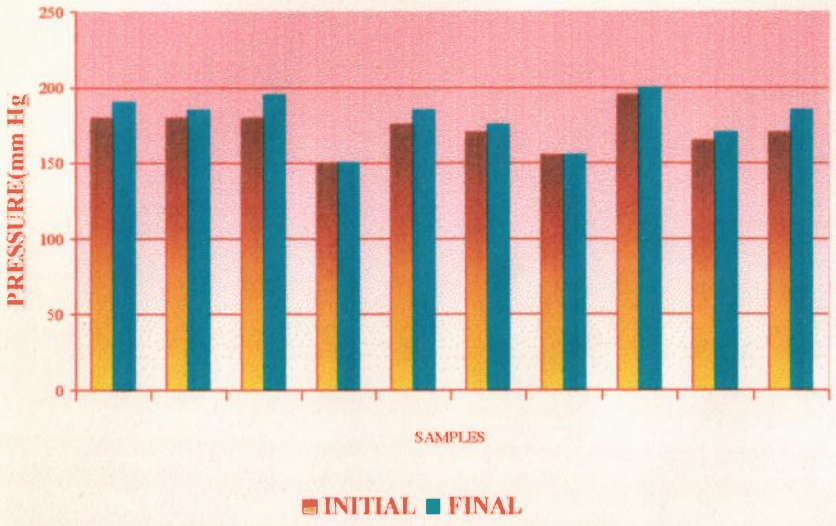
SEX	EXPERIMENTAL			CONTROL			EXPERIMENTAL VS CONTROL		
	MEAN WEIGHT		t- value	MEAN WEIGHT		t- Value	MEAN WEIGHT		t- value
	(B)	(D)		Initial	Final		Experimental	Control	
Male	94 ± 5.16	90.5±4.97	4.58**	93 ± 6.32	96.5 ±4.74	-2.33*	-3.5 ±2.4	3.5 ±4.74	-4.16**
Female	93.5 ± 5.79	86.5±5.29	6.33**	92.5 ±5.4	96.5 ±6.25	-2.75*	-7±3.49	4±4.59	-6.02**

B – Before supplementation
* - Five percent significance
D – During supplementation
N.S – Not significant
* * - One percent Significance
S.D – Standard Deviation

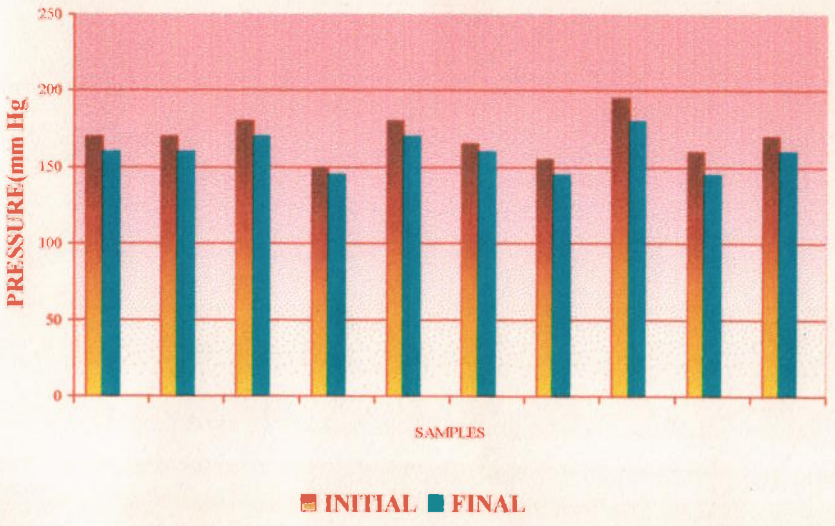
SYSTOLIC PRESSURES OF THE MALE HYPERTENSIVES IN SITTING POSITION

FIG -2

CONTROL - MALES

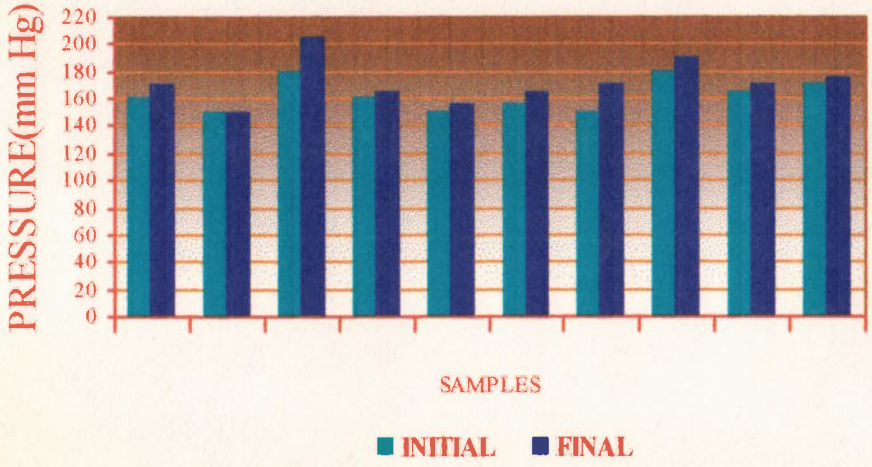


EXPERIMENTAL - MALES

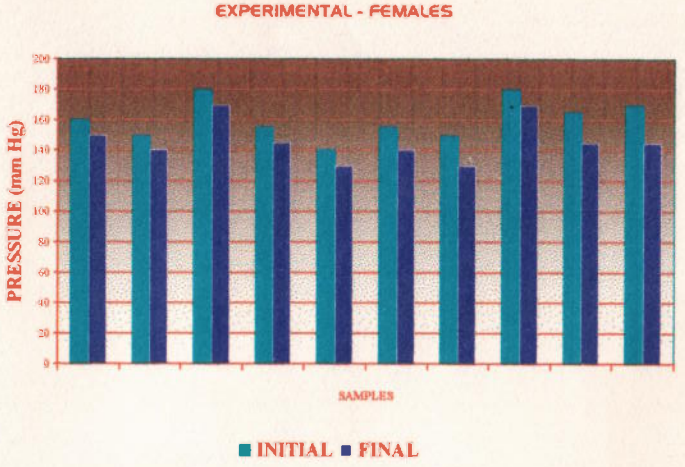


YSTOLIC PRESSURES OF THE FEMALE HYPERTENSIVES IN THE SITTING POSITION

CONTROL - FEMALES



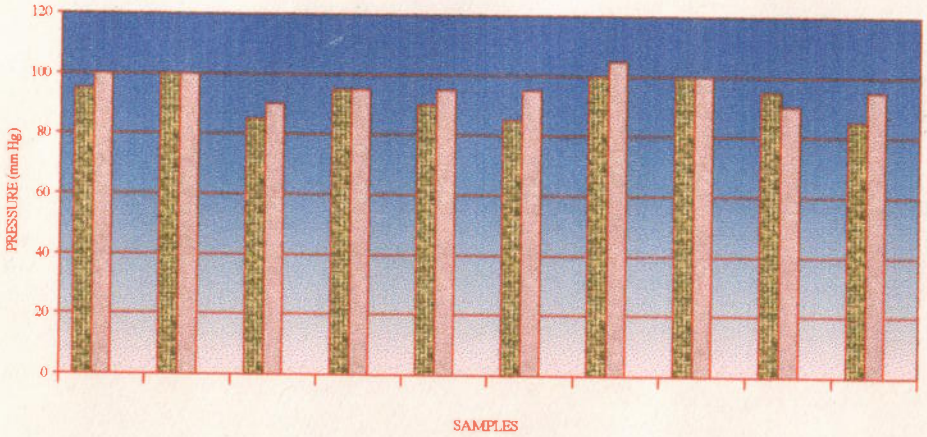
EXPERIMENTAL - FEMALES



DIASTOLIC PRESSURES OF THE MALE SUBJECTS IN SITTING POSITION

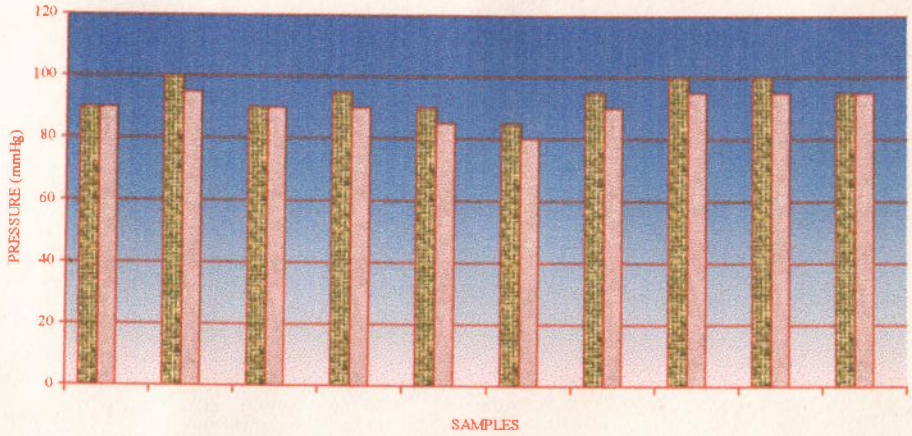
FIG - 3

CONTROL - MALES



INITIAL FINAL

EXPERIMENTAL - MALES



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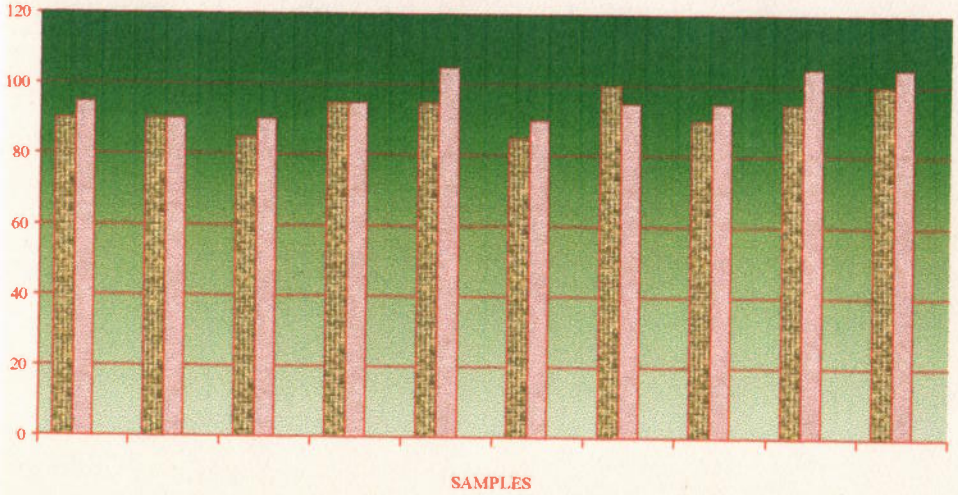
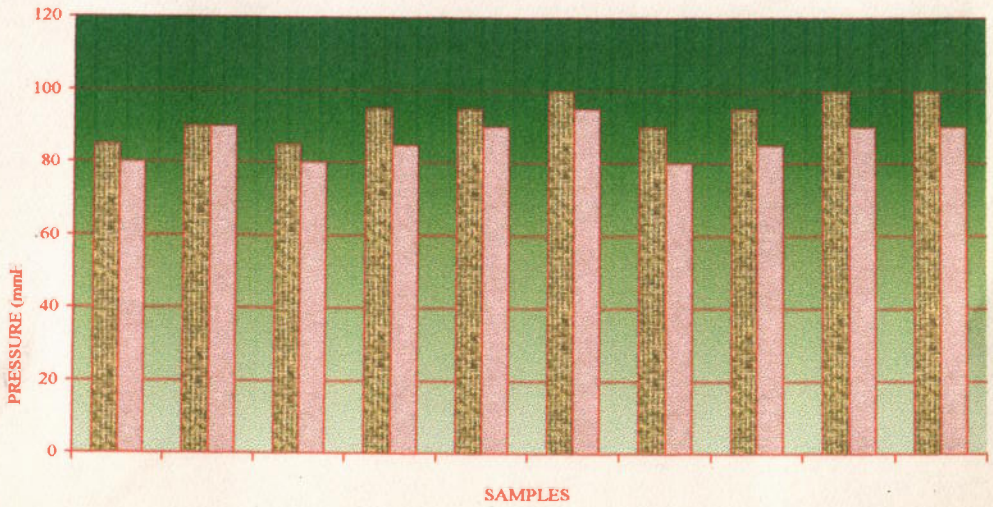
DIASTOLIC PRESSURES OF THE FEMALE SUBJECTS IN SITTING POSITION

CONTROL -FEMALES



INITIAL FINAL

EXPERIMENTAL - FEMALES



INITIAL FINAL

SUMMARY AND CONCLUSION

V. SUMMARY AND CONCLUSION

The present study entitled **" Effect of spirulina on blood pressure levels of selected hypertensives Coimbatore city"** was undertaken to find out the effect of spirulina on blood pressure. Hypertension is recognised as a serious health problem world wide. Spirulina is a multicellular, blue-green, filamentous cyanobacterium, belonging to an algae of class cyanophyta which has been established as a highly nutritious food. The recent applications of spirulina in the food and pharmaceutical field have been exciting. The main objective of this study was to study the impact of supplementation of spirulina on the blood pressure level of the selected hypertensives.

A total number of 40 samples were selected. The selected samples were divided into two groups as control and experimental groups. Twenty were chosen as control (10 men and 10 women) and twenty were chosen to be the experimentals (10 men and 10 women). Only persons who were not consuming any drugs (antihypertensive drugs) were selected for the study.

Spirulina capsules **(Recolina)** was supplemented to the diets of the hypertensives. Daily 3 grams of spirulina (6 capsules of 500 mg each) was supplemented for a period of 60 days.

Background information of selected hypertensives

1. Out of 40 subjects selected, twenty (10 men and 10 women) were chosen as control and twenty (10 men and 10 women) were chosen to be experimental .
2. The incidence of hypertension was greater in the age group of 40-55 years.
3. The majority in both control and experimental groups had a family size of 6-7 members (seven families in the control and eight families in the experimental).
4. Illiteracy was prevalent among the selected hypertensives.

5. Incidence of hypertension was found in people who did sedentary activity.

6. All the selected hypertensives belonged to the low income group.

Dietary practices of the selected hypertensives

7. It was found that only half of the selected hypertensives were vegetarians (four males and six females in the control and five males and five female in the experimental).

8. No one meal pattern dominated among the selected hypertensives.

9. The frequency of food intake by the selected hypertensives revealed that they consumed foods from all the food groups. Rice was the main cereal taken every day. Red gram dhal was commonly taken by all. Red gram dhal was used daily by the hypertensives either as thick dhal or as sambar or rasam. Onions and tomatoes was used in everyday cooking. Two males in the control and one female in the experimental took ragi daily.

10. Fleshy foods were consumed more on a weekly basis by the hypertensives.

11. Everybody consumed milk, in the form of hot beverage, curd or butter milk.

12. The hypertensives (seven males and eight females in the control and six males and nine females in the experimental) were much aware that garlic is a hypotensive food.

13. Majority of them consumed pickles in spite of being hypertensive.

14. Amount spent on food was more than on any other aspect

Life style pattern of the selected hypertensives

15. Majority (Six males and three females in the control and half the males and females in the experimental) had the habit of chewing pan with tobacco.

16.Coffee was preferred more by the hypertensives, and they liked instant coffee than filter coffee (three males and five females in the control and six males and five females in the experimental) .

17. It was noted that consumption of alcohol (four and three males in control and experimental) respectively and smoking (six and five males in control and experimental respectively) prevailed among the male hypertensives.

18. It was found that majority(5 males and 9 females in the control and 7 males and 9 females in the experimental)of the hypertensives did not perform any exercise .

Familial Tendency

19. Majority of the selected hypertensives had a positive familial tendency of hypertension (eight males and six females in the control and six males and seven females in the experimental).

20. The age of onset of hypertension was between 30-40 years.

21. Many (five males and six females in the control and three males and four female in the experimental)of the selected hypertensives often experienced tiredness and this led them to the physician and hence diagnosis of the disease.

22. Salt was asked to be restricted at the table, but yet they added salt to curd rice.

23. Majority of the hypertensives used unrefined crystal salt in cooking (six males and eight females in the control & eight males and seven females in the experimental).

24. Statistical analysis of the selected nutrients revealed that there was a significant difference at one percent level. (Before and during supplementation

Impact of supplementation of spirulina on weight reduction

25. Analysis of the mean weight of the selected hypertensives revealed that there was a significant difference at one percent level before and during supplementation. Also when the experimental and control were compared, there was one percent significant difference on weight reduction.

Impact of supplementation of spirulina on BMI of the selected hypertensives

26. Body Mass Index was also significant at 1% level in the experimentalgroup. There was no weight reduction noticed in the control group.

Impact of supplementation on blood pressure levels of the selected hypertensives

27. Impact of supplementation of spirulina after 60days revealed that the blood pressure levels, both systolic and diastolic has decreased . The difference was significant at one percent level. There was no reduction in the blood pressure levels of the control group. Also when the experimental and control were com pared , there was a significant difference in both systolic and diastolic at one percent level.

SUGGESTIONS FOR FUTURE STUDIES

1. **Effect of Spirulina on AIDS**
2. **Biovialability of spirulina carotenes in preschool children.**

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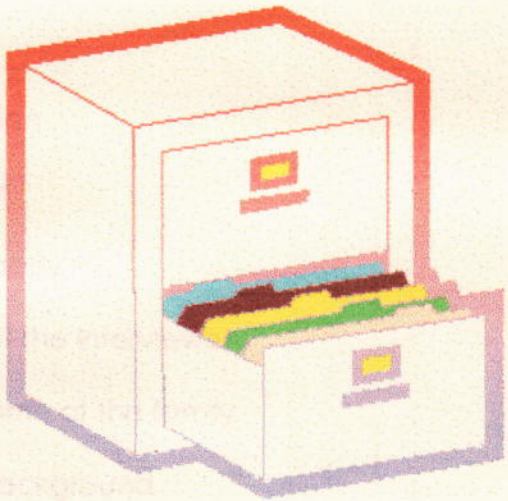

APPENDICES

APPENDICES

QUESTIONNAIRE TO FIND OUT THE INCIDENCE OF HYPERTENSION

APPENDIX IA

SOCIO ECONOMIC STATUS

1. Name of the Interviewer :
2. Address :
3. Age :
4. Sex :
5. Occupation :
6. Education :
7. Type of family : Joint Nuclear
8. Income of the Interviewer :
9. Total Income of the family :
10. Family Background :

Name	Relation to the Head of the Family	Sex	Age	Education	Income	Occupation

APPENDIX-IB
DIETARY PRACTICES

1. Are you a
   - Vegetarian
   - Non-vegetarian
   - Ova vegetarian

2. Is your meal pattern
   - 2 Meals/day
   - 3 Meals/day
   - 4 Meals/day

3. Frequency of food intake

FREQUENCY

Food	Daily	Weekly	Fortnightly	Occasionally
CEREAL				
Barley				
Maize				
Ragi				
Rice (Parboiled)				
Rice (Raw)				
Rice flakes				
Wheat				
Wheat flour				
Maida				
Wheat semolina				
PULSES				
Soyabean				
Redgram dhal				
Bengal gram whole				
Bengal gram dhal				
Bengal gram roasted				
Black gram whole				
Green gram whole				
Green gram dhal				
Horse gram				
Green peas				
Roasted peas				
LEAFY VEGETABLES				
Agathi				
Cabbage				
Drumstick leaves				
Fenugreek leaves				
Manathakkali leaves				
Mint leaves				
Ponnanganni Leaves				
Spinach.				
ROOTS AND TUBERS				
Beetroot				
Carrot				

Colocasia
onion(big,small)
Potato
Radish(Pink,white)
Sweet Potato
Tapioca
Turnip

OTHER VEGETABLES

Ash gourd
Beans
Bitter gourd
Bottle gourd
Brinjal
Cauliflower
Chow-chowS
Cluster beans
Drumstick
Ladies finger
Plantain flower
Plantain stem
Plantain green
Ridge gourd
Snake gourd
Sundakai(dry)
Tomato

NUTS AND OILSEEDS

Coconut (fresh, dry)
Ground nut

CONDIMENTS AND SPICES

Asafoetida
Chillies (dry,green)
Coriander seeds
Garlic
Fenugreek seeds
Ginger
Tamarind pulp
Turmeric.

FRUITS

Apple
Banana
Grapes
Guava
Lemon
Lime
Mango
Watermelon
Orange
Papaya
Pineapple
Sapota
Seethaphal

MEAT AND POULTRY

Fish
Egg
Mutton
Chicken

MILK AND MILK PRODUCTS

Milk
Buttermilk

FATS AND EDIBLE OIL

Butter
Ghee
Vanaspathi
Cooking oil

SUGARS

Sugar cane
Honey
Jaggery

5. Are you aware of **Hypotensive foods**

Yes No

If yes, List the foods.

6. Do you have the habit of eating outside the home.

Yes No

If yes, mention the frequency

Daily	Weekly	Fortnightly	Occasionally

7. What is the amount spent on food per month.

8. Frequency of food intake with special reference to sodium rich foods.

Sodium rich Foods	**Daily**	**Weekly**	**Fortnightly**	**Occasionally**
(50-100mg)				
Beetroot				
Beef				
Cauliflower				
Chicken				
Redgramdhal				
Spinach				
Amaranth				
Biscuits				
Bread				
Butter				
Cake				
Chips				
Egg				
Pasteries				
Pickles				

12. Dietary Pattern

Meal Pattern

Meal of the day	Item	Quantity
Breakfast Lunch Tea Dinner Bedtime		

APPENDIX-IC

LIFE STYLE PATTERN

1. Do you chew pan? Yes No

2. Do you drink coffee? Yes No 2- 4 cups 4 cups

3. What type of coffee do you prefer? Filter Instant Both

4. Do you drink tea? Yes No

5. Do you have the habit of smoking? Yes No

   If yes, state frequency, number/day

   5 Cigarettes/beedies 6-10 Cigarettes/beedies

   11-20 Cigarettes/beedies 20 Cigarettes/beedies

6. Are you an alcoholic? Yes No

   If yes, state frequency, quantity/day

   30ml per day 60-120ml per day

   30-60 ml per day 120 ml per day

7. Do you have the habit of exercising? Yes No

   If yes, indicate the type of exercise performed, duration and frequency.

Type	Duration	Frequency
Walking Jogging Yoga Others (specify)		

APPENDIX-ID

CLINICAL STATUS

1. Weight (Kgs) :

2. Height (cms) :

3. Body Mass Index :

4. Familial Tendency :

Familial Tendency	Hypertension
Father Mother **Sibling – Brother** Sister **Paternal Grandfather** Grandmother Uncle Aunt **Maternal Grandfather** Grandmother Uncle Aunt	

5. Blood Pressure level:

APPENDIX-IE

DIAGNOSIS AND SALT MANAGEMENT

1. Mention the age of onset of the disease.
2. What symptoms led you to visit the physician?

   1. Head ache 2. dizziness 3. Impaired vision

   4. Tiredness 5. G.I. d isturbance 6. Shortness of breath

   7. Pain over heart.
3. What is your salt consumption pattern/day?

   Was less salt used before diagnosis?
4. After diagnosis, is salt added in cooking or in the table
5. Do you add salt for curd rice?
6. What type of salt do you use?

   Iodised Non-iodised Unrefined Crystal salt.
7. What restrictions do you follow in the diet?
8. Are you frequently checking the blood pressure? Yes No

APPENDIX II

MEASUREMENT OF BLOOD PRESSURE

Blood pressure is measured with a stethescope and an instrument called sphygmomanometer. A sphygmomanometer consists of an airbag or cuff and a column of mercury marked off in millimetres. The cuff is wrapped around the upperarm and inflated by squeezing an attached rubber bulb. The inflated cuff depresses the branchial artery in the arm, stopping the flow of blood. Air pressure supports the column of mercury falls. When the cuff is no longer tight enough to prevent the passage of blood through the artery, then a thudding sound will be heard as blood flow resumes. The height of the mercury when the sound is first heard is the reading of the systolic blood pressure, the pressure when the heart is contracting . Again the air should be continuously released until the sound can no longer be heard. The pressure at this point is diastolic blood pressure, the pressure when the heart is relaxed is not necessarily accurate, for a number of reasons, including measurement error, anxiety, excitement and soon. Ordinarily blood pressure must be measured for two or more times. Cross sectional surveys in which blood pressure is measured on only one estimate of the prevalence of sustained hypertension. **[Paul et al., 1991].**

APPENDI X - III

FREQUENCTY OF FOOD INTAKE

CEREALS

Cereals	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Barley	-	1	-	1	-	1	-	1	-	-	1	1	-	-	2	1
Maize	-	1	1	2	-	1	1	-	-	-	1	-	1	-	1	-
Ragi	2	4	-	-	3	2	3	1	4	1	-	-	3	2	1	3
Rice(parboiled)	6	1	-	-	5	2	-	-	7	1	-	-	8	2	-	-
Rice (Raw)	8	-	-	-	5	4	1	-	3	-	2	-	2	-	-	2
Rice flakes	-	2	6	5	-	1	2	1	-	2	1	5	-	1	3	4
Wheat	-	4	-	3	-	3	2	4	-	4	-	3	-	3	1	4
Wheat flour	-	1	2	1	-	1	3	1	-	1	3	2	-	1	3	2
Maida	-	3	5	6	-	1	4	4	-	3	4	5	-	1	4	3
Wheat semolina	-	3	4	1	-	1	3	2	-	2	4	1	-	1	3	1

PULSES

Pulses	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Red gram dhal	6	-	1	3	7	-	-	-	8	-	2	-	6	1	1	2
Bengal gram dhal	-	2	3	4	-	4	2	1	-	2	1	3	-	2	3	4
Bengal gram whole	-	-	-	4	-	-	-	6	-	-	-	7	-	-	2	8
Black gram dhal	-	1	4	3	-	2	2	4	-	1	-	5	-	-	1	8
Bengal gram roasted	-	-	2	3	-	-	1	3	-	-	4	2	-	-	2	5
Green gram whole	-	2	-	2	1	-	2	4	-	-	2	1	-	1	2	4
Green gram dhal	-	1	-	2	1	-	2	4	-	1	2	1	-	1	2	4
Green peas	-	-	-	4	-	-	-	3	-	-	2	4	-	-	2	1

LEAFY VEGETABLES

Leafy Vegetables	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Agathi	-	3	-	1	1	2	1	1	-	2	4	1	1	1	1	2
Cabbage	-	4	2	-	1	1	-	1	1	4	-	-	-	3	-	4
Drumstick leaves	4	-	-	1	5	-	1	2	2	-	3	2	3	-	1	-
Fenugreek leaves	-	2	3	2	-	4	-	-	-	1	3	1	-	2	-	3
Manathakkali leaves	1	-	4	-	-	-	3	3	1	1	-	3	1	-	1	-
Mint leaves	-	4	-	1	-	1	-	1	-	1	2	4	-	4	-	5
Ponnanganni leaves	-	3	-	2	-	-	1	2	-	-	6	-	-	2	1	-
Spinach	-	-	2	3	-	2	-	1	1	4	-	2	1	-	2	4

ROOTS AND TUBERS

Roots and tubers	Control								Experimental							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Beetroot	-	4	-	-	-	-	2	1	-	-	1	2	-	-	1	-
Carrot	1	3	1	2	-	4	1	4	-	2	1	3	-	3	1	2
Colocasia	-	-	4	3	-	4	3	1	-	4	1	3	-	4	1	4
Onion(big)	5	1	2	-	7	1	-	-	6	1	-	1	8	2	1	3
Onion (small)	3	1	4	-	3	1	2	-	4	1	3	1	4	4	3	1
Potato	1	3	1	-	-	4	1	4	-	-	4	1	-	4	1	2
Radish (white)	-	4	-	4	-	-	4	-	-	4	-	-	-	-	4	3
Radish (pink)	-	-	2	3	-	2		1	1	4	-	-	-	1	1	2
Sweet potato	-	-	2	3	-	2		1	1	4		2	1		2	4
Tapioca	1	-	-	-	-	-	-	1	-	-	1	1	-	1	2	1
Turnip	0	4	-	4	-	-	-	3	-	2	-	1	-	-	-	2

OTHER VEGETABLES

Other Vegetables	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Ash gourd	-	2	1	2	-	2	1	4	-	3	1	2	-	2	1	3
Beans	-	3	1	2	-	3	1	2	-	2	1	3	-	2	1	4
Bitter gourd	2	-	2	-	-	-	2	-	-	3	1	2	2	3	1	2
Bottle gourd	-	2	3	1	-	2	4	1	2	-	2	-	-	-	2	-
BSrinjal	-	1	3	1	-	2	2	1	-	1	2	1	-	1	2	1
Cauliflower	-	-	-	5	2	-	4	-	-	-	-	2	-	-	4	-
Chow-chow	-	2	-	4	-	1	4	2	-	3	1	-	-	1	4	2
Cluster beans	-	-	4	1	-	4	3	1	-	-	1	-	-	-	4	3
Drumstick	2	4	-	3	2	2	1	3	-	3	-	4	-	1	1	3
Ladies finger	-	3	1	4	-	1	1	-	-	2	1	-	-	2	1	-
Plantain green	1	1	1	2	-	1	1	-	2	-	2	1	-	-	-	1
Ridge gourd	-	1	3	6	-	2	3	-	-	1	4	-	-	3	1	-
Snake gourd	-	2	4	7	3	1	-	1	-	1	-	2	-	1	2	1
Sundakai (dry)	1	2	3	1	-	2	1	3	-	-	1	2	-	3	1	2
Tomato	8	-	-	-	7	-	-	-	7	-	-	-	7	-	-	-

NUTS AND OILSEEDS

Nuts and Oilseeds	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Coconut (fresh)	2	1	2	5	3	1	-	6	1	-	2	5	2	-	2	4
Ground nut	-	1	1	4	-	1	2	4	-	1	1	4	-	1	1	3

CONDIMENTS AND SPICES

Condiments and spices	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Asafoctida	8	-	-	-	9	-	-	-	8	-	-	-	9	-	-	-
Chillies (Red)	10	-	2	-	9	-	2	-	8	-	2	-	9	-	1	1
Chillies (green)	6	-	-	-	7	-	-	-	8	-	-	-	8	-	-	-
Coriander seeds	3	1	2	-	4	1	3	-	5	1	2	-	6	-	1	2
Garlic	7	-	-	4	8	-	3	-	8	-	3	-	9	-	4	1
Fenugreek seeds	2	2	4	-	1	2	4	-	2	-	4	-	3	2	-	-
Ginger	6	-	2	1	8	-	1	2	9	-	1	2	10	-	1	2
Tamarind pulp	10	-	-	-	9	-	-	-	10	-	-	-	10	-	-	-
Turmeric	7	4	-	-	8	2	-	1	8	2	1	-	9	3	1	-

FRUITS

Fruits	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Apple	-	-	-	4	-	-	-	3	-	-	-	4	-	-	-	1
Banana	4	1	2	4	-	-	2	1	-	2	1	4	2	1	2	1
Grapes	-	2	-	2	-	-	1	3	-	2	-	1	-	1		2
Guava	-	4	2	1	-	3	1	2	-	3	1	2	4	1	3	1
Lemon	-	2	3	-	-	4	1		-	2		4	1	2	3	1
Mango	-	4	-	2	-	-	4	1	-	-	-	2	-	-	6	4
Water melon	4	-	3	-	-	-	-	1	1	2	1	-	-	3	4	1
Orange	-	3	-	-	-	-	3	1	-		4	-	-	3		1
Papaya	-	-	-	-	-	2	3	-	-	1	-	-	-	1	2	-
Sapota	-	-	1	-	-	-	-	2	-	-	-	1	-	-	-	1
Seethapal	-	-	-	6	-	-	-	4	-	-	-	5	-	-	-	4
Pineapple	-	-	-	3	-	-	-	5	-	-	-	5	-	-	-	4

MEAT AND POULTRY

Meat and poultry	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Fish	-	2	4	1	-	1	2	1	-	2	3	1	-	1	-	2
Egg	1	3	2	-	-	-	1	2	-	2	1	1	-	1	-	1
Chicken	-	2	3	4	-	2	3	1	-	3	2	4	-	5	2	1
Mutton	-	2	1	-	-	-	1	4	-	2	1	-	-	4	1	2

MILK AND MILK PRODUCTS

Milk and Milk products	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Milk	0	-	-	-	10	-	-	-	10	-	-	-	10	-	-	-
Curd	-	-	1	3	-	-	-	2	-	-	1	1	-	-	1	2
Butter milk	6	3	-	-	8	7	-	-	8	3	-	-	7	1	-	-

FATS AND EDIBLE OIL

Fats & Oils	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Butter	-	-	-	-	10	-	-	1	-	-	-	1	-	-	-	2
Ghee	-	-	2	6	-	-	-	3	-	-	4	7	-	-	3	2
Vanaspathi	1	-	3	-	-	2	-	1	-	-	1	2	-	-	1	2

SUGARS

Sugars	CONTROL								EXPERIMENTAL							
	M				F				M				F			
	D	W	F	O	D	W	F	O	D	W	F	O	D	W	F	O
Sugars	10	-	-	-	10	-	-	10	-	-	-	-	9	-	-	-
Honey	-	-	1	2	-	-	3	-	-	-	1	1	-	-	4	1
Jaggery	3	-	2	1	2	-	3	1	4	-	2	-	1	-	1	1

APPENDIX – IV & V

INDIVIDUAL NUTRIENT INTAKE OF THE SELECTED HYPERTENSIVE(EXPERIMENTAL) BEFORE AND DURING SUPPLEMENTATION

	ENERGY K. CAL		CARBOHYDRATE G		PROTEIN G		FAT G		FIBRE G		SODIUM MG		POTASSIUM (MG)	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEOFRE	AFTER
M														
1	2610	2501	541	503	31.8	43.7	29.1	27.13	4.81	7.43	431.7	389.25	964.7	979.3
2	2817	2784	444.3	414.31	36.43	39.89	31.01	35.7	6.84	10.41	391.3	374.7	1117.8	1218.4
3	3124	3161	371.71	315.67	58.3	68.9	31.13	22	7.3	12.4	498.7	461.8	1073.4	1161.7
4	1947	1817	451.89	449.7	43.1	48.32	24.59	30.5	6.3	7.1	571.8	534.5	1017.9	1107.3
6	2232	2103	392.4	348.78	65.81	69.78	39.1	36.2	6.5	5.4	563.5	505.5	931.34	964.7
6	2471	2143	300.13	294.31	43.2	48.73	29.7	25.38	9.1	13.18	497.3	431.6	914.34	949.41
7	1879	1781	295.79	260.74	65.71	69.78	36.1	30.4	7.84	11.01	401.7	384.7	843.7	869.8
8	1996	1998	357.31	319.13	48.81	53.2	40.2	34.5	6.17	8.91	534.6	501.6	917.4	971.7
9	2022	1974	317.4	304.38	31.3	47.87	39.8	37.18	5.8	7.18	473.1	417.9	971.3	1064.3
10	2491	2317	421.91	408.1	41.87	50.34	42.1	34.18	4.02	4.93	437.7	403.8	918.4	1071.3
W														
11	2150	2008	434.32	429.73	52.7	59.8	37.8	31.4	5.2	5.4	438.7	817.3	817.3	941.7
12	2451	2154	317.93	293.71	46.5	51.89	30.1	27.81	6.2	6.71	564.9	919.7	919.7	921.8
13	2982	2778	378.41	341.87	52.2	59.3	25.84	30.84	6.38	7.14	364.9	1072.5	1072.5	1171.7
14	2924	2948	343.38	312.84	47.3	51.51	41.88	31.71	8	11.4	423.4	871.2	871.2	984.31
15	2992	2318	432	417.69	53.48	59.1	35.84	39.71	7.63	8.19	431.3	957.3	957.3	1017.87
16	3101	3181	397.6	407.9	61.34	58.17	29.99	27	4.97	5.03	489.3	961.3	961.3	1011.71
17	1999	22018	341.3	384.78	43.36	44.08	38.78	38.84	8.9	9	454.1	973.5	973.5	1073.84
18	2199	2106	359.83	344.71	38.41	39.13	25	25	10.4	10.95	444.2	938	938	1071.7
19	2738	2818	319.41	323.18	39.64	40.18	37.51	38.4	7.71	8.31	468.7	914.75	914.75	1081.9
20	2554	2437	383.03	361.45	57.34	58.19	39.1	39	6.46	7.13	537.1	1087.30	1087.30	1187.31

APPENDIX- VI

INDIVIDUAL WEIGHTS (Kgs) OF THE MALE HYPERTENSIVES

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	6oth day
59	59	59	60	60	61	61	61	61	60
68	68	70	72	71	54	54	54	53	52
71	71	71	70.5	71	68	68	67	67.5	67
82	82	80.5	80.5	82	71	71	69.5	70	70
64	65	64	64	64	73	73	73	72.5	71
78	78	78	78	78	68	67	67	66	66
59	59	59	58.5	59	65	64	64	64	64
67	67	67	67	67	51	50.5	50.5	50	50
81	81	81	81	81	69	69	68.5	68	67.5
75	75	75	76	76	80	80	80	79	78.5

INDIVIDUAL WEIGHTS(Kgs) OF THE FEMALE HYPERTENSIVES

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	6oth day
63	62	61.5	60	61	68	67	67	66	66
54	54	55	55	55	71	71	70	70	69.5
62	62	64	64	64	69	69.5	67	67	67
49	49	50	50	49	62	61	60	59	59
59	59	59	59	59	54	54	53	52.5	52
68	67	67	67	68	68	68	67	67	66.5
80	79	79	79	80	65	65	64.5	64	63
68	67	67	68	68	73	72	72	72	71
73	73	73	75	75	71	69	70	70	70
78	77	78	80	80	64	63	62.5	61.5	62

APPENDIX – VII

INDIVIDUAL BMI VALUES OF THE SELECTED HYPERTENSIVES

EXPERIMENTAL				CONTROL	
MALE		FEMALE			
Before	After	Before	After	Male	Female
20.14	19.81	22.46	21.79	21.4	20.7
18.90	18.20	31.55	30.88	24.5	23.14
30.62	30.17	31.07	30.17	22.38	21.71
29.17	28.76	25.47	24.24	25.5	22.1
24.11	23.45	17.83	17.17	27.17	28.1
23.80	23.10	26.23	25.65	30.1	29.1
21.46	21.13	21.46	20.8	24.61	25.14
22.66	22.22	25.55	24.85	22.5	21.2
26.61	26.04	24.85	24.50	20.7	28.1
26.42	25.92	21.13	20.47	18.71	19.7

APPENDIX-VIII

INDIVIDUAL SYSTOLIC PRESSURES(mmHg) OF THE SELECTED MALE HYPERTENSIVES IN SITTING POSITION

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	60th day
180	180	185	190	190	170	170	165	165	160
180	185	185	185	185	170	165	170	165	160
180	185	180	190	195	180	180	175	170	170
150	150	155	150	150	150	155	150	145	145
175	170	175	180	185	180	175	175	170	170
170	170	175	170	170	165	160	165	160	160
155	160	160	160	155	155	155	155	150	145
195	200	200	205	200	195	190	195	185	180
165	160	165	160	165	160	160	160	150	145
170	110	180	180	185	170	170	170	170	160

INDIVIDUAL SYSTOLIC PRESSURES(mm Hg) OF THE SELECTED FEMALE HYPERTENSIVES IN SITTTING POSITION

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	60th day
160	160	160	170	170	160	160	170	155	150
150	150	150	150	150	150	150	150	145	140
180	200	195	200	205	180	180	185	170	170
160	160	170	160	165	155	155	150	150	145
150	145	150	155	155	140	140	140	140	130
155	155	160	165	165	155	155	130	140	140
150	160	160	170	170	150	150	145	140	130
180	180	180	180	185	180	185	180	180	170
165	165	165	170	170	165	160	160	150	145
170	165	165	160	165	170	170	165	165	1450

APPENDIX-IX

INDIVIDUAL DIASTOLIC PRESSURES(mmHg) OF THE MALE HYPERTENSIVES IN SITTING POSITION

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	6oth day
95	95	95	100	100	90	90	90	90	90
100	100	100	100	100	100	100	100	100	95
85	85	90	90	90	90	95	90	90	90
95	90	95	95	95	95	90	95	90	90
90	90	90	95	95	90	90	90	85	85
85	85	90	95	95	85	85	85	85	80
100	100	105	105	105	95	95	95	90	90
100	95	100	100	100	100	100	100	100	95
95	95	85	90	90	100	100	95	95	95
85	90	85	90	95	95	95	95	95	95

INDIVIDUAL DIASTOLIC PRESSURES(mmHg) OF THE FEMALEHYPERTENSIVES IN SITTING POSITION

CONTROL					EXPERIMENTAL				
Initial	15th day	30th day	45th day	60th day	Initial	15th day	30th day	40th day	6oth day
90	90	90	95	95	85	85	85	80	80
90	90	90	90	90	90	90	90	90	90
85	90	90	90	90	85	85	85	85	80
95	95	95	95	95	95	95	90	90	85
95	100	100	105	105	95	95	95	95	90
85	90	90	90	90	100	100	95	95	95
100	100	100	95	95	90	90	90	85	80
90	90	95	95	95	95	95	90	90	85
95	95	95	100	105	100	100	95	95	90
100	100	100	100	105	100	100	100	95	90