EFFICACY OF FLAXSEED SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

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Thesis submitted in partial fulfilment of the requirement
for the degree of

Master of Science in Home Science
(Food Science and Nutrition)

Faculty of Agriculture
Kerala Agricultural University, Thrissur

2007

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DECLARATION

I here by declare that this thesis entitled **"Efficacy of Flaxseed Supplement on the lipid profile of Hyperlipidemic subjects"** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this thesis entitled **"Efficacy of Flaxseed Supplement on the lipid profile of Hyperlipidemic subjects"** is a record of research work done independently by **Miss.LAKSHMI.V (2005-16-102)** under the guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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ACKNOWLEDGEMENT

First and foremost I bow my head in front of Almighty for his kindness, blessings and unspeakable help rendered through various hands and giving me courage and confidence to complete my work.

I have intense pleasure in expressing my deep sense of gratitude and indebtness to the Chairman of my Advisory Committee Dr.S.Chellammal, Associate Professor, Department of Home science College of Agriculture, Vellayani for her timely guidance, valuable suggestions, constant encouragement ,and sincere help during the entire course of study and preparation of the thesis.

I feel great pleasure and privilege in expressing my sincere and deep felt sense of gratitude to the following members of my advisory committee,
Smt. N.K.Vimalakumari, Associate Professor and Head, Department of Home science, Dr.P.V.Nandini Assistant Professor, Department of Home science, College of Agriculture, Vellayani and Dr.Vijayaraghavakumar, Associate Professor, Department of Agricultural Statistics, College of Agriculture, Padannakkadu for their constant encouragement and critical comments given during the conduct of this study.

I extend my sincere thanks to the Dean, College of Agriculture for providing all necessary help given to me during the whole course of study.

I also wish to extend my sincere thanks to all my respondents and staffs of the hospitals for their help, willingness and whole hearted cooperation through out my work.

It is my great pleasure to express my deep sense of gratitude to all teaching and non teaching staff in the Department of Home science for their timely help. I extend my sincere thanks to all my friends for their wholehearted cooperation and constant encouragement during the period of study.

Finally, I would like to express my heartfelt thanks to my parents, relatives and all my well wishers for their prayers, inspiration, constant mental support and encouragement through out the course of this investigation.

Lakshmi.V

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ABBREVIATIONS

1.	TC	Total Cholesterol
2.	TG	Triglycerides
3.	LDL	Low- density lipoprotein
4.	HDL	High- density lipoprotein
5.	VLDL	Very low- density lipoprotein
6.	RDA	Recommended dietary allowances
7.	BMI	Body mass index
8.	WHR	Waist hip ratio

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INTRODUCTION

1. INTRODUCTION

"Health of All" is an enduring vision that recognizes the oneness of humanity and therefore there is a need to promote health universally. Health is the precondition for happiness and progress in life of an individual as well as community. In the present scenario a better knowledge of nutrition, advances in preventive medicine and control of bacterial diseases by antibiotics have increased life expectancy. But health expectancy is more significant WHO (1997) also supports this point and quality health care is the life line for the growth of any nation.

Progress in technological development, industrialization and economic conditions have increased the standard of living of people which created changes in food habits and lifestyles leading to health problems. The health problems that parallel economic development are largely those of chronic diseases such as cardiovascular disease, hypertension, diabetes mellitus and cancer (Park, 1997).

Though communicable and non- communicable diseases are responsible for health problems, non-Communicable diseases continue to be important public health problems in India. Unhealthy diet and physical inactivity are the leading causes of major non-communicable diseases.

Among the major non-communicable diseases cardiovascular disease is highly predictable, preventable and treatable. All over the world, cardiovascular disease is now recognized as one of the main cause of death in adults (Medical Update, 1999).

More than 500,000 deaths in a year is attributed to coronary heart disease in the US .At least a third of the individuals who die of coronary heart disease are younger than 55 years of age. Coronary heart disease is the most common cause of morbidity and mortality in the developed world; over the course of this century it will assume this distinction in the developing world as well (NCEP, 1994).

Coronary artery disease rates doubled in India due to the dietary changes associated with epidemiological transition from rural economy to urban oriented economy. Current urbanization rate in India is 35per cent as compared to 15per cent in 1950. The burden of cardiovascular disease has increased by 100per cent in both rural and urban areas (Ahuja, 1994). In India, the death rate from cardiovascular disease is increased at an alarming rate and estimated currently as 52per cent (Gupta, 2001).

Rising affluence has modified the dietary pattern characterized by increased consumption of diets rich in fat sugar and calorie which is directly related to coronary artery disease (Das et al., 2005).

Many factors contribute to heart disease, including age gender, family history, hypertension and diabetes and hyperlipidemia. Hyperlipidemia figures prominently as such a risk factor.

Hyperlipidemia is known to be one of the greatest risk factor for the development of coronary heart disease. It is an abnormal high level of fatty substance called lipids in the blood which includes cholesterol and triglycerides. The causes of hyperlipidemia are multifactorial such as, genetic factors, environmental factors, unhealthy diet, and inadequate medical care.

Lipid and lipoprotein abnormalities are extremely common in general population and are regarded as a highly modifiable risk factor for cardiovascular disease due to the influence of cholesterol, one of the most clinically relevant lipid substances on atherosclerosis.

The risk factors for cardiovascular disease are amenable to Therapeutic Lifestyle Changes (TLC).Therapeutic lifestyle changes can be brought through dietary modification , lifestyle and behaviour modifications.

Diet is one of the essential elements for TLC. It plays an important role in enhancing the health of an individual. Among the various factors which influence serum lipid levels, dietary factors are the most important, (Kemppainen et al., 1993).

Diet favourably alters the lipid/lipoprotein profile and may allow use of lower drug doses with a reduced potential for adverse effects. Dietary interventions serve as the mainstay of any attempt to reduce burden of disease in individual patients and in general population. These interventions include the restriction of total fat, saturated fat and cholesterol, and an increase in the intake of complex carbohydrates and high fibre foods.

Studies have proved that the incidence of cardiovascular disease is reduced by supplementing fibre rich foods in the diet there by lowering and changing pattern of living with regular exercise programme. Incorporating functional foods in the diet brings about reduction in serum cholesterol.

The Institute of Medicine's Food and Nutrition Board (IOM/FNB, 1994) defined functional foods as "any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains."

Functional foods for hyperlipidemia are obtained from plant source (flaxseed, spirulina, psyllium seed, soya, and oats) and animal sources (fish and fish oil, fermented dairy product). These foods help to lower hyperlipidemia the modifiable risk factor of coronary heart disease.

The present study focuses on the "Efficacy of flaxseed supplement on the lipid profile hyperlipidemic subject's aims to assess the efficacy of a food supplement based on flaxseed on the lipid profile of hyperlipidemic subjects.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The literature collected for the study on "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects is listed under the following heads:

2.1 Prevalence of hyperlipidemia

2.2 Role of supplementary feeding and dietary counselling

2.3 Functional foods for hyperlipidemia

2.4 Significance of flaxseed

2.1 PREVALENCE OF HYPERLIPIDEMIA

Lipid is the scientific term for fats in the blood. At proper levels, lipids perform important functions in our body, but can cause health problems if they are present in excess. The term 'Hyperlipidemia' means high lipid levels. Hyperlipidemia includes several conditions, but it usually means high cholesterol and high triglyceride levels.

Hyperlipidemia is a well recognized as a major contributor to chronic coronary heart disease and other cardiovascular events. According to Jayakumar (2000) prevalence of hypertension, hyperlipidemia, and diabetes mellitus multiplies the risk of development of macro vascular diseases several fold.

Cardiovascular disease remains the number one killer of Americans, and its prevalence is increasing worldwide. Nearly one half of Americans, die of cardiovascular disease. The morbidity and mortality associated with coronary artery disease is strongly related to abnormal lipid levels, oxidation of lipids and intra-arterial clot formation (Masley, 1998).

Mortality in UK is one of the highest in the world; the average intake of saturated fatty acids there is 36.5g/kg or16 per cent of the total dietary calories while the recommendation is only 10 per cent (Bingham, 1991).

According to NCHS data the prevalence of Hyperlipidemia is higher in men than in women and is somewhat higher in men than in women and is higher in white Americans than in African Americans. The prevalence of Hyperlipidemia is higher in both white men (52 per cent) and women (49 per cent) than in African American men (45 per cent) and women (46 per cent) (American Heart Association, 2001).

In the US the South Asians, also known as Asian Indian exhibit the highest prevalence of coronary artery disease and coronary risk factors as compared with Caucasian (American Heart Association, 2005). South Asians have been identified to have twice the risk of Caucasians when they are exposed to better living standards and altered lifestyle habits (Gupta et al., 1995).

Hyperlipidemia in most Westernized countries is widespread, largely because of diets that are high in fat content and lifestyles that do not incorporate enough physical activity (Kannel, 1990). A recent estimate based on data from the Third National Health and Nutrition Examination Survey (NHANES III) suggests that approximately 28 per cent (>50 million) of US adults older than 20 years have hyperlipidemia that warrents treatment (Hoerger et al., 1998).

The prevalence of hyperlipidemia, defined as fasting total cholesterol equal or exceeding 6.2m/mol/l,was evaluated in two comparable studies in 18- 69 age group. They showed a fall from 27 per cent in 1984 to 19 per cent in 1992 (National University of Singapore, 1984 and National Health Survey, 1992).

Several studies have reported the prevalence of hyperlipidemia in diabetics is between 21 per cent to 43 per cent (Akbar, 2000).Recent studies have clearly indicated that the rate of cardiovascular disease complications associated with diabetes mellitus can be considerably reduced through intensified treatment of hyperlipidemia (Pyorala et al., 1997).

The prevalence of lipid abnormalities on a survey done in Mexican city revealed that severe hypertriglyceridemia was observed in the population. Half of the hypertriglyceridemic subjects had mixed dyslipidaemia or low-HDL cholesterol. The prevalence of different types of dyslipidaemia in Mexican adults is high (Aguilar Salinas, 2001)

The prevalence of coronary artery disease has been increasing in India over the past few decades (Reddy and Yusaf, 1998).The prevalence of risk factors for arthrosclerosis is increasing in India due to the changing socio-economic factors and lifestyles.

WHO (1996) has predicted that deaths due to cardiovascular diseases would be doubled by 2015. Deaths from coronary heart disease in India rose from 1.17 million in 1990 to 1.59 million in 2000 and are expected to rise to 2.03 million in 2010. Previous studies in India have pointed to differences in the prevalence of coronary risk factors across different geographic territories of the country (Begom and Singh, 1995).

The prevalence of Diabetes and coronary artery disease was noted to be higher in South India compared to the north. Cross sectional studies in India show that Total to HDL cholesterol ratios of > 4.5 exist in 73 per cent of urban men and 54 per cent of urban women and in 52 per cent of both rural men and rural women (Reddy et al., unpublished data).

A study done by Krishna Reddy et al., (2002) on prevalence of risk factors for coronary atherosclerosis in a cross-sectional population of Andhra Pradesh revealed that 1/3rd of the study population had at least one risk factor and 1/4th of the population had more than one risk factor. The higher prevalence of many of the risk factors was noted in females due to advancing age or gender.

A study done to estimate the prevalence of hyperlipidemia in and around the city of Varanasi. About 50 per cent population over age 20-29yrs had serum cholesterol above 200mg/dl. 15 per cent male and 18 per cent female had total cholesterol above 240mg/dl and LDL cholesterol above 160mg/dl (Tiwari et al., 1997).

A community survey of 500 households in a rural setting near Thiruvanathapuram city in Kerala, South India was undertaken to assess the coronary risk factors in a poor population. This study in a rural population showed a very high prevalence of the conventional risk factors, such as smoking, hypertension and hyperlipidemia with increased LDL (Siva Prasad et al., Medical College, Thiruvanathapuram).

A study conducted among urban population in Thiruvanathapuram city showed that about 87 per cent of the population had a total cholesterol level above 200mg/dl (Chellammal, 2006 unpublished data).

2.2 ROLE OF SUPPLEMENTARY FEEDING AND DIETARY COUNSELLING

Management of hyperlipidemia is the cornerstone of therapeutic strategy for coronary artery disease risk reduction. High blood pressure, hyperlipidemia, and elevated blood sugar are serious risk factors of cardiovascular disease.

Physicians frequently prescribe medications to treat these problems and reduce these risks. But researches have shown that many of the risk factors are amenable to therapeutic lifestyle changes.

Therapeutic Lifestyle Changes can be brought through two ways:

- Dietary Modifications
- Lifestyle Modifications

In dietary modification along with the alteration in diet various dietary supplements are also provided. According to Rosado et al., (2000) supplementary foods should include all the nutrients that are essential for the target population and that it should be well tolerated and accepted by the population in terms of flavor and appearance. Moreover it should be easy to use: should be stable and have a shelf life long enough to allow for adequate distribution and utilization and should be of low cost and produced locally.

Mahadevan (1992) has reported that supplementary feeding programmes should be viewed as short term means for achieving specific nutrition and health objectives

Various studies had been done in the formulation of different supplementary foods for people of different age groups and also for prevention of various degenerative diseases.

WHO and UNICEF (2002) have declared that ideal supplementary food should be adequate in quantity and foods that are rich in energy should be combined with those, which are good sources of proteins, minerals and vitamins.

A high protein beverage based on soy flour was formulated and its impact was studied on the selected adolescent children by Litty and Chellammal (1998). It was found to be effective in improving their health status.

Devi et al., (2000) developed four types of supplementary biscuits using Green gram dhal, wheat flour and soybean and they were found to be nutritious as well as acceptable.

Madruga and Camara (2000) have reported that "Multimistura" is a low cost food supplement used in institutional nutrition programmes for prevention of under nutrition in low income populations of Brazil.

A clinical study by Stanford researchers published in the American Journal of Cardiology (1992) demonstrated that a mixture of water soluble dietary fibre sources (psyllium husk, pectin and guar and locust bean gums) can be practically incorporated into the diet and resulted in significant cholesterol lowering within 4 weeks. Soluble dietary fibre supplementation of diet reduces serum hypercholesterolemia significantly (Bell et al., 1990).

A study was conducted by Parvathi et al., (2002) test the impact of antioxidant vitamins E and C on the lipid profile of hyperlipidemics and the study has brought out the fact that consumption of liberal amounts of fruits and vegetables that are rich in antioxidant vitamins improves the blood lipid levels.

According to Lakentiew et al.,(2006) a study done to analyze the impact of soybean oil supplement in hyperlipidemics revealed that the supplement of 30g soybean oil proved to be hypolipidemic, since there was a significant reduction in Total cholesterol and LDL cholesterol and increase in HDL cholesterol after three months period.

Supplementation of fish oil capsule was found to be effective in lowering serum cholesterol, TG and LDL cholesterol and there by increasing HDL cholesterol in hyperlipidemic subjects (Amrithveni, 2003).

In a study on dietary supplementation with flaxseed oil (8 g/day), on blood pressure in middle-aged dyslipidaemic men resulted in significant lowering of systolic and diastolic blood pressure levels (Paschos et al., 2007).

Dietary counselling brings scientifically sound nutrition practices regarding human needs and available food sources to awareness. Counselling can be supplemented by the use of audio-visual aids. Clara (1986) reported that diet counselling is necessary to lower the blood lipids and to maintain the normal levels of atherosclerotic patients.

The major objective of dietary counselling was to educate the participants about the nature of the disease, its hazards and how it can be recognized and prevented or controlled through diet (Srilakshmi, 1999).

Sheppard et al., (1991) reported that intensive instruction to maintain a low fat diet resulted in reduction of fat intake from 39 per cent to 22per cent of calories and was accompanied by 3kg weight loss in 6 months.

2.3 FUNCTIONAL FOODS FOR HYPERLIPIDEMIA

Traditionally, the role of diet was to provide energy and essential nutrients to sustain life and growth. In recent years, however the role of diet has evolved into one in which foods are also called on to deliver physiological benefits in management and prevention of diseases. Foods with these attributes are referred to as functional foods.

According to Wildman 2001, a functional food is "any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains".

In contrast to most dietary supplements functional foods are components of the usual diet that may have special disease prevention attributes and are the topic of current traditional scientific investigation. Unlike dietary supplements that can claim only general health benefits, functional foods may claim specific health benefits because they are considered as a part of the diet (Rosado, 2000).

According to Health Canada "a functional food is similar in appearance to conventional foods, is consumed as a part of a useful diet and has demonstrated physiological benefits and/or reduces the risk of chronic disease beyond basic nutrition.

Thus a functional food is any food that has positive effect on a person's health, physical performance or state of mind. Foods act as antioxidant, detoxifying agent, blocking or suppressing agent. Thus it plays an important role in the prevention of disease and in promoting health.

Functional foods are obtained from both plant sources and animal sources .These foods play important role in lowering hyperlipidemia. Functional foods for hyperlipidemia from plant sources include the following:

1. Flaxseed
2. Spirulina
3. Psyllium Seed
4. Soy products and legumes
5. Garlic
6. Plant Sterols and
7. Oats

Flaxseed

Flax is truly an amazing grain which is proving itself over and over again as a nutritional wonder-grain. Flax seed has some truly amazing nutritional characteristics. It is most noted for its high levels of LNA, lignans and fibre.
Flax seed is beneficial in lowering cholesterol and lowering the risk of heart disease, preventing cancer, correcting auto-immune disorders and the relief of constipation.

Spirulina

Spirulina has a long history for human usage in Mexico and Central Africa where it grows naturally in the alkaline lake. Spirulina has been promoted as a natural health and slimming food in US and Europe.

Spirulina acts directly upon lipid metabolism by preventing accumulation of fats and cholesterol (Seema 1996). Spirulina supplementation significantly reduces the TC, TG, LDL and VLDL, without decreasing the body weight or blood pressure (Anuradha and Vidhya, 2000).

The effect of spirulina on hypercholesterolemic patients was carried out by Ramamoorthy and Kumari (1996). 2-4 g was supplemented for three months. Results indicated that spirulina play a key role in weight reduction, lowering blood cholesterol levels and improving the lipid profile of the patients.

Spirulina is now available in powder and tablet form, fruit and snack bars enriched with spirulina are also available nowdays. According to Venkataraman (1992) the best way to use spirulina is to grind the sun dried material and mix the powder in the flour by wheat, rice, maize, millets and dhal or in sups, curries and other food preparation.

Psyllium Seed

Psyllium seed is an inexpensive and safe fibre used as laxative in a dose of 5g twice a day. It lowers cholesterol significantly (Sprecher et al., 1993).

Soy products and legumes

Soy has been in the spotlight during the 1990's. Soy is a high quality protein as assessed by the FDA's. The health claims that the consumption of soy protein is associated with a reduction in the risk of coronary heart disease. The FDA concluded that soy protein that is included in a diet low in saturated fat and cholesterol may reduce the risk of heart disease by lowering blood cholesterol levels (FDA, 1999).

Intake of soy products decreases LDL and TC levels without decreasing HDL cholesterol levels. A 1995 meta analysis of 36 separate studies found that the consumption of soy protein resulted in significant reductions in total cholesterol (9.3 per cent), LDL cholesterol (12.9 per cent) and TG (10.5 per cent) with a small but insignificant increase (2.4 per cent) in HDL cholesterol (Anderson et al., 1995).

Studies have also been shown to decrease LDL and TC levels without decreasing HDL levels. Thus soy and bean products can serve as a protein source in a meal and can further reduce LDL levels if they are substituted for fatty animal products.

Garlic

Garlic is the herb most widely quoted in the literature for medicinal properties. The health benefits of garlic are numerous including cancer, chemo preventive, antibiotic, antihypertensive and cholesterol lowering properties Garlic supplementation may have an important role in the treatment of hypercholesterolemia.

Medical studies have shown that garlic can lower cholesterol; prevent dangerous blood clots (Srivastava et al., 1995). Sulfur containing compounds in garlic are responsible for many of its healing properties-specially these compounds lower cholesterol by stimulating the release of bile by the gall bladder and by decreasing the production of cholesterol in the liver.

Garlic is a proven antioxidant. This property might help to prevent LDL from being oxidised. Thus the cholesterol builds up that clots in the arteries could be reduced. (Kerckhoffs et al., 2002).

In a study done by Adesh and Jain (1994) reported that garlic can lower blood levels of TC and particularly of the dangerous LDL form. By the end of the study it was seen that, the blood cholesterol levels dropped by an average of 6per cent among those taking the garlic tablets. The garlic takers were also benefited by an 11per cent decrease in the LDL form of cholesterol. Thus garlic contains a wide variety of phytochemicals.

Garlic is said to be good for cardiovascular problems due to its blood pressure lowering effects, blood lipid lowering effects and its anticoagulant properties.

Plant Sterols

Plant Sterols represent another functional food that has been the object of increasing interest. Plant sterols are compounds that are structurally similar to cholesterol were shown to lower serum lipid levels by inhibiting cholesterol absorption.

Plant sterols and its derivatives act in the small bowel by competitively inhibiting intestinal absorption of cholesterol (Miettinen et al., 2000, Jones et al., 2000 and Ostlund et al., 1999).

Available data showed that sterols and stanols to be equally effective, with or without a fatty acid ester attached to the sterol ring, in their ability to lower LDL cholesterol (Jones et al., 2001 and Law, 2000).Plant sterols include: vegetable oils, seeds and nuts.

Nuts: Although nuts are relatively high in fat, most of this fat in the mono or polyunsaturated form. Of nuts commonly consumed almonds and walnuts may be most effective in lowering cholesterol. Other include Brazil nuts, peanuts etc.

Three large prospective studies demonstrated that the consumption of 1-4 servings of nuts per week was associated with about a 40 per cent reduction in risk of coronary heart disease, even after adjusting for conventional risk factors such as hypertension, smoking, diabetes and hyperlipidemia (Fraser et al., 1995 and Sabate et al., 2001).

The beneficial effects of nuts include improvement of serum lipid profiles with a predicted 16 per cent reduction in LDL cholesterol and presence of relatively high amounts of nitric oxide precursor arginine, dietary fibre and antioxidant vitamin E. Walnuts are particularly noteworthy for having a high content of n-3 linolenic acid (Sabate et al., 2001).

Thus nuts contain many factors that could be responsible for protection against heart disease including fibre, vitamin E, alpha-linolenic acid {ALA} [found in walnuts], oleic acid, magnesium, potassium, and arginine.

Vegetable Oils: Studies of Ramadas and Easwaran (2000) on the influence of different plant oil consumed at desired level did maintain normal serum lipid fractions. Though the adults consuming coconut oil had a high mean value of TG of 208mg/dl, the HDL level was 54.5 mg/dl which was the highest compound to those consuming groundnut oil, gingelly oil, sunflower oil, ghee etc.

According to studies conducted by Charul and Vasanthamani (1998), groundnut oil brought about a significant reduction in all the lipid fractions such as TG, VLDL, serum TG at 1 per cent level. Significant reductions in LDL levels were obtained at 5 per cent level.

Olive oil lowers LDL-cholesterol especially when the olive oil replaces saturated fat in the diet. Diets high in MUFA from olive oil do not adversely affect HDL levels. Although olive oil is clearly safe for people with elevated cholesterol, it is like any fat or oil high in calories, so people who are over weight should limit its source.

Oats

The soluble fibre in oats, called beta-glucan, has specifically been shown to reduce serum cholesterol level. A high daily intake of soluble fibre, through generous servings of oat and bean-based foods, helps eliminate cholesterol-laden bile acids and fats from the body.

Soluble fiber is found primarily in oats, legumes, apples, pears, plums, carrots, okra, and barley. Oat products are widely studied dietary source of the cholesterol-lowering soluble fibre beta-glucan (Anderson et al., 1990).

Oat bran is a rich source of soluble fibre called beta glucan. Oats (oat meal, oat bran) and legumes are the best whole food fibre foods to lower cholesterol. Soluble fibres are found in foods such as beans, oats, legumes, pectin, psyllium, barley and Guava (Dwyer, 1995).

Use of the soluble fibre oat bran in cardiovascular risk management was the first health claim allowed under the US Dietary Supplement Health Education Act (DSHEA) during the 1990's (Brown et al., 1999).

Higher daily intake of fibre (25-30g) was associated with a modest, but significant reduction in risk for cardiovascular disease by lowering Total and LDL cholesterol levels (Kushi et al., 1999).

According to Richard et al., (1991) 3-26 per cent reduction in plasma total cholesterol was observed with an intake of 40-75 g oat bran per day. Thus soluble fibre increases excretion of faecal bile acid and removal of cholesterol.

Several studies have shown that daily serving of oat bran or oat meal decreases total cholesterol levels up to 3 per cent (Ripsin et al., 1992).

Functional foods from animal sources are as follows:

1. Fish and Fish oil
2. Dairy Products

Fish and Fish oil

Fatty acids in fish and fish oils have gained interest and publicity for their role in the prevention and management of cardiovascular disease. Cold water fish are the best sources of Omega-3fatty acids. Mackerel, Herring, Sardines, and Salmon are few examples.

Eating fish has been reported to increase HDL cholesterol (Santos et al., 1992). Fish oil contains Eicosa pentanoic acid (EPA) and Docosa hexanoic acid (DHA), omega-3 fatty acids that appear to protect against heart disease (Albert et al., 1996).

Consumption of fish and fish oil with EPA and DHA lowers cholesterol and TG levels in Hyperlipidemics (Tillotson et al., 1997 and Wahlquist and Dalais, 1999). Mahmond et al., (1994) reported that fish oil, the long chain n-3 PUFA namely EPA and DHA are the active components in lowering plasma lipid levels.

A study published in the journal of the American Medical Association showed a data in younger women (34-59yrs) where a higher consumption of fish and omega-3fatty acids were associated with a significant reduction in total stroke and lacunar infraction and a reduction in thrombiotic infraction. Thus consumption of fish and fish oil has great benefits in reducing Hyperlipidemia and heart disease.

Dairy Products

There is no doubt that dairy products are functional foods. They are one of the best sources of calcium. In addition, however recent research has focused specifically on other components in dairy products particularly fermented dairy products known as probiotics.

Probiotics are bacteria containing foods, such as milk and milk solids, yoghurt and kefir. In spite of high meat diet people had low levels of serum cholesterol because they consume daily 4-5litre of fermented whole milk. (Sanders, 1994). Some fermented milk products include skimmed milk non fat yoghurt and non fat cheese.

2.4 SIGNIFICANCE OF FLAXSEED

Flaxseed, also known as Linseed, is an edible oilseed /grain that were a major dietary staple before the industrial revolution. However, because of its limited shelf life, flaxseed virtually vanished from the modern day diet by the turn of the century (Thompson, 1995). The major fibre flax-producing countries are Canada USA and China, though there is also significant production in India and throughout Europe. North Dakota is the flax production leader with over 95 per cent of crop area planted in 2001.

Flaxseed has been described in herbals from very early times. Traditionally it has been esteemed as a medicament for minor medical afflictions; however, in recent years, medical research teams have developed an interest in flaxseed's apparent ability to prevent or mitigate several serious diseases that plague humankind.

Flaxseed has recently gained attention as a 'functional food' because of its nutritional profile (Expert panel of Food Safety and Nutrition, 1998) and potential to affect the risk and course of cardiovascular disease and some cancers (Adlercreutz et al., 1997). Flax products are currently one of the most popular functional foods in the natural health market and are available as oil or whole seed or as milled seed. Ground or whole flaxseeds or flaxseed flour can be added to breads, muffins and cereals.

What does Flax means?

In Flax

F- Stands for fibre

L- for Lignan

A- Alpha linolenic Acid

X- Excellence

F for FLAX

Fibre is the endogenous component of plant materials in the diet that is resistant to digestion by enzymes produced by humans. Dietary fibre is classified as insoluble or soluble fibre and specific agents include cellulose, hemi-cellulose, pectin and lignin (LSRO, 1987).

Flaxseed is rich in both soluble and insoluble fibre. The soluble fibre in flaxseed and oil enhances the HDL activity and decreases up to 18 per cent of LDL cholesterol which is responsible for heart attack (Harris et al., 1993).

Consumption of soluble fibre has been shown to lower LDL cholesterol levels through a series of processes that alter cholesterol and glucose metabolism. Regular intake of dietary fibre at appropriate levels is reported to be effective in counteracting many of the risk factors associated with coronary heart disease. Such an increased apolipoprotein increases LDL cholesterol, elevated serum cholesterol levels, fibrinogen, hypertension, obesity and diabetes (Singh et al., 2000).

Dietary fibre is significantly associated with plasma, Total and LDL cholesterol. Additional high fibre intake is positively correlated with HDL cholesterol (Ludwig et al., 1999).

Dietary flaxseed supplementation is effective in reducing hypercholesterolemic atherosclerosis markedly with lowering serum cholesterol (Prasad, 1997).

L for LIGNANS

Flaxseed is an especially rich source of dietary lignans, with 75 to 800 times more than any other food (Thompson, 1995). Like the isoflavones in soy, lignans and their associated phenolic compounds are classified as Phytoestrogens (Adlercreutz et al., 1997).

Flaxseed is unique among oilseeds because it contains an exceptionally high concentration of phytoestrogenic compounds known as lignans. Lignans are able to bind to estrogen receptors and also have weak estrogenic and anti estrogenic properties. Available research suggests that the anti estrogenic effects of lignans may contribute to anti cancer properties of flaxseed diets (Rickard and Thompson, 1997).

Several studies have shown that flax lignans also act as antioxidants thus lowering the promotion and synthesis of free radicals which can cause damage at the cellular level (Prasad, 1998).

A recent study by Haggens et al., (2000) suggested that flaxseed supplementation (10 g/day for 8 weeks) significantly increases the ratio of 2 hydroxyestrogen to 16 alpha- hydroxyestrogen among women and there by holds promise as a chemo preventive agent for breast cancer.

A for ALPHA LINOLENIC ACID

Alpha-linolenic acid is an n-3 fatty acid found in green leafy vegetables, canola oil, flax oil, soybean products, walnuts and hazelnuts. Increased intake of foods rich in alpha-linolenic acid decreases LDL cholesterol levels. (Cunnane et al., 1994).

Increased attention to the possible role of specific fatty acids in health and disease has created an interest in specialty oils in particular sources of alpha linolenic acid. Flaxseed contains 35 per cent of its mass as oil of which 55 per cent is ALA (Omega-3fatty acid) and 15 to 18 per cent of linoleic acid (Carter, 1993).

Flaxseed is the richest source of plant based omega 3fatty acid. The natural health products market for omega-3fatty acid .ALA is well established. ALA is found to be effective in lowering cholesterol levels, reducing the clotting of blood platelets and lowering blood pressure (Mantzioris et al., 1994).

Ground flaxseed fed in muffins also reduces blood cholesterol levels (Cunnane et al., 1993) and LDL cholesterol while maintaining the good cholesterol HDL (Bierenbaum et al., 1993).

Flax may also protect against strokes by reducing blood clotting and platelet aggression. In recent analysis (Simon et al., 1995) omega-3fatty acids including ALA were shown to be associated with a lower risk of stroke in middle aged men at high risk for coronary heart disease.

X for EXCELLENCE

Flaxseed consumption prevents constipation. The flaxseed phytochemicals help in the potential treatment of diseases including hyperlipidemia, cancer, systemic lupus, chronic renal transplant rejection, malaria and rheumatoid arthritis (Haggerty, 1999).

The consumption of flaxseed is associated with a reduction of TC, including the LDL cholesterol and TG. Eating low fat foods, increasing your exercise, limiting salt and sugar and eating flaxseed daily are a few ways by which we can win the battle against high cholesterol.

Health benefits of Flaxseed

i) Flaxseed and Cholesterol

High serum cholesterol is considered a significant risk factor for coronary heart disease. Eating foods that are high in saturated fats and hydrogenated oils cause the liver to produce more LDL cholesterol that increases the cholesterol levels.

Several drug treatments are available for reducing cholesterol; however, when possible, it is better to control its level through diet. If the foods that we eat are also high in cholesterol, and if we don't have sources of soluble fiber, phytosterols, and polyunsaturated fats in your diet, it can result in high blood cholesterol.

Flaxseed has been reported to lower serum cholesterol in both normolipidemic and hyperlipidemic subjects (Cunnane et al., 1995).

ii) Flaxseed and Cancer

The active ingredient in flax that may be responsible for the protective effect against prostate cancer is still unclear. Lignans and alpha-linolenic acid are found abundantly in flaxseed, and both have been implicated in cancer prevention — especially breast cancer.

Fewer studies have evaluated the effects of flaxseed feeding on risk markers for cancer in humans. The ingestion of 10 g of flaxseed per day elicited several hormonal changes associated with reduced breast cancer risk. Flaxseed may slow growth of prostate tumors. Including flaxseed as part of a low-fat diet may slow the growth of tumors in men with prostate cancer.

According to a study published in the *Journal Urology*, 25 men with prostate cancer supplemented with 3 tablespoons of ground flaxseed daily for an average of one month had a greater rate of prostate tumor cell death than men who did not follow this diet.

iii) Flaxseed and Bones

Flax seed meal is an excellent source soluble fiber. It has also been found to help strengthen the Bones by retarding the rate of bone resorption. A crossover study was designed to evaluate the effects of flaxseed consumption on several markers of bone resorption and bone formation in the blood and urine of postmenopausal women. The results revealed that Flaxseed supplementation positively influences bone metabolism in postmenopausal women.

The flaxseed diet also tended to decrease both urinary excretions of another marker of bone resorption, and calcium. Thus the findings suggest that flaxseed retards the rate of bone resorption (Arjmandi, et al., 1998).

iv) Effect of Flaxseed on Lupus

Systemic lupus erythematosus (SLE or lupus) is considered a prototype autoimmune disease that primarily affects young women between the ages of 15 to 35. Clark and co-workers explored a nutritional approach to treat the initial phases of SLE. They found that omega-3 fatty acid supplementation helped reduce inflammation.

Clark and co-workers decided to explore the use of flaxseed as a nutritional treatment for both early and late phase SLE complications. They based their hypothesis on the previously known facts that flaxseed contains high concentrations

of omega-3 fatty acids and is also a rich source of lignans. The results of the study revealed diets containing 30 grams/day flaxseed were well tolerated by patients with SLE nephritis, exerted significant effects on kidney function, and lowered plasma lipids [particularly LDL cholesterol by 11 per cent] (Clark, 1994).

v) Flaxseed and Rheumatoid Arthritis

Flaxseed oil is also receiving attention as a possible treatment for rheumatoid arthritis. Caughey et al., (1996.) investigated substituting flaxseed oil for treatment of rheumatoid arthritis with fish oils. In healthy human voluhteers, they found approximately 30 per cent reductions in the synthesis of both TNF-alpha and IL-1-beta when flaxseed oil was part of their diet.

Thus, flax or it's by products have served humankind as a food, fiber, herbal, and in many other ways since prehistoric times. Today both the seed and its oil are being assessed through medical research as nutritional supplements for the cure or the alleviation of some of the serious diseases that plague humankind. Perhaps in the near future, flax's health benefits will become one of the brilliant facets of this herbal jewel

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The materials and methods adopted for the study on "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects are discussed under the following headings:

3.1 FORMULATION OF FLAXSEED SUPPLEMENT

3.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

3.3 CONDUCT OF FEEDING TRIAL

3.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

3.1 FORMULATION OF FLAXSEED SUPPLEMENT

3.1.1 SELECTION OF RAW INGREDIENTS

The basic ingredient selected for the formulation of the supplement was flaxseed. Rice and jaggery were the other ingredients added to flaxseed. These were selected to improve the nutritional adequacy, organoleptic qualities and economic significance of the supplement.

3.1.2 JUSTIFICATIONFOR THE SELECTION OF INGREDIENTS

FLAXSEED: Flaxseed has been proven markedly to reduce cholesterol levels as effectively as Oat bran and pectin. Dietary flaxseed supplementation has been effective in reducing hypercholesterolemia. Flaxseed contains good amount of fibre

PLATE NO. 1 - FLAXSEED

and Omega- 3fattty acids which are helpful in reducing hyperlipidemia. Hence flaxseed was selected as the basic ingredient for the supplement.

RICE: Rice is the staple food of Kerala and is an essential ingredient for a variety of recipes. Rice supplies about 1/3rd of the required calories to an adult Indian. Since rice is a familiar food to the Keralites it was selected.

JAGGERY: Jaggery was used in small quantity to improve the taste and flavor.

3.1.3 SELECTION OF THE BEST COMBINATION FOR THE DEVELOPMENT OF THE SUPPLEMENT

Ten combinations were tried with the ingredients in different proportions for the formulation of the supplement. These combinations are listed in Table: 1 indicating the proportion of the ingredients tried.

The principle governing the selection of the most suitable combination was its acceptability. The nutritional adequacy and cost were the other criteria.

As the formulated supplement was consumed by the subjects along with their routine food it was taken only 40g for the formulation. 25g of flaxseed was taken because flaxseed tolerance for human beings was 20- 30g per day (Bhatty, 1995).

PLATE NO. 2 - RAW INGREDIENTS USED FOR THE FORMULATION OF SUPPLEMENT

Table: 1 Different Combinations tried for the Supplement

Combinations	Ingredients			
	Flaxseed (g)	Rice (g)	Jaggery (g)	Total
C1	25	13	2	40g
C2	25	12	3	40g
C3	25	11	4	40g
C4	25	10	5	40g
C5	25	9	6	40g
C6	25	8	7	40g
C7	25	7	8	40g
C8	25	6	9	40g
C9	25	5	10	40g
C10	25	4	11	40g

3.1.4 FORMULATION OF THE SUPPLEMENT

Flaxseed was bought in bulk from Hyderabad and all impurities were manually removed. It was cleaned thoroughly with cotton cloth and sun dried for two days to remove any trace of moisture. Then it was roasted lightly for five minutes to remove the raw taste cooled and milled into fine powder. Similarly rice was also taken cleaned and roasted for seven minutes cooled and milled into fine powder. Both the powders were mixed together. Jaggery was then taken and melted for five minutes to get it in the liquefied form. It was added to the powder, mixed thoroughly and made into small balls. The formulation of the supplement is presented in figure 1.

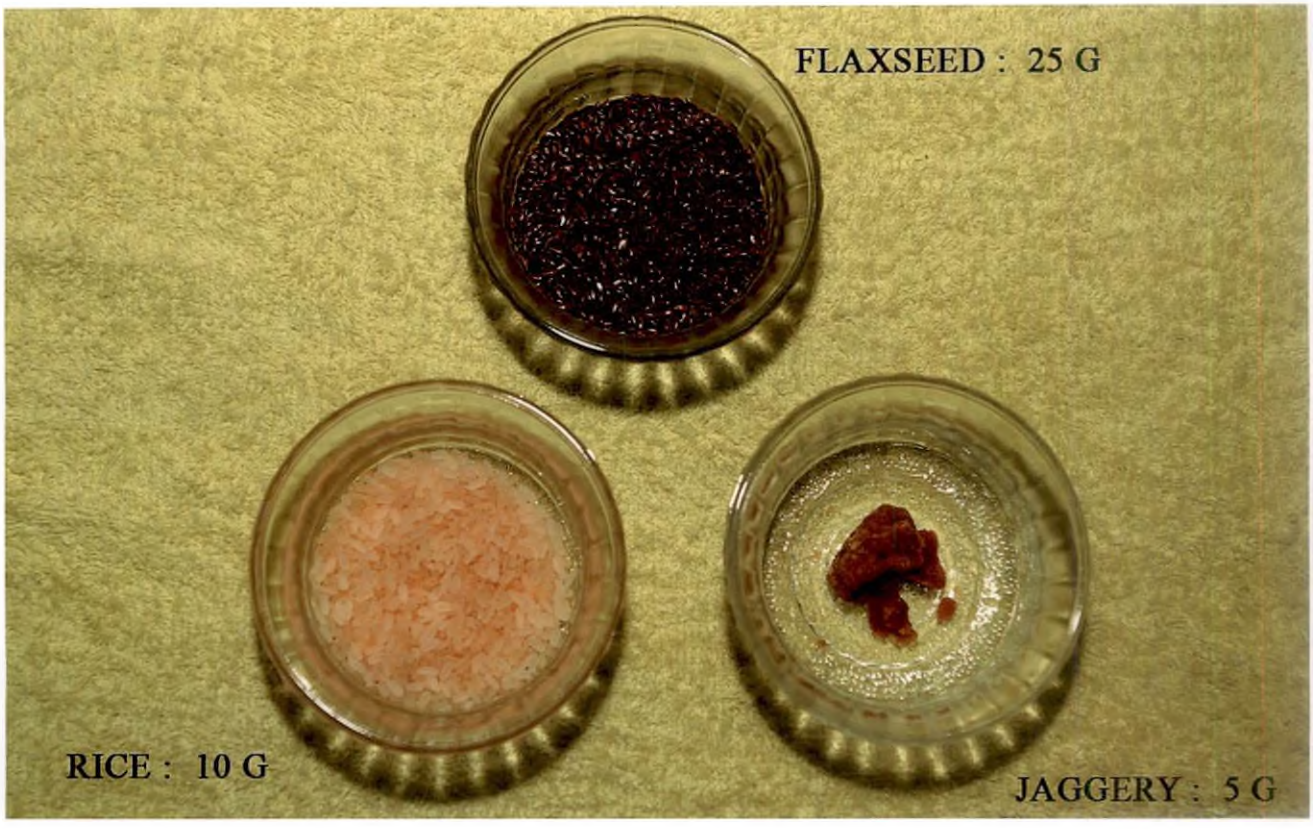

PLATE NO. 3 - WEIGHED INGREDIENTS

PLATE NO . 4 - RAW INGREDIENTS USED FOR THE FORMULATION OF SUPPLEMENT IN POWDERED FORM

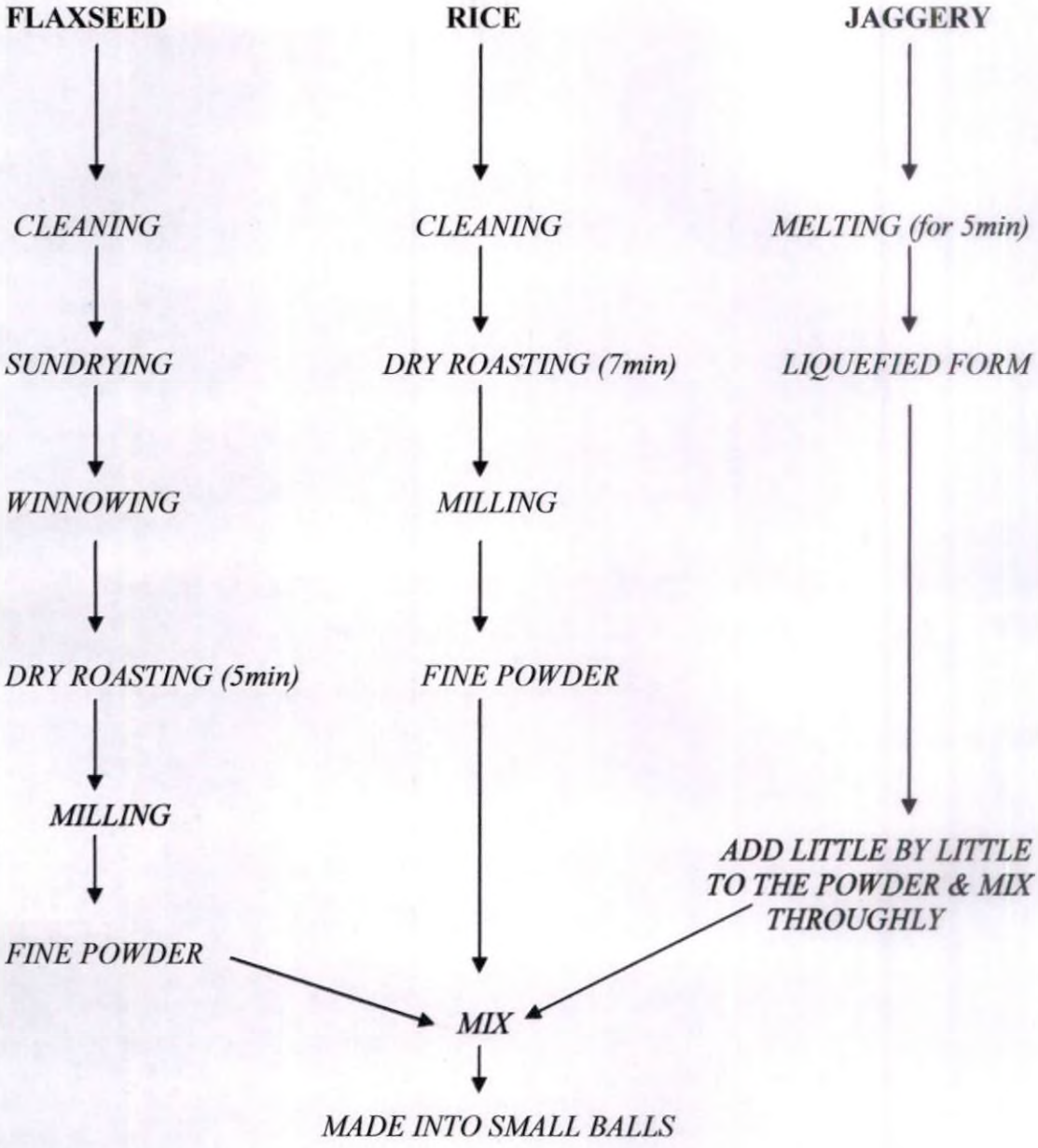

Fig: 1 FORMULATION OF FLAXSEED SUPPLEMENT

3.1.5 OVERALL ACCEPTABILITYOF THE SUPPLEMENT

The acceptability of the supplement was assessed through organoleptic evaluation by a selected panel of judges using score cards. The major quality attributes included in the score card were appearance, colour, flavor, taste and texture.

Overall acceptability of the product was assessed through organoleptic evaluation which was done in the laboratory. Organoleptic tests can be considered as important means for evaluating a new product. The evaluation was done by a panel of 10 judges who were selected using triangle tests (Donald et al., 1984).

3.1.6 NUTRITIONAL ADEQUACY

Nutritional adequacy was ascertained by computing the energy, protein, fat and fibre content of different combinations.

3.1.7 COST

Cost was computed as per market price of the ingredients selected and cost involved in processing. The combination which secured high scores in all the parameters was selected for the development of the supplement.

Before the start of feeding trial a preference test was conducted. Preference test for the supplements made from the ten combinations were conducted among 30 subjects. The prepared supplements were served to the subjects and were asked to rank each combination according to their preference. A scale from nine to one was used, nine representating the optimum. Care was taken to avoid discussion among subjects during rating. Thus the combination which got maximum rating was accepted for the feeding trial.

PLATE NO. 5 - FLAXSEED SUPPLEMENT

3.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

The inclusion criteria for the selection of the subject were:

- Willingness and Co-operation
- Age (between 35 to 55yrs)
- Serum cholesterol level 200mg/dl and above
- Free from other degenerative diseases
- Persons who are not under medication for Hyperlipidemia

The subjects were selected through convenience random sampling. The investigator approached three hospitals viz., S.K Hospital, PRS Hospital and Chelsa Hospital in Thiruvanathapuram city and prepared a list of hyperlipidemics attending the hospitals and persons under medication were deleted.

From the list hundred subjects were selected who fulfilled the above criteria. Both male and female subjects were included. After the selection, Preliminary information regarding their medical history, socio-economic background, dietary and lifestyle pattern were collected through a suitably structured pretested questionnaire.

3.2.1 MEDICAL AND HEALTH STATUS

Details on the medical history of 100 subjects for various diseases, consumption pattern of drugs and presence of diseases were collected through the interview schedule and the lipid profile of the respondents was estimated. Health status of the respondents was assessed through anthropometry.

According to Bhasin and Kapil (1998) anthropometric measurements are important tools to assess the nutritional status of individuals. Anthropometry has been accepted as an important tool for assessment of nutritional status, which

provides the single, most portable, universally applicable, inexpensive and non-invasive technique for assessing the size, proportions and composition of the human body. Anthropometric measurements used in this study included height, weight, waist and hip circumference. These were measured using standardized techniques as detailed below.

3.2.1.1 Measurement of Height

The height is a measure of longstanding nutritional status. To determine height an anthropometric rod was fixed vertically on a smooth wall, perpendicular to the ground taking care to se that the floor area was clean and not rough.

The subjects were asked to remove their slippers and to stand with the centre of the back touching the wall with feet paralleled and heels, buttocks, shoulders and back of head touching the wall. The head was held comfortably erect, the arms hanging closely by the side.

A smooth, thin ruler was held on the top of the head in the centre crushing the hair at right angles to the wall and the height read off from the lower edge of the ruler to the nearest 0.5cm. Each reading was taken twice to ensure the correctness of measurement.

3.2.1.2 Measurement of Weight

Weight is the measurement of body mass (Rao and Vijayaraghavan, 1996). Body weight is the most widely used and simplest reproducible anthropometric measurement for the evaluation of nutritional status of individuals. In this study weight was measured using a platform balance.

PLATE NO. 6 - MEASUREMENT OF HEIGHT OF SUBJECTS

PLATE NO. 7 - MEASUREMENT OF BODY WEIGHT OF SUBJECTS

3.2.1.3 Body Mass Index

Body Mass Index (BMI) is expressed as the ratio of weight to height square. [Weight (kg)/ height $(m)^2$. This is used as a good indicator of nutritional status. From the recorded height and weight, Body Mass Index was computed. Based on the BMI subjects were classified as underweight, normal and overweight.

3.2.1.4 Waist hip circumference

According to Lean et al, (1995) waist circumference is used as a measurement that indicates the need for weight management and in the present study the circumference of waist was measured by passing a fibre glass tape around the waist and for hip measurements, the circumference of hip at the maximum point of proleons was measured using fibre glass tape as per the technique suggested by Bray (1991).

After recording waist and hip measurements of the subjects their Waist Hip Ratio was calculated by dividing the circumference of waist by the circumference of hip as suggested by (Chanda et al., 1995).

3.2.2 SOCIO-ECONOMIC PROFILE

The socio- economic profile of the subjects such as socio-economic level, religion, family background in general has a very distinct part to play in determining the attitude and food consumption, health and behavioural pattern of the individual (Arora, 1991; Nayga, 1994).

The socio-economic profile consisted of details regarding the family size, type of family, education and occupation of family members, total monthly income and percentage of monthly income spent on food and health care.

PLATE NO. 8 - MEASUREMENT OF HIP CIRCUMFERENCE OF THE SUJECTS

PLATE NO. 9 - MEASUREMENT OF WAIST CIRCUMFERENCE OF THE SUBJECTS

Details regarding the socio economic profile of hundred respondents were assessed using a pre tested questionnaire schedule. The socio-economic survey was conducted since the social and economic condition in which one lives is said to have a direct impact on food habits and health status says Meer et al, (1995).

3.2.3 CURRENT DIETARY PATTERN

According to Swaminathan (1993), through diet surveys information on nutrient intake levels, sources of nutrients, food consumption pattern and preference could be collected.

In the present study a diet survey was carried out on a sample of 100 respondents. Details regarding the inclusion of a food item in meals per week by the respondent as well as the total quantity of the particular food consumed were recorded using systematic pretested questionnaire.

3.2.3.1 Food Use Frequency

A Food use frequency score sheet was also included in the diet survey schedule, since the frequency of use of different food groups would give an indication to the adequacy of the family diet pattern.

Based on the frequency of use of various food items by the respondents food use frequency scores were calculated using the formula as suggested by Reaburn et al, (1979).

The mean score for various food items was calculated using the formula:

$$\text{Mean Score} = \frac{R_1S_1 + R_2S_2 + \ldots\ldots\ldots\ldots + R_nS_n}{100}$$

$$\text{Percentage of total score} = \frac{\text{Mean Score}}{n}$$

Si = Scale of rating given for frequency of use of a food item (i=1, 2……8)

Ri = Percentage of subjects selecting rating coming under each frequency group (i=1, 2……..8)

n = Maximum scale rating (= 8)

Based on the percentage score obtained the food articles were classified into several groups, i.e. daily, thrice in a week, twice a week, once in a week, once in a month, occasionally and never.

3.2.3.2 Twenty four hour recall method was used to assess the food intake of subjects. The nutrient intake was computed from the average food consumption of individual using food composition table (ICMR, 1991) and the values were compared with recommended dietary allowances (RDA) of the respective age groups based on their sex and activity.

3.2.4 LIFE STYLE PATTERN

Life style pattern include the personal habits, stress and strain in daily life, type of food they consume etc. Life style pattern has its own effect on the health of an individual. Personal habits of the subjects such as the use of alcohol, cigarette, beedi, snuff etc were recorded. Data regarding the habit of doing exercise as well as the different stress and strain faced by the subjects were also recorded.

3.2.5 GENERAL DIET COUNSELLING

After collecting the above mentioned data, all the respondents were given a general diet counselling on "Hyperlipidemia and its Management". Prior to counselling a pre-test was conducted among the respondents to check their attitude towards foods and supplements that lowered cholesterol. For this purpose an attitude scale was first developed.

Attitude Scale construction included the following steps:

- Selecting topic of interest (Universe of content)
- Collection of statements
- Editing of statements
- Selection of statements by a panel of judges
- Treating of the statement with available techniques
- Testing the reliability, validity and practicability

By following the above steps, 30 statements were selected initially and were distributed to a panel of judges. It included both positive and negative statements. Based on the scoring of judges statements which were similiar in response were avoided and after editing 20 statements were selected. The Scale value and Q value

PLATE NO. 10 - GENERAL DIET COUNSELLING

of the 20 statements was obtained and are presented in Appendix II. Those statements with lowest Q value were taken for the development of attitude scale. Thus finally 16 statements were selected and distributed to respondents prior to counselling.

Statements given to respondents are presented in Appendix III. The respondents were given the statements and the scores were obtained before counselling. Then a suitable day was fixed and the respondents were informed. The counselling programme included the following sessions:

A lecture class was taken along with charts, pictures etc which helped to arouse interest in respondents. After the class there was a discussion session in which the doubts of the subjects will be cleared through an interactive process. The last step in diet counselling was that the respondents were given the same set of statements which was given early for the pre-test. This step is very important because it helps to know whether there is any change in the attitude of respondents. Thus the scores of the post test were also taken.

3.3 CONDUCT OF FEEDING TRIAL

Based on the high scores obtained from attitude test forty five subjects who were willing to participate in the study and not under medication for hyperlipidemia were selected. The study group of forty five subjects was further divided into two groups:

(i) Experimental Group
(ii) Control Group

The experimental group consisted of thirty subjects and the control group consisted of fifteen subjects. The supplement was prepared in the laboratory and the

formulated supplement was distributed to the experimental group for a period of three months. The control group was kept as such without flaxseed supplementation and there was no restriction on their food consumption pattern during the study period. Each subject of experimental group was given 40g of the supplement daily. For ease of consumption, the subjects were given the supplement in the form of small laddus. These laddus were distributed to the subjects daily for a period of three months.

After forty five days of supplementation, the lipid profile of both experimental and control group was estimated. In between the investigator had contacted the subjects both personally and through phone to know whether the subjects consumed the supplement on a regular basis and if there was any alteration made in the consumption pattern of the supplement by the respondents. The supplementation was continued for another forty five days.

3.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

Feeding experiments over a given period of time is considered as the most reliable method to determine the impact of a food. The feeding experiment conducted for a period of three months to assess the efficacy of flaxseed supplement on hyperlipidemic subjects was carried out by assessing the lipid profile. After forty five days of supplementation the lipid profile of both experimental group and control group was estimated.

After the completion of the feeding trial(after 3 months) the lipid profile was again estimated and were compared with the initial, intermediate values obtained to test whether there was any significant difference in the lipid profile of subjects after

supplementation and were also compared with the initial, intermediate and final values of the control group to test its significance. Lipid profile of both experimental group and control group was taken and the results are presented in the Appendix V and VI.

CONSOLIDATION AND ANALYSIS OF DATA

The data collected was coded, scored and consolidated before subjecting to statistical analysis and interpretations. Data collected through the above mentioned methods and procedures were analysed using suitable statistical tools. The statistical procedures used for the study are as follows:

(i) Mean, Percentage: for finding frequency distribution of data

(ii) Correlation: for determining the relationship of selected independent variables with dependent variables.

(iii) Analysis of Variance (ANOVA): for comparison of mean values among the variables

(iv) t- test: used to test the significance between two variables.

RESULTS

4. RESULTS

The present study entitled "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects" was initiated and the results of the study are presented under the following topics

4.1 FORMULATION OF THE SUPPLEMENT

4.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

4.3 CONDUCT OF FEEDING TRIAL

4.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

4.1 FORMULATION OF THE SUPPLEMENT

4.1.1 SELECTION OF RAW INGREDIENTS

The basic raw ingredients selected for the formulation of supplement was flaxseed. Other ingredients used were rice and jaggery. While selecting the ingredients care was taken to incorporate locally available, low cost as well as nutritionally superior food materials.

The raw ingredients were combined in different proportions for the formulation of the supplement. As presented in Table-2, the main ingredient of the supplement was added in the proportion of 25g which was common for all the ten combinations. The other two ingredients, rice and jaggery were added in different proportions. Rice was incorporated in the proportion ranging from four grams to thirteen grams and jaggery was added in the proportion ranging from two grams to eleven grams.

Table: 2 Composition of food ingredients for different combinations of the Supplement

SL. No	Combinations	Ingredients	Proportion (g)	Total (g)
1.	C1	Flaxseed: Rice: Jaggery	25: 13: 2	40
2.	C2	Flaxseed: Rice: Jaggery	25: 12: 3	40
3.	C3	Flaxseed: Rice: Jaggery	25: 11: 4	40
4.	C4	Flaxseed: Rice: Jaggery	25: 10: 5	40
5.	C5	Flaxseed: Rice: Jaggery	25: 9: 6	40
6.	C6	Flaxseed: Rice: Jaggery	25: 8: 7	40
7.	C7	Flaxseed: Rice: Jaggery	25: 7: 8	40
8.	C8	Flaxseed: Rice: Jaggery	25: 6: 9	40
9.	C9	Flaxseed: Rice: Jaggery	25: 5:10	40
10.	C10	Flaxseed: Rice: Jaggery	25: 4: 11	40

4.1.2 SELECTION OF THE BEST COMBINATION

The principle governing the selection of the best combination was overall acceptability. Nutritional adequacy and cost were the other criterions.

4.1.2.1 OVERALL ACCEPTABILITY OF THE SUPPLEMENT

Overall acceptability of the combination was assessed through evaluation of organoleptic qualities. The organoleptic quality parameters namely appearance, colour, flavour, taste and texture of the ten combinations was carried out by a panel of ten selected judges using standard pre-tested score card with a maximum score range of 5.

Table: 3 MEAN SCORES FOR ORGANOLEPTIC QUALITIES OF DIFFERENT COMBINATIONS

Quality Parameters	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
APPEARANCE	3.7	3.9	4.0	4.2	4.0	3.9	4.0	3.6	4.4	3.9
COLOUR	4.2	2.9	3.8	4.5	3.0	3.6	3.6	3.2	2.8	3.6
FLAVOUR	3.7	4.0	3.9	4.6	3.9	4.0	3.4	2.9	3.4	2.8
TASTE	4.0	3.8	3.9	4.8	2.5	3.8	3.5	3.3	3.9	3.1
TEXTURE	3.8	3.4	4.0	4.6	2.6	4.0	3.6	3.7	3.0	3.7
OVERALL ACCEPTABILITY	3.9	3.6	4.0	4.5	3.2	3.8	3.6	3.3	3.5	3.4

The supplement for feeding experiment was prepared by trying out ten different combinations. These combinations were given to a panel of selected judges for organoleptic evaluation. The mean scores obtained for organoleptic parameters are presented in Table: 3

As per the decision of panel members, C1 combination obtained an overall acceptability of 3.9. It had got a sore of 4.2 for colour, 4.0 for taste and 3.8 for texture. The lowest score of 3.7 was obtained for appearance and flavour respectively.

C2 combination had secured a score of 3.6 for overall acceptability which was the same as that of C7 combination. It obtained a score of 3.9 for appearance, 2.9 for colour, 4.0 for flavour, 3.8 for taste and 3.4 for texture.

C3 combination had obtained the second highest overall acceptability score of 4.0. The other parameters include appearance 4.0, colour 3.8, flavour 3.9, tate3.9 and texture 4.0.

C4 combination had secured a score of 4.2 for appearance, 4.5 for colour, 4.6 for flavour, 4.8 for taste and 4.6 for texture. The overall acceptability for C4combination was found to be 4.5, which was highest score obtained among other combinations.

C5 combination had comparatively low scores for parameters like taste 2.5 and texture 2.6. The scores obtained for appearance was 4.0, colour 3.0 and flavour 3.9. C5 combination had got the lowest overall acceptability score of 3.2 when compared to other combinations.

C6 combination obtained an overall acceptability of 3.8. It got a score of 3.9 for appearance, 3.6 for colour, 4.0 for flavour, 3.8 for taste and 4.0 for texture

C7 combination has got an overall acceptability of 3.6. It had obtained a score of 4.0 for appearance, 3.6 for colour, 3.5 for taste and 3.6 for texture. The lowest score was obtained for flavour 3.4.

C8 combination had obtained the second lowest mean score for overall acceptability. The scores obtained for colour was 3.2, flavour 2.9, taste 3.3 and texture 3.7 .It had also obtained lowest score for appearance 3.6 when compared to other combinations

C9 combination got a mean score of 3.5 for overall acceptability. It obtained a score of 4.4 for appearance, 3.4 for flavour, 3.9 for taste, 3.0 for texture and 2.8 for colour which was the least score obtained for C9 combination when compared to other combinations.

C10 combination had got an overall acceptability of 3.4. The combination obtained the score of 3.9 for appearance, 3.6 for colour, 2.8 for flavour and 3.7 for texture. The lowest score of 3.1 was obtained for taste when compared with other combinations.

The result of organoleptic evaluation showed that out of the ten combinations tried, C4 combination had secured highest score in all parameters.

4.1.2.2 NUTRITIONAL ADEQUACY

The nutritional adequacy of ten combinations was assessed by computing the calorie, protein, fat and fibre content. The computed values are presented in Table: 4

Table: 4 Nutrient content of different combinations

Combinations	Calorie (Kcal)	Protein (g)	Fat (g)	Fibre (g)
C1	100	3.0	3.16	4.34
C2	101	3.0	3.15	4.25
C3	100	3.2	3.14	4.24
C4	103	3.3	3.12	4.34
C5	101	3.2	3.14	4.24
C6	101	3.1	3.14	4.24
C7	102	3.1	3.13	4.23
C8	102	3.0	3.13	4.24
C9	101	3.0	3.15	4.25
C10	102	2.9	3.13	4.23

The calorie, protein, fat and fibre content of the ten combinations are presented in Table: 4.As revealed in the table, the energy values ranged from 100-103Kcal per 40g. C4 combination which contained flaxseed, rice and jaggery in the ratio 25: 10: 5 obtained the highest calorie content of 103 Kcal per 40g. The calorie content of 102kcal was obtained for C7, C8 and C10 combinations followed by 101Kcal for C2, C5, C6 and C9combinations. C1 and C3 combination obtained the lowest calorie content of 100 Kcal per 40g.

Regarding protein content, the values ranged from 2.9-3.3g per 40g. Among the ten combinations, C4 combination obtained the highest protein content of 3.3g per

40g. The lowest protein content of 2.9g was obtained for C10 combination when compared to rest of the combinations.

With regard to the fat content, out of the ten combinations, C1 combination obtained the highest fat content of 3.16g per 40g, while the lowest fat content of 3.12g was observed for C4 combination when compared to rest of the combinations.

Fibre plays an important part of the supplement. The fibre content of ten combinations ranged between 4.23-4.34 per 40g. C4 combination had obtained the highest fibre content of 4.34per 40g. Thus regarding nutritional adequacy also, C4 combination was found to be the best among the ten combinations.

4.1.2.3 COST

The cost of different combinations was computed as per the market price of ingredients selected and are presented in Table: 5

Table: 5 Cost of different combinations

Combinations	Cost (Rs/ 40g)
C1	1.30
C2	1.20
C3	1.20
C4	1.10
C5	1.14
C6	1.12
C7	1.12
C8	1.12
C9	1.20
C10	1.12

Since 40g of the supplement was distributed daily to each subject, the cost for 40g of the supplement was calculated. As per table above the highest cost of Rs 1.30 was obtained for C1 combination. The cost for C2, C3 and C9 was Rs 1.20 per 40g. Similarly the cost for C6, C7, C8 and C10 were also found to be uniform (Rs 1.12 per 40g). The lowest cost of Rs 1.10 was observed for C4 combination.

From the above tests, it was observed that, C4 combination (where flaxseed, rice and jaggery was taken in the proportion 25: 10: 5) had secured high scores in all parameters such as overall acceptability, nutritional adequacy and cost Hence C4 combination was selected for the conduct of feeding trial.

4.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

Selection of Hundred subjects was done by simple random sampling. For this purpose, three hospitals from the city namely SK Hospital, PRS Hospital and Chelsa Hospital were selected. A list of hyperlipidemic subjects was collected from the hospital records and from that, hundred subjects those fulfilling the inclusion criteria mentioned in methodology were selected.

After selection of subjects, data on their medical and health history, socio-economic background, dietary and lifestyle pattern were collected and the results are as follows:

4.2.1 MEDICAL AND HEALTH HISTORY

Medical and health history of the subjects was assessed through their, presence of diseases, anthropometric measurements and lipid profile

Table: 6 depicts the data on the distribution of respondents according to their family history for different diseases .

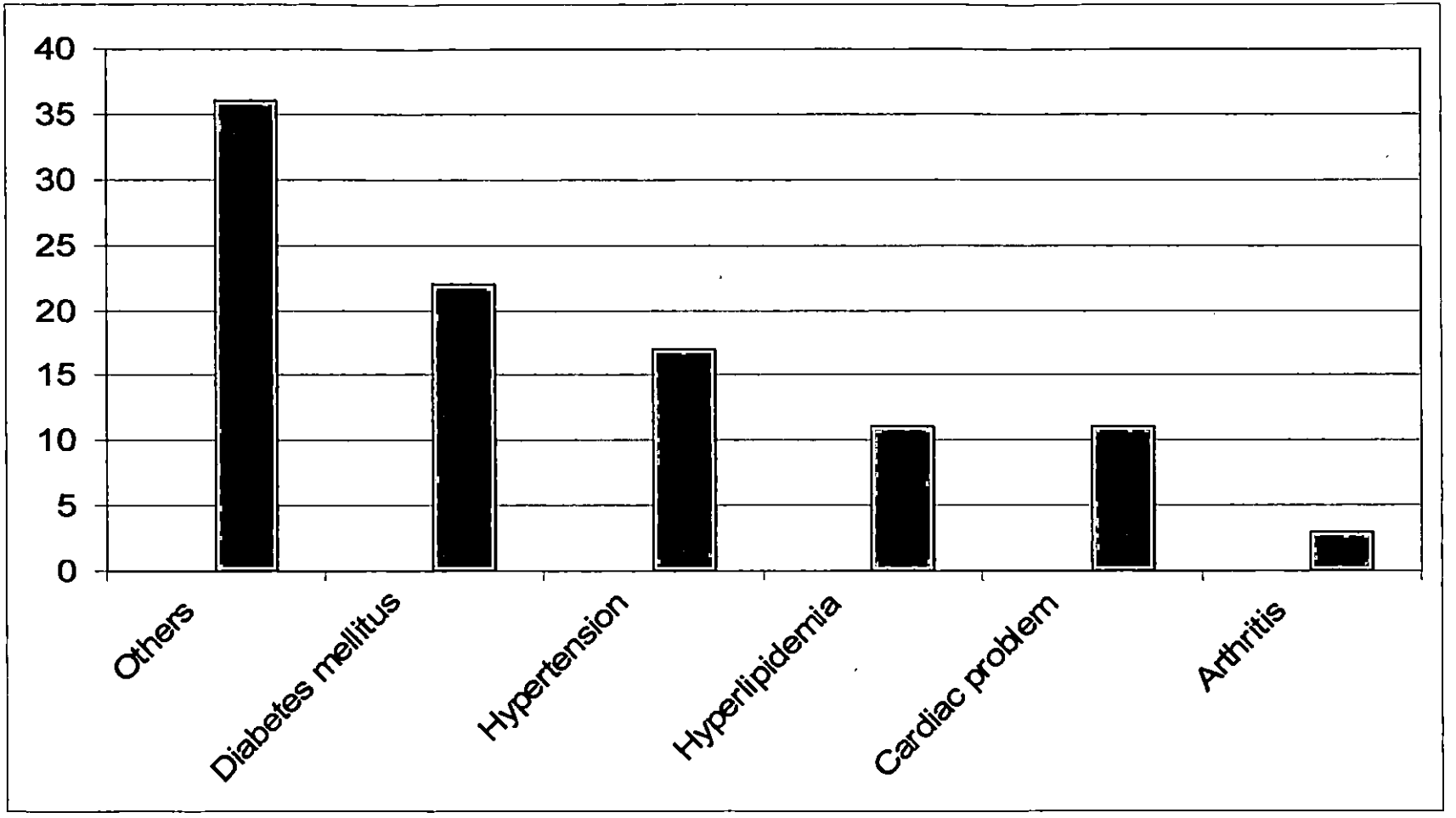

Fig: 2 Distribution of respondents according to their family history for various diseases

Table: 6 Distribution of respondents according to their family history on different diseases

Sl. No.	Characteristic	Category	Percentage
1.	**Family history for Diseases**	**Hyperlipidemia** **Cardiac problem** **Diabetes** **Hypertension** **Arthritis** **Others (nil)**	11 11 22 17 3 36
		Total	100

The above table shows that, out of hundred respondents, 36 per cent of them did not have a family history for the above mentioned diseases. 11 per cent of respondents have a family history for hyperlipidemia and another 11 per cent had a history for cardiac problem. 22 per cent of respondents had family history for diabetes and 17 per cent of them had family history for hypertension. Only 3 per cent had a family history for arthritis.

Table: 7 reveals data on the distribution of respondents based on the presence of disease and the number of years they have been affected

Table: 7 Distribution of respondents based on the presence of disease and the number of years they have been affected

SL.No.	Characteristics	Category	Percentage
1.	Not having the above diseases	Nil	54
2.	Having diseases and Number of years been affected	< 1 year 1- 3 years 3-6 years > 6 years	 3 18 13 12
		Total	46
		Grand Total	100

Table: 7 depicts that out of hundred respondents surveyed 46 per cent of them had one or the other disease mentioned in Table: 6. Regarding the number of years 18 per cent had been affected from 1-3 years, followed by 13 percent from 3-6 years, 12 per cent above 6years and only 3 per cent had been affected for less than 1year.

The consumption pattern of medicines by the respondents revealed that, Out of hundred respondents surveyed, 37 per cent consume medicines for various diseases and 63 per cent were not under any medication.

Distribution of respondents according to height and weight is presented in Table: 8

Table: 8 Distribution of respondents according to Height and Weight

SL.No.	Characteristics	Category	Mean Height	Percentage
1.	Height (cm)	145 – 155	160cm	19
		155 – 165		50
		165 – 175		23
		175 and above		8
				100
			Mean Weight	
2.	Weight (Kg)	40 – 50	66kg	2
		50 - 60		14
		60 - 70		47
		70 – 80		37
			Total	100

The above table shows that the height of hundred respondents ranged from 145cm to 180cm with a mean height of 160cm. Majority of respondents (50 per cent) had their height in the range between 155cm and 165cm respectively. Regarding weight of respondents, it ranged from 40 to 92kg with a mean weight of 66kg. 47 per cent had a weight in the range of 60 – 70kg, followed by 37 per cent in the range of 70-80kg, 14 per cent in the range of 50 – 60kg and only 2 per cent in the range of 40 – 50kg.

Table: 9 Distribution of respondents based on Body Mass Index (BMI)

BMI Classification*	Percentage
< 16 CED Grade III (Severe)	1
16.1 – 17.1 CED Grade II (Moderate)	1
17.1 – 18.5 CED Grade I (Mild)	0
18.5 – 20.0 (Low weight, Normal)	2
20.0 – 25.0 (Normal)	26
25.0 – 30.0 (Obese, Grade I)	59
> 30.0 (Obese, Grade II)	11
Total	100

*Source: Bamji, 2003

Table:9 shows the classification of respondents based on the BMI .It showed that 59 per cent of respondents had a BMI in the range of 25.0 – 30.0 (Obese, Grade I), followed by 26 per cent in the range between 20.0 – 25.0 (Normal) and 11 per cent in the range of > 30.0 (Obese, Grade II). Only 2 per cent was observed in the range of 18.5 – 20.0 (Low weight, Normal), followed by 1 per cent each in < 16 CED Grade III (Severe) and 16.1 – 17.1 CED Grade II (Moderate).

Table: 10 Distribution of respondents based on Waist Hip Ratio (WHR)

Waist Hip Ratio (Range)*	Mean	percentage
< 0.8 (Low)		0
0.8 – 0.85 (Normal)	0.84	70
0.86 – 0.9 (Abdominal obesity)		18
> 0.9		12
	Total	100

*Source: Srilakshmi, 2003

Table: 10 shows that result of respondents based on the WHR which revealed that majority of respondents (70 per cent) had normal WHR, followed by 18 per cent in the range of 0.86 – 0.9 and 12 per cent above 0.9. None of the respondents had a WHR below 0.9. The mean value obtained for WHR was 0.84.

Distribution of respondents based on blood lipid profile are presented in Table: 11

Table: 11 Distribution of respondents based on blood lipid profile

SL.No.	Lipid constituents	Normal values* (mg/dl)	Category (mg/dl)	Mean values	Percentage
1.	Total Cholesterol (TC)	<200	<200 200-250 250 & above	220mg/dl	31 48 21
				Total	100
2.	Triglycerides (TG)	150	<150 150- 200 200 & above	159mg/dl	43 33 24
				Total	100
3.	Low Density Lipoprotein (LDL)	150	<150 150- 200 200& above	147mg/dl	46 53 1
				Total	100
4.	High Density Lipoprotein (HDL)	>40	30-40 40- 50 50 & above	43mg/dl	20 69 11
				Total	100
5.	Very low Density Lipoprotein (LDL)	<40	10- 20 20- 30 30- 40 40 & above	29mg/dl	13 47 20 20
				Total	100

*Source: Srilakshmi 2006

The results of initial blood analysis of respondents show that the TC ranged from 140 to325mg/dl with a mean value of 220mg/dl. Out of hundred respondents 31 per cent had TC less than 200mg/dl, while majority of them had TC above 200mg/dl.

Similarly, 43 per cent of respondents had TG values below the normal value (150mg/dl). 33 per cent had TG value in range of 150 – 200mg/dl and 24 per cent in the range above 200mg/dl with a mean value of 159mg/dl.

Regarding LDL Cholesterol, out of hundred respondents 53 per cent had LDL values in the range of 150 – 200mg/dl, followed by 46 per cent in the range below 150mg/dl and only 1 per cent had above 200mg/dl with a mean value of 147mg/dl.

HDL of the respondents ranged from 33 to 54mg/dl with a mean value of 43mg.dl. 20 per cent had a HDL value in the range of 30 to 40mg/dl, while majority of respondents (69 per cent) had desirable level of HDL levels.

The VLDL values ranged from 12mg/dl to 50 mg/dl with a mean value of 29mg/dl. 47 per cent had VLDL values in the range of 20 – 30mg/dl.

4.2.2 SOCIO ECONOMIC PROFILE

The socio economic profile consisted details regarding age, sex, religion, type of family, occupation, monthly income and monthly expenditure on food and health care of the respondents.

Data on the age wise and sex wise distribution of respondents are presented in Table: 12

Table: 12 Distribution of respondents according to age and sex

SL.No.	Characteristics	Category	Percentage
1.	Age	35 – 45years	41
		45 – 55years	49
		55years & above	10
			100
2.	Sex	Male	33
		Female	67
		Total	100

The above table reveals that, Among the hundred respondents, 49 per cent belonged to the age group between 45 – 55years, followed by 41 per cent in the age group of 35–45years and only 10 per cent were in the age group of 55years.On the basis of sex , 33 per cent were males and 67 per cent were females.

The religion wise distribution and the type of family of respondents are presented in Table: 13.

Table: 13 Distribution of respondents according to religion and type of family

SL.No.	Characteristics	Category	Percentage
1.	Religion	Hindu	95
		Muslim	2
		Christian	3
		Total	100
2.	Type of Family	Nuclear	80
		Extended	5
		Joint	15
		Total	100

The above table reveals that, majority of respondents (95 per cent) belonged to Hindu community followed by 2 per cent belonged to Muslim community and 3 per cent belonged to Christian community. Regarding the type of family, 80 per cent belonged to nuclear families, 5 per cent from extended families and 15 per cent belonged to joint families.

The educational status and occupation of the respondents are presented in Table: 14

Table: 14 *Distribution of respondents based on their educational status and occupation*

SL.No.	Characteristics	Category	Percentage
1.	Educational Status	Below SSLC	11
		SSLC	36
		Pre-degree	9
		Graduate	33
		Post graduate	11
		Total	100
2	Occupation	Government Service	43
		Business	10
		Self employment	4
		Others	43
		Total	100

The above data reveals that, 11 per cent had a educational level below SSLC, followed by 36 per cent belonged to group II (SSLC), 9 per cent were pre-degree, 33 per cent graduates, 11 per cent were post graduates. As far as occupation is concerned majority of respondents (43 per cent) were in Government service, 10 per cent of them were doing business and only 4 per cent were self employed. 43 per cent of ladies were housewives.

The economic status of the family and distribution of respondents based on their monthly expenditure on food and health care is presented in Table: 15.

Table: 15 Distribution of families according to their monthly Income and monthly expenditure on food and health care

SL.No.	Characteristics	Category (Range Rs)	Percentage
1.	Monthly Income	5000 – 10,000	68
		10,000 – 20,000	31
		20,000 – 30,000	1
		Total	100
2.	Monthly Expenditure on food	1000 - 4000	85
		4000 – 6000	15
		Total	100
3.	Health Care	500 – 1000	70
		1000 – 1500	1
		1500 – 2500	3
		Others	26
		Total	100

The above table shows that, based on monthly income 68 per cent of respondents had income in the range of Rs5000 to 10,000 followed by 31 per cent in the range between Rs 10,000 to 20,000.and only 1 per cent had an income in the range of Rs20, 000 to 30,000. The monthly expenditure on food and health care shows that, 85 per cent of respondents expenditure on food falls between the range of Rs 1000 to 4000 followed by 15 per cent expenditure on food was in the range of Rs4000 to 6000 respectively.

Regarding health care, 70 per cent of respondent's expenditure on health care fall in the range of Rs500 to 1000 per month .26 per cent of them did not spend money on health care and only 3 per cent expenditure fall in the range of Rs1500 to 2500 and only 1per cent expenditure fall in the range between Rs 1000 to 1500 respectively.

4.2.3 CURRENT DIETARY PATTERN

Details regarding the food habit of respondents, frequency of consumption of a food item per week, quantity of food consumed, type and quantity of oil consumed per month and mean nutrients were considered to assess the dietary pattern of respondents

Among the hundred respondents surveyed majority of respondents (90 per cent) were non- vegetarians and 10 per cent were pure vegetarians.

Frequency of use of various food items among the respondents was assessed through scores ranging from one to eight depending on the frequency of use. Food use frequency scores were calculated Reaburn's method mentioned in methodology.

Data collected based on these scores to determine the use of different food items is presented in Table: 16. It was noticed that cereals and vegetables were consumed by 100 per cent of the respondents daily.

Considering the frequency of use of pulses 57 per cent of respondents consumed pulses more than thrice a week, followed by 31 per cent that used it thrice a week and only 12 per cent of respondents consumed it once or twice a week.

Frequency of use of roots and tubers was found comparatively less among respondents. Majority of respondents (86 per cent) used it once twice or thrice a week followed by 14 per cent used it more than thrice a week. With regard to spices 62 per cent used it once twice or rarely in their diet, while 26 per cent used more than thrice a week and only 12 per cent used spices daily in their diet6.

Data regarding the frequency of use of protective foods like fruits revealed that majority of respondents (78 per cent)consumed fruits more than thrice a week and only 22 per cent consumed it twice or rarely in a week.

Table: 16 Frequency of use of various food items by the Respondents

Food items	7days a week	6days a week	5days a week	4days a week	3days a week	2days a week	Once in a week	Rare
Cereals	100	-	-	-	-	-	-	-
Pulses	11	10	17	19	31	9	2	1
Roots &Tubers	2	2	6	4	15	38	25	8
Vegetables	100	-	-	-	-	-	-	-
Spices	12	8	7	6	5	30	20	12
Fruits	17	25	19	17	10	6	-	6
Fish	50	8	18	4	-	3	1	16
Meat	-	-	-	-	-	11	59	30
Egg	-	-	15	10	20	35	10	10

Data regarding the frequency of use of protein rich foods revealed that, 50 per cent of respondents included fish in their daily diet and 30 per cent consumed more than thrice a week and only 20 per cent consumed fish twice or rarely in a week.

Consumption of meat among respondents revealed that 59 per cent used meat once in a month while 30 per cent used it rarely and 11 per cent used it twice a week. Regarding the use of eggs it was found that 75 per cent of respondents consumed it once, twice or thrice a week and 25 per cent of them consumed egg more than thrice a week.

To make the data presented in Table:16 (food use frequency) more precise food frequency scores were calculated and their mean scores and percentage score of various food items based on the frequency of use by the respondents are presented in Table: 17.

Table: 17 Distribution of respondents based on the mean frequency scores of various food items

Food Items	Mean frequency scores of various food items	Percentage of total Scores
Cereals	8.00	100.00
Pulses	5.11	64.00
Roots and Tubers	3.48	43.50
Vegetables	8.00	100.00
Spices	3.86	48.25
Fruits	5.74	72.00
Fish	6.11	76.37
Meat	1.81	23.00
Egg	3.55	44.00

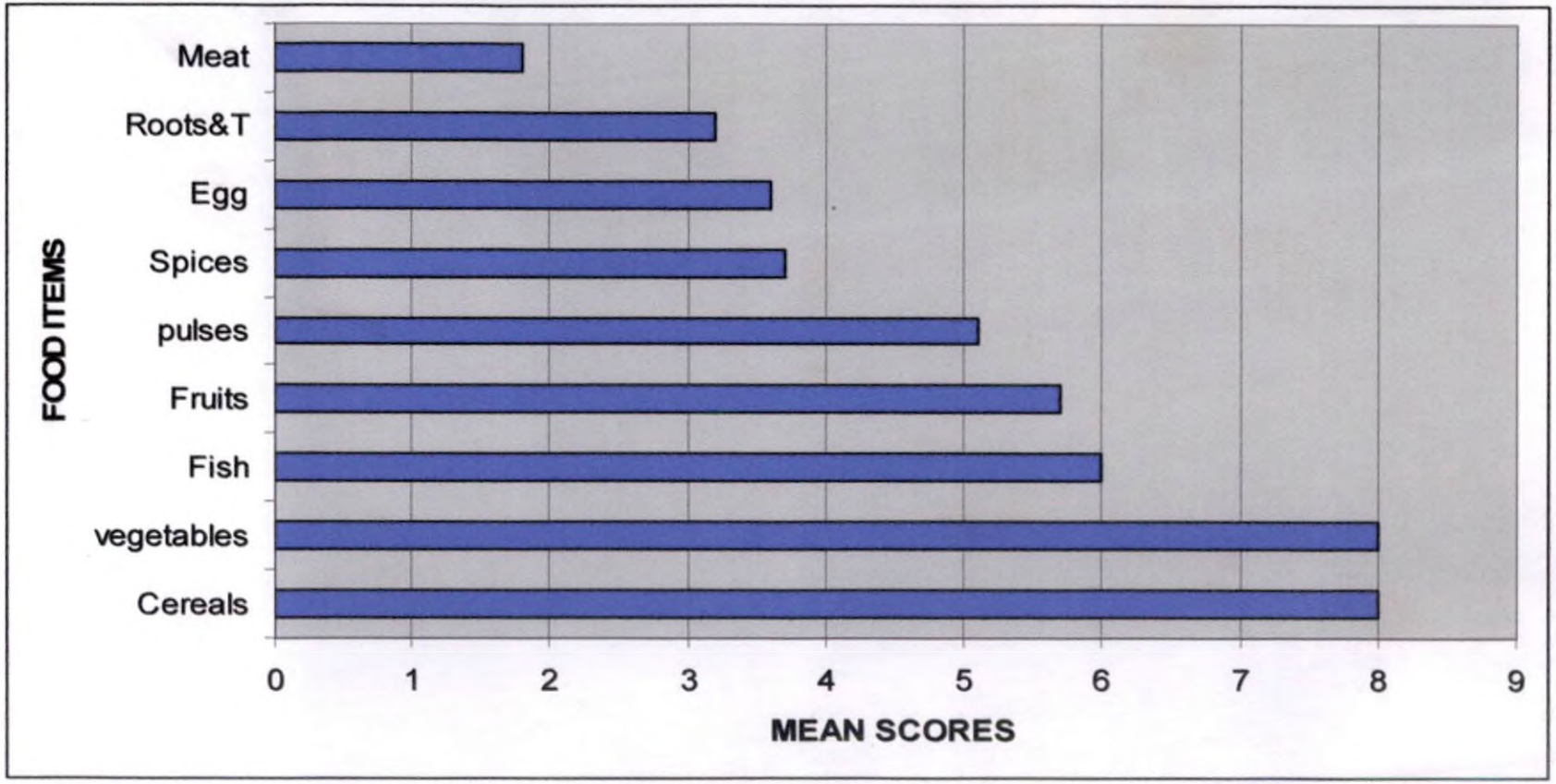

Fig: 3 FREQUENCY OF FOODS USED

As indicated in Table: 17 cereals and vegetables were found to obtain a mean score of 8. This was followed by fish, fruits and pulses with a mean score of 6.11, 5.74 and 5.11 respectively. The mean scores obtained for spices were 3.86, for eggs it was 3.55 and for roots and tubers it was 3.48 respectively. The least mean score of 1.81 was observed for meat.

Table: 18 Classification of foods based on the food scores

Particulars	Percentage of total scores	Food Items
Daily used foods	76 - 100	Cereals and vegetables
Moderately used foods	51 - 75	Fish, fruits and pulses
Less frequently used foods	26 – 50	Roots and tubers, egg and spices
Least frequently used foods	<25	Meat

Table: 18 shows the classification of foods based on the percentage of food scores. It was found that cereals and vegetables were used daily by all respondents with a percentage of total scores ranging from 76 – 100.

Fish, fruits and pulses were found to be moderately used with a percentage total score ranging from 51 – 75, while roots and tubers, egg and spices were found to be less frequently used with a percentage score ranging between 21 – 50 and meat was the least frequently used food item by the respondents with a percentage total scores less than 25.

Table: 19 Distribution of respondents based on the type, consumption and quantity of milk and milk products

SL.No.	Characteristics	Category	Percentage
1.	Do not consume milk as such	Nil	45
2.	Consume milk and type of milk used	Cows milk Milma Both	43 11 1
		Total	55
		Grand Total	100
3.	Quantity of milk used for tea and coffee	100 – 200ml 200 – 300ml 300 – 400ml 400 – 500ml	9 46 12 33
		Total	100
4.	Milk products consumed per day	Curd Buttermilk	25 32
		Total	100

Table: 19 reveal that 55 per cent of respondents consumed milk as such daily. Regarding the type of milk consumed majority of respondents (43 per cent) consumed cows milk followed by 11 per cent used milma and only 1 per cent used both respectively. With regard to the quantity of milk used, 46per cent used 200 - 300ml of milk daily for tea and coffee, followed by 33per cent who used 400 500ml of milk and only 9per cent used 100 – 200ml of milk daily for tea and coffee.

Regarding the consumption of milk products, 32 per cent of them consumed butter milk while 25 per cent only consumed curd. Remaining 43 per cent did not consumed these milk products

The consumption pattern of egg, fish and meat by the respondents are presented in table: 20, 21 and 22.

Table: 20 Distribution of respondents based on the consumption pattern and number of eggs consumed in a week

SL.No.	Characteristics	Category	Percentage
1.	Do not consume egg	Nil	45
2.	Number of eggs consumed in a week	1 – 2 2 – 3 3 & above	21 30 4
		Total	55
		Grand Total	100

Table: 20 reveals that out of hundred respondents surveyed 55 per cent consumed eggs. Regarding the number of eggs consumed in a week 30 per cent consumed 2-3 numbers in a week followed by 21 per cent who consumed 1-2 eggs a week and only 4 per cent consumed more than 3eggs a week.

Table: 21 Distribution of respondents based on the consumption pattern, type of fish, form and quantity consumed

SL.No.	Characteristics	Category	Percentage
1.	Do not consume fish	Nil	16
2.	Type of fish consumed	Sea River	80 4
		Total	84
3.	Quantity of fish consumed	100 – 150g 150 – 200g	53 31
		Total	84
4.	Form	Curry Fry Both	10 54 20
		Total	84
		Grand Total	100

Table: 21 depicts the data based on the consumption pattern, type of fish, form and quantity consumed. It shows that 84 per cent consumed fish daily and out of which 80 per cent consumed fish obtained from sea and only 4 per cent consumed fish obtained from river. Regarding the quantity consumed 53 per cent consumed 100 to 150g of fish per day, while 31 per cent consumed 150 to 200g per day respectively.

On the basis of form of consumption out of 84 per cent consuming fish 54 per cent preferred curry and 10 per cent preferred only the fried forms, while 20 per cent preferred both the forms.

Table: 22 Distribution of respondents based on the consumption pattern, type, form and quantity of meat

SL.No.	Characteristics	Category	Percentage
1.	Do not consume meat	Nil	30
2.	Type of meat consumed	Mutton Chicken Beef All the above	5 55 6 4
		Total	70
3.	Quantity of meat consumed	100 – 150g 150 – 200g	47 23
		Total	70
4.	Form	Curry Fry Both	2 50 18
		Total	70
		Grand Total	100

Table: 22 reveals that out of hundred respondents surveyed, 70 per cent of respondents consumed meat, while 30 per cent did not consume meat.

Among the different type of meat, chicken (55 per cent) was more consumed than mutton (5 per cent) and beef (6 per cent). Only 4 per cent consumed all the types of meat mentioned above.

Regarding the quantity consumed 47 per cent consumed 100 to 150g of meat, while 31 per cent consumed 150 to 200g of meat respectively. Based on the form of consumption 50 per cent preferred curry and 2per cent preferred it in the fried form, while 20 per cent preferred both the forms.

Details regarding the usage of oil and quantity of oil used by the families are presented in Table: 23

Table: 23 Distribution of families according to the type and quantity of oil consumed per month.

SL.No.	Characteristics	Category	Percentage
1.	Oil used for cooking	Coconut Sunflower Coconut &Sunflower	59 13 28
		Total	100
2.	Quantity of oil used by the Family per month	1 – 2kg 2 – 3kg >3kg	12 40 48
		Total	100

Table: 23 shows that out of hundred respondents surveyed, 59 per cent used coconut oil followed by 28 per cent used coconut and sunflower oil, while 13 per cent used sunflower oil alone.

Regarding the quantity of oil consumed it was found that a majority of 48 per cent used more than 3kg of oil per month followed by 40 per cent who used 2-3kg of oil per month while 12 per cent used 1-2kg of oil per month.

Data on the consumption pattern of sugar and sweet meats revealed that out of hundred respondents surveyed 82 per cent used sugar daily mainly for tea and coffee. 18 per cent did not consume sugar due to diabetes. Out of hundred respondents surveyed 37 per cent of respondents have a habit of consuming sweet meats in the form of cake, laddu, ice-cream and puddings.

Consumption pattern of salads revealed that 83 per cent had the habit of including salad in their diet while the remaining 17 per cent did not consume salad at all. Regarding the frequency of consumption 46 per cent consumed it occasionally while28 per cent consumed it weekly, once and only nine per cent consumed salad daily.

Consumption of food from outside and frequency of consumption of hundred respondents surveyed reveals that 76 per cent consumed food from outside; of which 62 per cent consumed occasionally from outside while 13 per cent consumed food from outside once in a month and only 1per cent consumed food daily from outside their homes.

Consumption pattern of beverages like tea, coffee and fruit juice among hundred respondents is presented in Table: 24

Table: 24 Consumption pattern of beverages among the respondents

SL.No.	Characteristics	Category	Percentage
(A) 1.	Consume Tea	yes	100
2.	Number of days a week	All days	100
3.	Quantity consumed [1cup- 120ml]	240ml	100
(B) 1.	Do not consume coffee	Nil	83
2.	Consume coffee and number of days a week	7days 4days 3days Occasionally	1 1 2 13
		Total	17
		Grand Total	100
3.	Quantity consumed [1cup- 120ml]	120ml 240ml	15 2
		Total	17
		Grand Total	100
(C) 1.	Do not consume fruit juice	Nil	60
2.	Consume fruit juice and number of days a week	Once Twice Thrice	27 9 4
		Total	40
		Grand Total	100
3.	Quantity consumed [1glass 200ml]	200ml	40
		Grand Total	100

The above table reveals details on the consumption pattern of beverages by the respondents are presented in Table: 24. It was found that all the respondents consumed two cups of tea daily. Only 17 per cent of the respondents consumed coffee, of which 13 per cent consumed occasionally and the remaining 4 per cent consumed it twice or thrice a week and the quantity consumed was one cup by15 per cent of respondents and two cups by 2 per cent of the respondents. Fruit juice was consumed by 40 per cent of respondents and majority of respondents (27 per cent) consumed it once in a week, followed by 9 per cent consumed twice and 4 per cent consumed thrice a week respectively.

Actual nutrient intake of the respondents was computed through their average intake of major nutrients like energy, protein and fat from three consecutive days menu and the mean values obtained was finally compared with the RDA values of the respective age group and the result is presented in Table :25.

Table: 25 Actual nutrient intake of the respondents

Nutrients	Mean values obtained	RDA values	Percentage of RDA met	Percentage of RDA deficit
Energy (Kcal)	2248	2425	93	7
Protein (g)	64	60	107	-
Fat (g)	32	20	160	-

The above table shows that the mean intake of calories by respondents was 2248Kcal which met 93 per cent of RDA value and showed a deficit of 7 per cent. Regarding protein intake the mean intake of respondents was 64g which was higher than the RDA value. Similarly the mean intake fat by the respondents was 32g while RDA is 20g. It showed an excess intake of 60 per cent.

4.2.4 LIFE STYLE PATTERN

The life style pattern of respondents such as stress and strain, smoking habit, frequency, type and quantity of alcohol consumed, type and duration of exercise was recorded.

The life style pattern of respondents based on the stress and strain in day today life is presented in Table: 26.

Table: 26 Distribution of respondents based on stress and strain in day today life

SL.No	Characteristics	Category	Percentage
1.	Having stress and strain in day today life	Yes Nil	65 35
		Total	100
2.	Types of stress	Occupational Family problems Health problems Financial problems Old age problems	16 14 16 15 4
		Total	100

The above table shows that out of hundred subjects surveyed 65 per cent have stress strain in day today life. Majority of respondents (16 per cent) had occupational stress and similar pattern was observed in health related problem also 15 per cent had stress related to financial problem and stress related to old age was experienced by 4 per cent of respondents.

Distribution of respondents based on family support and social support are presented in Table: 27

Table: 27 Distribution of respondents based on family support and social support

SL. No	Characteristics	Percentage
1.	Adequate family support	87
	Nil	13
	Total	100
2.	Adequate social support	87
	Nil	13
	Total	100
3.	Member of social organization	8
	Nil	92
	Total	100

The above table reveals that majority of respondents (87 per cent) have adequate family support and social support. Regarding membership in social organizations only 8 per cent were members of different organizations.

Distribution of respondents based on their habit of doing exercise revealed that walking was the most popular exercise followed by the respondents. Forty one per cent had the habit of walking and 2 per cent did jogging. Fifty seven per cent of respondents never used to do any exercise other than their routine work. Regarding relaxation technique, majority of 93 per cent of respondents do not practice any relaxation techniques, while 7 per cent practiced yoga.

Table: 28 Distribution of respondents based on their smoking habit

SL.No	Characteristics	Category	Percentage
1.	Smoking habit	Smokers Ex-smokers Non- smokers	9 11 80
		Total	100

Table: 28 shows that out of hundred respondents surveyed only 9 per cent were smokers and they used cigarettes followed by 11 per cent were ex- smokers while majority of respondents were non- smokers.

Table: 29 Distribution of respondents based on, type, quantity and frequency of alcohol consumed

SL.No	Characteristics	Category	Percentage
1.	Do not consume alcohol	Non- alcoholics Ex- alcoholics	78 5
		Total	83
2.	Type of alcohol consumed	Beer Whiskey Rum Others	5 4 3 5
		Total	17

3.	Frequency of alcohol consumed	Regular Most days Weekends Occasionally	4 1 6 6
		Total	17
4.	Quantity of alcohol consumed	<200ml 200-250ml >250ml	13 3 1
		Total	17
		Grand Total	100

The above table reveals that out of hundred respondents surveyed, 78 per cent were not using alcohol which included all women surveyed and5 per cent of them were ex- alcoholics. Regarding the type of alcohol, 5 per cent consumed beer, 4 per cent consumed whiskey, 3 per cent consumed rum and 5 per cent used other brands.

Regarding the frequency of consumption of alcohol it was found that 4 per cent of the respondents were regular consumers of alcohol followed by 6 per cent consumed on all weekends and similarly 6 per cent consumed alcohol occasionally.

Regarding the quantity of alcohol consumption majority of respondents consumed less than 200ml of alcohol only, 3 per cent consumed in the range between 200-250ml and 1 per cent consumed more than 250ml of alcohol per day.

The correlation of various variables with the lipid profile of respondents was analysed statistically and the data is presented in Table: 30

Table: 30 Correlation of various variables with the lipid profile of respondents

SL. No.	Variables	TC	TG	LDL	HDL	VLDL
1.	Age	0.2698**	0.0871	0.0701	0.1801	0.0289
2.	Stress and Strain	0.2396*	0.1597	0.0741	0.0144	0.1968*
3.	Exercise	-0.1910*	-0.2313*	0.0588	0.0286	0.1703
8.	Egg consumption	0.2592**	0.2151*	0.1840	0.1425	0.0017

* Significant at 1per cent level

** Significant at 5per cent level

As depicted in Table: 30 there was a highly significant correlation observed between age and TC (0.2698**) at 5 per cent level. Similarly for stress significant correlation was observed with TC (0.2396*) at 1 per cent level.

With regard to exercise a significant negative correlation was observed between exercise and TC (-0.1910*) and TG (-0.2313*) at 1 per cent level. With regard to food consumption, there was highly significant correlation observed between egg consumption and TC (0.2592**) at 5 per cent level and TG (0.2151*) at 1 per cent level.

4.3 CONDUCT OF FEEDING TRIAL

Before the conduct of feeding trial a general diet counselling was given to the respondents and to test the attitude of respondents towards foods and supplements a attitude test was conducted before and after diet counselling. The result of the attitude test revealed significant change in the attitude of respondents after diet counselling.

The subjects for the feeding trial were selected on the basis of the scores of attitude test and willingness of the respondents. A study group of 45 subjects were selected and were divided into experimental group (30 subjects) and control group (15 subjects).

The experimental group was fed with the flaxseed supplement for three months and their blood lipid profile was assessed initially in between and finally after supplementation along with control group.

4.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

The efficacy of flaxseed supplement was assessed by determining the initial and finally lipid profile. The blood samples of both the experimental and control group were collected and lipid profile was analysed.

4.4.1 CHANGE IN THE BLOOD LIPID PROFILE

The results of the experimental group showed that, initially the mean value obtained for TC was 250mg/dl while it was reduced to 234mg/dl intermediately and216mg/dl finally after supplementation. The initial TG values obtained for subjects with a mean value of 180mg/dl followed by a decrease to 167mg/dl and 165mg/dl finally.

Regarding HDL, the initial mean value obtained was 40mg/dl which was significantly increased to 42mg/dl intermediately and 48mg/dl finally. The initial mean value obtained for LDL cholesterol was 152mg/dl which was found to be reduced to148mg/dl intermediately and 143mg/dl finally after flaxseed supplementation. With regard to VLDL cholesterol the mean value initially was37mg/dl and was significantly reduced to31mg/dl and 26mg/dl finally.

The results of the control group showed that, initially the mean value obtained for TC was 255mg/dl while 257mg/dl intermediately and260mg/dl finally. No significant change was observed but only a slight variation was observed in the TC values. Similar result was obtained for TG, HDL, LDL and VLDL values. As this group was not given the supplementation there was no marked variation observed in the values of the control group.

Lipid profile values of experimental and control group is presented in Table: 31

Table: 31 LIPID PROFILE VALES OF EXPERIMENTAL AND CONTROL GROUP (Using t- test and ANOVA)

	Total Cholesterol (TC)			Triglycerides (TG)			Low density lipoprotein (LDL)			High density lipoprotein (HDL)			Very low density lipoprotein (VLDL)		
	Exp. grp	Ctrl grp	t value	Exp. grp	Ctrl grp	t value	Exp. grp	Ctrl grp	t value	Exp. grp	Ctrl grp	t value	Exp. grp	Ctrl grp	t value
Initial values	250	255	0.46 (NS)*	180	167	1.14 (NS)*	152	175	1.68 (NS)*	40	40	1.28 (NS)*	37	31	1.54 (NS)*
Intermediate values	234	257	2.88**	167	168	0.19 (NS)*	148	174	7.80**	42	39	2.73**	31	32	3.19**
Final values	216	260	5.33**	165	169	1.50 (NS)*	143	177	10.3**	48	40	10.7**	26	35	7.58**
ANOVA	Exp. grp	Ctrl grp		Exp. grp	Ctrl grp		Exp. grp	Ctrl grp		Exp. grp	Ctrl grp		Exp. grp	Ctrl grp	
Critical Difference (CD)	15.18**	0.57 (NS)*		16.73 (NS)*	17.36 (NS)*		4.60**	13.25 (NS)*		1.97**	0.93 (NS)*		3.84**	4.22 (NS)*	

* NS

** Significant at 5 per cent level

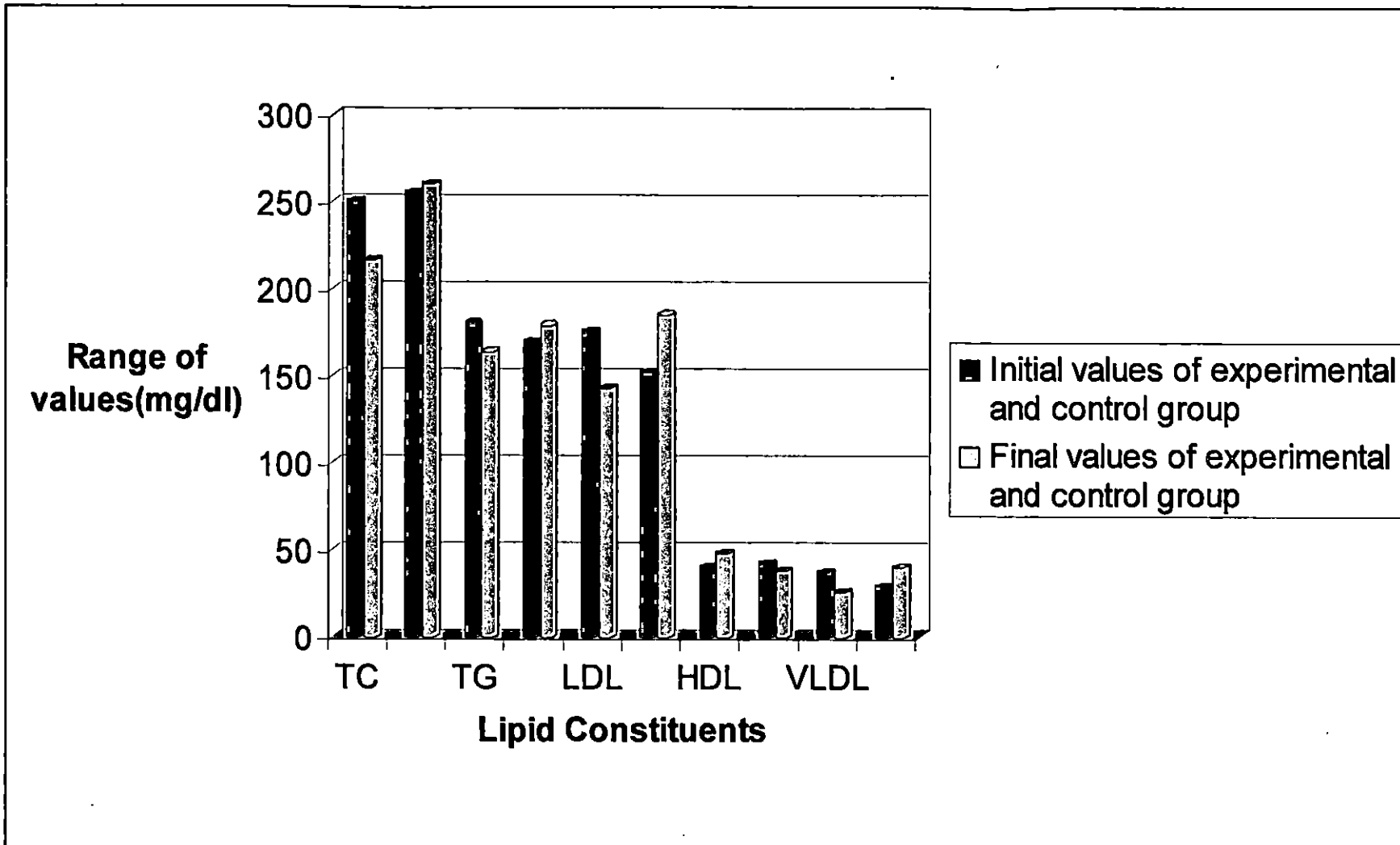

Fig: 4 CHANGE IN LIPID PROFILE OF BOTH EXPERIMENTAL AND CONTROL GROUP

The results obtained were analysed using statistical procedures. t-test and analysis of variance (ANOVA) to test the significance of experimental group and control group.

The results of t-test revealed significant difference within the experimental group and between experimental and control group. Since the tabulated t- value was greater than the calculated t value for TC, HDL, LDL and VLDL it showed significance at 5 per cent level.

Regarding TG, the calculated t value was less than the tabulated t- value and hence was not statistically significant at 5 per cent level. This test revealed a significant reduction in the lipid profile of experimental group when compared to the lipid profile of control group.

The data on the test for significance using ANOVA between experimental group and control group. The results of the test showed that, there was significance difference observed in the value for TC, HDL, LDL and VLDL of experimental group when compared with control group. The mean values obtained initially, intermediately and finally for TC, HDL, LDL and VLDL within the experimental group showed significant difference and the values were greater to the critical difference values of experimental group. Thus it was significant at 5 per cent level. The mean values obtained for TG was observed to be lower to the critical difference value hence it was found to be statistically insignificant.

The results clearly reveal that flaxseed supplementation has brought out a significant positive modification in the lipid profile of the hyperlipidemic subjects.

DISCUSSION

5. DISSCUSSION

Hyperlipidemia is the result of complex interrelated processes that involve several dietary factors influencing numerous physiological and metabolic processes. Therefore dietary goals for prevention and treatment should be to achieve proper balancing of nutrients, which ultimately maintains appropriate body weight and regulate the blood lipids (Ghafoorunissa and Swamy, 1995). According to Gopalan (1995), there is increasing need of public awareness for the importance of diet maintaince and promotion of health.

The present study entitled "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects" was undertaken with a view to study the impact of flaxseed supplement on the lipid profile of hyperlipidemic subjects. The results of the study are discussed under the following heads:

5.1 FORMULATION OF THE SUPPLEMENT

5.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

5.3 CONDUCT OF FEEDING TRIAL

5.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

5.1 FORMULATION OF THE SUPPLEMENT

Food consumption pattern have witnessed a major change in the past few decades with the availability of a large quantity of convenient foods (Renjini et al., 2000). Significant progress has been made by the food industries in our country in recent years in the area of new development of food products (Rao, 1993).

5.1.1 SELECTION OF RAW MATERIALS

The raw materials selected for the development of any food play an important role in determining the quality of a product. Flaxseed was the major ingredient selected for the formulation of the supplement because; flaxseed has been shown effective in reducing hypercholesterolemic atherosclerosis by 46per cent with out reducing serum cholesterol (Prasad, 1997). It is also a rich source of omega 3 fatty acid and richest source of plant lignans (Hunter, 1990).

Rice and jaggery were the other ingredients added in different proportions ranging from 4 to 13per cent and 2 to 11per cent respectively. The proportion of flaxseed was maintained (25g). Combining different ingredients in a product is also as important as the nature and properties of the ingredients.

5.1.2 SELECTION OF THE BEST COMBINATION

In the standardization of a new product different proportions of ingredients as in the standard recipe will be taken and different combinations will be tried out. In the present study, the ingredients were combined in ten different proportions and the best combination was selected on the basis of overall acceptability, nutritional adequacy and cost.

5.1.2.1 OVERALL ACCEPTABILITY OF THE SUPPLEMENT

Organoleptic qualities can be defined as qualities effecting a bodily organ or sense particularly of the combination of taste and aroma (Sindhu, 1995). Sensory evaluation of food is assumed to be of increasing significance as this provides information which may be utilized for the development of a product and its improvement. Quality parameters such as, appearance, colour, flavour, taste and texture are assessed by means of sensory organs.

According to Watts's et al, (1984) the information on the specific sensory characteristics of a food must be obtained by product oriented tests. Accordingly the organoleptic qualities of the ten combinations were carried out in the laboratory by ten selected judges.

Acceptability of any product can be influenced by their constituents as well as by the procedure selected for processing (Sindhu Chandran, 1995). Scores for overall acceptability was obtained by determining the mean scores of each character.

Appearance is a composite of all information about the product and its environment which reaches the eye (Birch et al., 1988). The score for appearance of C9 was superior to all other combinations and C8 was observed to be inferior to other combinations.

Colour is one of the most important characteristics by which quality of food is judged. The aesthetic, sensory characteristic and acceptability of food are all affected by colour (CFTRI, 1990). The score for colour of C4 combination was superior to all other combinations. C2 and C9 were observed to be inferior to other combinations.

The significance of flavour in a product is expressed by many authorities. Flavour is one of the most important sensory properties and is used for judging both quality and variety of food products (Vandana, 1999).Out of the ten combinations C4 obtained the highest score for flavour followed by C2 and C6.

Taste is the sensory response to soluble materials of the mouth. It is a important parameter for acceptance of a food material. C4 obtained a mean score of 4.8 which was the highest among other combinations.

Texture is a perception resulting from interaction between food and its consumers (Jack et al., 1995). It constitutes a physical property of food stuffs apprehended by the age, the skin and muscle sense located in the mouth. Similar to the other characters C4 obtained the highest score when compared to other combinations and C5obtained the least score for texture when compared to other combinations.

Finally by analyzing the mean score of each character it was observed that C4 obtained the highest score for overall acceptability and was selected as the best combination from the rest of the combinations.

5.1.2.2 NUTRITIONAL ADEQUACY

According to Potty (1993) the nutritive value of food is an important parameter for the development of any new food. The selected combination was analysed for its energy, protein, fat and fibre content.

Nutritional adequacy was assessed by computing the energy, protein, fat and fibre content of the ten combinations. It was observed that the calorie content of combinations varied from 100-103Kcal per 40g of the supplement. Out of the ten combinations C4 obtained the highest calorie content of 103 Kcal per 40g. The lowest calorie content of 100Kcal was observed for C1 and C3 combinations.

Protein is one of the important nutrient required by the body to carry out a wide range of functions essential for body building and maintaince of health. Regarding protein content, the values ranged from 2.9-3.3g per 40g. Out of the ten combinations C4 obtained the highest protein content of 3.3g per 40g when compared to other combinations.

But regarding fat content, Out of the ten combinations C4 obtained the least fat content of 3.12g per 40g when compared with rest of the combinations. The highest fat content was observed in C1 combination with a value of 3.16g per 40g. Ghafoorunissa (1992) remarked that the quantity and quality of dietary fat alters serum lipid fractions, which in turn play an important part in the precipitation of cardio vascular disease.

Regarding the fibre content, It was observed that the values of ten combinations ranged between 4.23 - 4.34 per 40g. The highest fibre content was observed for C4 combination. Different forms of fibre have different effects on serum cholesterol level and mainly soluble fibres help to reduce total cholesterol and LDL cholesterol levels reports Chanda et al, (1997).

5.1.2.3 COST ANALYSIS

Cost analysis is an important criterion for the selection of the best combinations. The supplement formulated weighed 40g and thus the cost was calculated for 40gm of the supplement. It was observed that C1 cost the maximum of Rs 1.30 and the lowest cost was observed for C4combination (Rs 1.10 per 40g) there was no much difference in cost of ten combinations but while comparing the costs C4 was more feasible.

The overall acceptability, nutritional adequacy and cost was best for C4 combination (flaxseed, rice and jaggery in the proportion 25: 10: 5). It secured high scores in all parameters. Hence C4 combination (flaxseed: 25, Rice: 10 and Jaggery: 5g) was selected for the conduct of feeding trial.

5.2 SELECTION OF HYPERLIPIDEMIC SUBJECTS

A list of hyperlipidemic subjects was collected from three hospitals in Thiruvanathapuram city namely SK Hospital, PRS Hospital and Chelsa Hospital and from the list one hundred subjects were selected who fulfilled the inclusion criteria mentioned in methodology. Data on their medical and health history, socio-economic background, dietary and lifestyle pattern was collected and discussed under following headings:

5.2.1 MEDICAL AND HEALTH HISTORY

Details related to the health history of the respondents were collected to get an accurate account of their health and to see this against the background of their life as a whole. In the present study out of hundred respondents 64 per cent had a family history for hyperlipidemia, cardiac problem, diabetes, hypertension, arthritis and the remaining 36 per cent were not having a family history for the above mentioned diseases.

Out of hundred respondents surveyed 46 per cent had one or other of the above mentioned diseases where as majority of respondents (54 per cent) were free from diseases. This data clearly revealed that if there is a family history for certain degenerative diseases it can affect the future generation of the family to some extent (Fraser et al., 1995). Regarding the consumption of drugs, majority of respondents (66 per cent) were not under any medication at present and only 34 per cent consumed medicines at present for various diseases.

Diet has been acclaimed to be one of the primary factors that help to promote growth and maintain life. The adequacy of diet consumed by the subjects can also be estimated through their anthropometric profile. Persons receiving good food and who are maintaining optimal dietary habits are expected to maintain the structure, form and composition of the body, even while ageing.

ICMR (1994) reported that in field studies to assess nutritional status heavy reliance must be placed in the measurement of external morphology of the body. Hence the health and nutritional status of the subjects were ascertained through anthropometric measurements such as height, weight and waist hip ratio.

Height and weight measured periodically are simple and useful indicators of body composition. From the height and weight of the subjects it was noticed that majority of (50 per cent) the subjects had height in the range of 155-165cm and (47 per cent) had weight in the range of 60-70kg. The mean height of respondents was observed to be 160cm and weight 66kg.

A highly significant positive correlation was found between age of respondents and their weight (0.2354*). It was observed that as age increased, weight of the individual also increased. According to a study done by Anselmo et al, (1992) reported that ageing seemed to be associated with increase in weight.

Body mass index (BMI) expressed as the ratio of weight to height ^{2} [Weight (kg)/ height $(m)^2$] was used as a parameter for detecting chronic energy deficiency (CED) and obesity. The results of the present study showed that only 26 per cent of respondents had a normal BMI in the range between 20 to25. 59 per cent of the subjects were in obese grade-I category. Obesity in respondents may be attributed due to hereditary characters or due to poor diet.

Crofit et al, (1995) reviewed that waist to hip circumference is a better predictor of obesity than BMI. Waist hip ratio (WHR) of the respondents showed that 70 per cent had normal WHR, where as 18 per cent had abdominal obesity. It was alarming to note that 12 per cent of the respondents had a WHR above 0.9 which is reported to be of greater risk.

Jain and Singh (2003) reported that WHR is a sensitive indicator to assess the risk of developing various degenerative diseases. WHO (2000) in their technical report has clearly pointed out that men with WHR above 1.0 and women with WHR above 0.85 are at risk.

The overall anthropometric data revealed that the respondents surveyed had weight above the standard weight which had made elevation in their BMI. Along with anthropometric measurements the blood lipid profiles of the respondents was also taken and are discussed below.

The total cholesterol (TC) values of respondents surveyed revealed that majority of them (69 per cent) had TC above the normal value i.e. 200mg/dl. Similarly the triglyceride (TG) values of 57 per cent of respondents were above 150mg/dl. According to Stampfer et al, (1996) higher TG levels are frequently accompanied by increased TC and LDL levels.

Regarding high density lipoprotein (HDL) 80 per cent of respondents had HDL values in the range of 40mg/dl and above. Low density lipoprotein (LDL) values of respondents showed that 54 per cent had LDL values above the normal range i.e. > 150mg/dl. Similarly the VLDL values of respondents showed that, 47 per cent had VLDL values in the range of 20 – 30mg/dl.

5.2.2 SOCIO ECONOMIC PROFILE

Socio economic factors have a definite bearing on the dietary factors of the people and there by on the dietary intake and nutritional status (Cicil, 2000). Economic and social conditions are reported to affect the nutritional status of an individual. Social factors like religion, occupation, education, beliefs and culture had important bearing on health (Ghosh, 1989).

In the present study, parameters studied were age, sex, religion, type of family, educational and employment status, family income and expenditure pattern. The results obtained are discussed below:

Age wise distribution of hundred respondents revealed that, 41 per cent belonged to the age group of 35-45 years, while majority of 49 per cent belonged to the age group of 45- 55 years and only 10per cent belonged to the age group of 55 years and above.

Sex wise distribution of respondents showed that out of one hundred respondents 67 per cent were females and 33 per cent were males. This shows the changing picture of Kerala, were the sex ratio favors women population. According to Censes figures there are more females than males. Kerala is the only State in India where the females out number of males in population with a sex ratio of 1058: 1000 (Economic Review, 2003).

The religion wise break up of the respondents was assessed, since it has been observed by Arora (19991) that religion plays a dominant role in the process of socialization and it maintains the stability of the social system and social relationships. In the present study, a sizable majority of the respondents (95 per cent) belonged to Hindu community while, 3 per cent were Christians and 2 per cent were Muslims.

This result is in accordance with the demographic profile of Thiruvanathapuram district. Kerala Statistical Institute Report (2001) states that Thiruvanathapuram district had a majority of population who followed Hindu religion.

Type of family and family size has an important role on the dietary habits of the subjects. Nuclear type of families was found to be more popular in the area surveyed. This reveals the recent social trend universally observed the fading of joint family system. .

Predominance of nuclear type families among those residing in Thiruvanathapuram has been reported by Lovely (1996). Similar trend was observed in the present study. 80 per cent of respondent's belonged to nuclear families followed by 15 per cent from joint families and 5 per cent belonged to extended families.

Educational status and literacy rate have been proved to be powerful determinants of nutritional status as it may influence the awareness about importance of good nutrition which can affect food choices. Present study revealed 100 per cent literacy and none of the respondents were illiterate and had a good educational status. According to KSI (2000), the literacy rate of Thiruvanathapuram district is as much as 89.22 per cent.

Employment is a set of activities centered on an economic role and is usually associated with earning a living, which is an important factor, defining a person's prestige, class, position and style of life. The occupational status directly or indirectly influences the health condition of an individual. The study revealed that 57 per cent respondents were employed and the remaining 43 per cent were housewives.

According to Arora (1991) income is an important indicator of the social and economic status of an individual. It is the family income which determines the socio economic strata to which a person belongs. The present study also showed that majority of the respondents belonged to the middle income group. 68 per cent of them earned a monthly income in the range of Rs5000-10,000 followed by 31 per cent between Rs10, 000-20,000 and only 1per cent earned above 20.000.

Food is the major vehicle for improving the nutrition of people and is influenced by income level. A general trend was observed in the present study that as the monthly income increased, percentage of income spend on food decreased and vice versa. A survey conducted by NIN (1991) revealed that the dietary intake was found to be markedly influenced by income level.

There was highly significant correlation (0.4021**) at 5 per cent level was observed between monthly income and monthly expenditure on food. Report by Kamal (2000) was also in line with the above result. The expenditure on medical care ad health showed that 70 per cent of respondents spends an amount greater than Rs 500 per month for medicines. These families had elderly persons and infants who needed a sizable portion of income for their medication.

5.2.3 CURRENT DIETARY PATTERN

Diet has a far reaching influence on health and nutritional status. Food is the major vehicle for improving the nutrition of people and hence assessment of food consumption and dietary habits of people is very important. Among the various factors which influence serum lipid levels, dietary factors are the most important, reports Kemppainen et al, (1993).

Food consumption pattern is an essential prerequisite for planning food needs, and in the present study, a diet survey was conducted as a preliminary step to determine the dietary profile of respondents and it revealed information regarding the food habits, frequency of use of various foods and actual nutrient intake. Similar result was observed Pariat and Saradha (2006) in their study on the impact of consumption of soybean oil and mustard oil in the lipid profile of selected hyperlipidemic adults in Shillong city.

Regarding food habit, 90 per cent of respondents were non vegetarians and only 10per cent were vegetarians. This result is in accordance with the findings of Stephanie (1984) who opinioned that in South India, only about 28 per cent of the total population were completely vegetarians. Barasi (1997) opinioned that the non vegetarians were at border line risk level for cardiovascular disease with elevated serum TC and LDL cholesterol levels.

Frequency of consumption of various food items of the hundred respondents was recorded. Based on the frequency scores, it was observed that 100 per cent of respondents consumed cereals regularly. Similar results observed by Soumya (2001) regarding cereal consumption. Rice was the major cereal consumed as it is the staple food in the state.

Different types of pulses were used by the respondents at least once in a week. It obtained a frequency score of 64 per cent. The gas forming nature of most pulses is a drawback in its consumption reports Achaya (1995). 100 per cent of respondent's daily included vegetables in their daily diet. Roots and tubers are the most economical source of carbohydrate .Majority of respondents used it once or twice in a week only. With regard to spice only 40 per cent included it daily in their diet.

Intake of fish was observed to be high and it has obtained a frequency score of 76 per cent. Due to its easy availability and familiarity because of the awareness about the beneficial effect of fish consumption it was widely consumed by all. 84 per cent of the respondents consumed fish daily Meat consumption was observed for 70 per cent of the respondents. Among different types of meat, chicken was most preferred by55 per cent. Quantity of meat consumed ranged from100 to 200g and 47 per cent consumed in the range between 100 to150g, but the intake was only once in a week or once in a month.

Regarding egg consumption out of hundred respondents 54 per cent consumed egg. 30 per cent of respondents consumed 2 to 3 eggs a week followed by 21 per cent consumed 1 to 2 number of eggs a week It was also observed that, there was highly significant positive correlation observed between egg consumption with TC (0.2592**) and TG (0.2151*) values of respondents.

Regarding the intake of fruits it was observed that 72 per cent consumed fruits twice or thrice a week. Plantain was the most commonly consumed fruit by the respondents.

Regarding milk consumption, 55 per cent of respondents consumed milk as such daily. 43 per cent of respondents consumed cow's milk, 11 per cent used milma milk and only 1 per cent used both the types.

Quantity of milk used for tea and coffee ranged from 100 to 500ml and majority of respondents used 200-300ml of milk per day. With regard to milk products curd and butter was preferred by the respondents Butter milk was found to be consumed by majority of them rather than curd.

With regard to the type and quantity of oil used coconut oil was most frequently used oil by 59 per cent of respondents followed by 28 per cent of respondents used a combination of coconut and sunflower oil. Oil was used more frequently by non-vegetarians. 88 per cent of families purchased more than 2kg of oil per month. There was significant positive correlation observed between type of oil used and TC (0.2159*) values of respondents.

Sugar was used by all non diabetic respondents 82 per cent consumed sugar daily and was used mainly as for tea and coffee, while 18 per cent did not consumed because of diabetes.

Regarding the habit of including salad in their daily diet it was found that 83 per cent of respondents consumed salads along with their diet but frequency of consumption was weekly and occasionally.

Beverage consumption among respondents showed that 100 per cent of respondents consumed 2cups of tea daily, while only 17 per cent consumed coffee and that to occasionally. Consumption of beverages like tea and coffee significantly alters TG and VLDL values were reported by Soumya (2001). Fruit juice was consumed by only 40per cent of respondents respectively.

Mean intake of nutrients of hundred respondents revealed that the mean energy intake of respondents was found to be lesser than the RDAvalues while the mean protein and fat intake was higher than the RDA values. This revealed that respondents consumed more protein rich and fat dense foods than energy rich foods.

5.2.4 LIFE STYLE PATTERN

Personal profile of an individual plays an important role on the pattern of consumption of foods and nutrients. The life style pattern of a subject reflects his/her physiological as well as psychological health. Sedentary life, stress and strain, smoking, alcoholism can lead to a troublesome life. Under life style pattern details regarding stress and strain, exercise, smoking, and alcohol consumption were recorded.

Present study revealed that 65 per cent of respondents had some type of stress and strain. They had various kinds of worries and tension which was either related to occupation, health or financial problem. Taylor et al, (1998) are of the opinion that psychological and emotional stress is often an important factor in triggering number of diseases.

Contemporary factors such as job strain, low income financial worries and double exposure in terms of high physical and heavy domestic responsibilities increased the risk for poor self reported health in individuals (Melliner and Christin, 2003).

A significant positive correlation was observed for stress against TC (0.2396*) and VLDL (0.1968*) values at 1 per cent level. Stress was one of the factors for increasing the blood lipid levels.

Exercise is a pre-requisite for health. Physiologically it increases the electrical stability of the heart and decreases blood glucose, B.P and blood lipid levels. (Ghafoorunissa and Swamy, 1995).The study revealed that 43 per cent was in the habit of doing exercise regularly. Walking was the most preferred exercise among 41 per cent of the respondents.

William (1994) has reported that exercise favourably modifies plasma lipoproteins, lipid concentrations, insulin sensitivity and blood pressure. He had also reported comparable increase in HDL cholesterol in subjects with increased physical activity. A negative correlation was observed for exercise with TC (-0.1910*) and TG (0.2313*). It revealed that by doing exercise the higher TC and TG values decrease significantly.

Present study revealed that only 9 per cent were smoker's and11 per cent were ex-smokers. Remaining 80 per cent were non-smokers. Smoking directly has an impact on the lipid profile of subjects. Habits such as smoking, alcohol use and tobacco chewing should be viewed as important as they are one of the contributory causes to a number of chronic and fatal diseases (Ramankutty et al., 1993).

Regarding alcohol consumption17 per cent consumed alcohol and majority of respondents (78 per cent) were non users of alcohol as most of the respondents surveyed (67per cent) were females

According to Ghafoorunissa and Swamy(1995) alcoholic beverages like Whiskey, Brandy, Rum, Beer and Wine increases the blood pressure, weakens the heart muscle and lead to pathological condition known as alcoholic cardiomyopathy.

5.3 CONDUCT OF FEEDING TRIAL

Based on the score obtained in attitude test and willingness of respondents 45subjects were selected. This was further divided into two group's experimental group consisting of 30 subjects who were given the flaxseed supplement for three months and their lipid profile was estimated and compared with the control group consisting of 15 subjects.

5.4 ASSESSING THE EFFICACY OF THE SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

Conducting feeding experiments constitute an essential part of any study to determine the impact of certain foods. In the present study the efficiacy of flaxseed supplement was assessed through determining the lipid profile to test whether there was significant change after supplementation.

5.4.1 CHANGE IN THE LIPID PROFILE

The results of feeding trial showed a significant difference in the blood lipid values of experimental group after flaxseed supplementation. Data from a crossover study (Lemay et al., 2002) in hypercholesterolemic menopausal women indicated that after 2 months of treatment flaxseed is as effective as 0.625gm conjucated oestrogens in relieving mild menopausal symptoms and in lowering glucose and insulin levels. A similar study was conducted by Nazni et al, (2005) which also showed a distinct change of value in the lipid profile of experimental group after flaxseed supplementation.

The mean values of both experimental group and control group were taken and the results of the mean values of experimental group revealed that mean TC value of the subjects initially was 250mg/dl which has decreased to 234mg/dl intermediately and216mg/dl finally.

The results obtained are in accordance with the studies of Bhathena et al, (1998) and Jenkins, (1999) who indicated that like other fibre rich foods flaxseed is also helpful in reducing cholesterol. Lucas et al, (2002) showed that flaxseed supplementation (40g/day) for 3 months improved lipid profile. The above studies support the results obtained in this study.

A study was done by Mandasescu et al., 2005 to test the effect of daily consumption of dietary flaxseed (as a source of linolenic acid, LNA) on plasma lipid concentrations in mildly hyperlipidemic patients. The results revealed that flaxseed supplementation was associated with significant reductions in TC (-17.2 per cent), LDL-C (-3.9 per cent), TG (-36.3 per cent).

Thus it was concluded that dietary flaxseed significantly improves lipid profile in hyperlipidemic patients and may favorably modify cardiovascular risk factors.

Regarding TG, the results showed a reduction in the mean value from initial 180mg/dl to 165mg/dl finally. This result is in accordance with the result of Soumya (2001) on the introduction of reversal diet on the lipid profile of cardiac patients. which revealed a significant reduction in TG and other lipid constituents.

A significant increase in the HDL values was observed after supplementation from the initial mean value of 40mg/dl to 48mg/dl finally. According to a study conducted by Lakentiew et al,(2006) showed a significant reduction in TC, LDL cholesterol and increase in HDL cholesterol was observed in their study. The mean value of LDL initially was 152mg/dl which was significantly reduced to 143mg/dl finally after flaxseed supplementation. Similar result was observed for VLDL too. A study done by Amrithveni et al, (2001) on hypercholesterolemic subjects showed a significant reduction in the blood lipid profile of subjects.

The high fibre content in flaxseed may be one of the reasons for the significant reduction in the lipid profile of subjects. In a clinical study by Stanford researchers, it was demonstrated that a mixture of water soluble fibre sources can be practically incorporated in the diet resulting in significant cholesterol lowering within four weeks (AHA, 1999).Regarding control group no much significant change was observed in the lipid profile of subjects.

The lipid value of the experimental group was compared with the values of the control group to test the significance of flaxseed supplementation using t-test and analysis of variance (ANOVA). The results of t-test and ANOVA showed that there was significant difference observed in the TC, HDL, LDL, and VLDL values within groups and between two groups at 5 per cent level of significance. In a double-blind study of about 200 post-menopausal women, use of flaxseed at a dose of 40 grams daily produced measurable improvements in cholesterol profile (Dodin et al., 2004).

Regarding TG, there was no significant change observed statistically. This result is in accordance with the study of Chellammal (2006, unpublished data). A similiar result was also observed in the study conducted by Vijayalakshmi and Radha (2006) which revealed the reduction in the lipid profile of subjects was statistically significant for TC only.

Thus the present study carried out to test the efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects revealed that there was significant reduction in TC and LDL and increase in HDL after supplementation with flaxseed for a period of three months. The study clearly supports the hypolipidemic effect of flaxseed.

SUMMARY

6. SUMMARY

The present study entitled "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects" was undertaken with an objective to assess the impact of flaxseed supplement on the blood lipid profile of hyperlipidemic subjects.

In the beginning of the study, the supplement for the feeding trial was formulated. For the formulation, flaxseed was selected as the basic ingredient along with rice and jaggery. Ten combinations of varying proportions were prepared and out of these ten combinations, the best combination was selected based on overall acceptability, nutritional adequacy and cost.

Overall acceptability was assessed through organoleptic parameters such as, appearance, colour, flavour, taste and texture. The mean scores obtained for each character was taken and it was observed that C4 combination (containing flaxseed: 25g, rice: 10g and jaggery: 5g) obtained the highest score in all parameters of overall acceptability and was selected as the best combination from the rest of the combinations.

Regarding nutritional adequacy, it was assessed by computing the energy, protein, fat and fibre content of the ten combinations. It was observed that out of the ten combinations C4 obtained the highest calorie content (103 kcal per 40g), protein content (3.3g per 40g) and fibre content (4.34 per 40g) while, fat content (3.12g per 40g) was observed to be the least. Regarding the cost, there was no much difference in the cost of the ten combinations. But while comparing with the rest of the combinations C4 was found to be cheaper.

Based on the scores obtained from the above characteristics, C4 combination (flaxseed: 25, Rice: 10 and Jaggery: 5g) was selected for the conduct of feeding trial. A list of hyperlipidemic subjects was collected from three hospitals namely SK Hospital, PRS Hospital and Chelsa Hospital and from that list hundred respondents who fulfilled the inclusion criteria mentioned in methodology were selected.

Data on their medical and health history, socio-economic background, dietary pattern and lifestyle were collected. The data on the medical and health history revealed that, 64 per cent had a family history for hyperlipidemia, cardiac problem, diabetes, hypertension and arthritis. Out of one hundred respondents surveyed 46 per cent had one or the above mentioned diseases. Regarding the consumption of drugs, majority of respondents (63 per cent) were not under any medication at present.

The results of the anthropometric measurement such as height, weight and waist hip ratio revealed that mean height of respondents was observed as 160cm and weight 66kg respectively. A highly significant positive correlation was found between age of respondents and their weight (0.2354*). Regarding body mass index (BMI) majority of respondents of were in obese grade-I category and waist hip ratio (WHR) of the respondents showed that 70 per cent had normal WHR. The results of blood lipid profile of subjects revealed that majority of respondents had their TC, TG, HDL, LDL and VLDL above the normal range.

Regarding socio economic profile parameters studied were age, sex, religion, type of family, educational and employment status, family income and expenditure pattern. Majority of respondents belonged to the age group of 45- 55years and sex wise distribution showed that 67 per cent of respondents were females. Religion wise distribution of the respondents showed that 95 per cent of them followed Hindu

religion and nuclear type of families were found to be more popular in the area surveyed. Regarding education and occupation it was observed that all had good educational status and majority of them were employed. With regard to monthly income and monthly expenditure on food a highly significant correlation (0.4021**) at 5 per cent level was observed.

Food consumption pattern of respondents revealed, information regarding the food habits, frequency of use of various foods and actual nutrient intake. Regarding food habit majority of respondents were non vegetarians. Frequency of consumption of various food items revealed that cereals and vegetables were consumed daily while fish fruits and pulses were used moderately and the frequency of use of root and tubers ,egg and spices were less frequently consumed and meat was the least frequently consumed by the respondents. With regard to the type and quantity of oil used coconut oil was most frequently used oil.

Regarding beverage consumption 100 per cent consumed two cups of tea daily. Sugar was used by all non diabetic respondents. Regarding the habit of including salad in their daily diet majority of respondents consumed salads but frequency of consumption was weekly and occasionally. Mean intake of nutrients of hundred respondents showed that energy intake of respondents was less when compared to protein and fat intake.

The life style pattern of respondents revealed significant positive correlation was observed for stress against TC (0.2396*) and VLDL (0.1968*) values of respondents at 1per cent level. With regard to exercise a significant negative correlation was observed for exercise with TC (-0.1910*) and TG (0.2313*).

For the conduct of feeding trial, subjects were selected on the basis of score obtained in attitude test and willingness of respondents. The study group of forty five subjects was further divided into two groups experimental group (30 subjects) and control group15 subjects). The formulated flaxseed supplement was distributed to the experimental group for a period of three months and the lipid profile of the subjects was assessed through lipid profile test to test whether there was significant change in the lipid profile of subjects after supplementation.

The results of blood lipid profile test showed a significant difference in the blood lipid values of experimental group after flaxseed supplementation. The mean values of both experimental group and control group were taken to analyze the significant change in the lipid profile values.

The lipid profile values of the experimental group were compared with the values of the control group to test the significance of flaxseed supplementation using t-test and analysis of variance (ANOVA). The results showed that there was significant difference in the TC, HDL, LDL, and VLDL values between two groups at 5per cent level of significance.

The present study carried out to test the efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects revealed that there was significant reduction in TC and LDL and increase in HDL after supplementation with flaxseed. The study clearly supports the hypolipidemic effect of flaxseed.

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APPENDICES

APPENDIX I

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

Questionnaire to elicit information on the socio economic background of the selected respondents

1. Name of the Respondent :
2. Age :
3. Sex : Male/ Female
4. Religion :
5. Caste :
6. Address : .....
.....
.....
7. Marital status : Single/ Married
8. Type of family : Nuclear/ Extended/ Joint
9. Educational Status :
10. Occupation :
11. Monthly Income (Family) :
12. Monthly Expenditure for food :
13. Monthly Expenditure for Health care :
14. Do you have a family history for :

    Hyperlipidemia
    Cardiac problem
    Diabetes
    Hypertension
    Arthritis
    Any other

15. Do you have any of the above diseases : Yes/ No

16. If yes, how long have you been affected :

17. Clinical Pictures

Height	-	HDL	-	Triglycerides	-
Weight	-	LDL	-	Waist	-
BMI	-	VLDL	-	Hip	-
		Total Cholesterol	-		

18. What was your cholesterol level last recorded :

19. Are you under any medicine : Yes/ No

20. Do you consume any medicine : Yes/ No

21. Does any of your close relatives have high cholesterol level - Yes/ No

22. If yes, relationship to the person :

APPENDIX – I CONTINUED

Questionnaire to elicit information on the life style pattern of the selected respondents

1. Do you have any stress and strain in your day-to-day life : Yes/ No

2. If yes, type

Occupational
Family problem
Health problem
Financial problem
Old age problem
Any other

3. Do you practice any relaxation techniques : Yes/ No

If yes what is it?

4. Do you have the habit of doing exercise : Yes/ No

5. If yes, specify

Time :
Duration:
Type :

6. Do you smoke : Yes/ No

7. Particulars about smoking : Cigarette/ Beedi

8. If you do not smoke now, have you ever smoked before : Yes/ No

9. How many years back :

10. Do you have the habit of pan/ beetle chewing - Yes/ No

11. Do you take alcoholic drinks - Yes/ No

12. Frequency of alcohol consumption

Regular
Most days
Weekends
Occasionally
Never

13. Type of alcohol taken - Beer, Whiskey, Rum, Wine, Others

14. Qty of alcohol taken?

15. If you do not drink alcohol now have you ever took alcoholic drinks before - Yes/ No

16. How many years back?

17. Do you have adequate family support - Yes/ No

18. Do you have adequate social support - Yes/ No

19. Are you a member of any voluntary organization - Yes/ No

If yes – which and what type

APPENDIX – I CONTINUED

Questionnaire to elicit information on the dietary intake of the selected respondents

1. Please give the number of days per week on which you usually eat various foods

If you eat a food 7 days a week then ring the "7" thus	(7)	6	5	4	3	2	1	R
If you eat a food 3 days a week then ring the "3" thus	7	6	5	4	(3)	2	1	R
If you eat food less than once a month then ring "R"	7	6	5	4	3	2	1	R

Cereals	7	6	5	4	3	2	1	R
Pulses	7	6	5	4	3	2	1	R
Roots and Tubers	7	6	5	4	3	2	1	R
Vegetables	7	6	5	4	3	2	1	R
Spices	7	6	5	4	3	2	1	R
Fruits	7	6	5	4	3	2	1	R

2. Are you a vegetarian : Yes/ No

3. Do you take milk : Yes/ No

4. Type of milk :

5. How much milk do you drink a day (including tea & coffee)

6. How much quantity of curds/ buttermilk you consume per day:

7. Do you take sugar : Yes/ No

8. If yes, how much?

9. Do you take egg : Yes/ No
If yes, how many numbers of eggs in a week.

10.

Food	Type	Quantity	No. of days in a week	Form
Fish	Sea River Both			Fry/ Curry
Meat	Mutton Chicken Beef Pork			Fry/ Curry

11. Type of oil used:

Coconut	Safflower
Gingelly	Soya bean
Sunflower	

12. Quantity of oil

13. Do you have the habit of consuming sweet meals : Yes/ No
If yes, specify

14.

Food	No. of days in a week	Quantity
Ice cream, sweet, coconut, Chocolate Fruit cake, sponge cake, jelabi, laddu, pudding		

15. Do you include salad in your diet : Yes/ No

16. If yes frequency of using

Daily

Weekly

Occasionally

17. Do you consume food from outside: Yes/ No

18. If yes, frequency: Daily/ Bi-weekly/ Bi-monthly/ Monthly/ occasionally / Never

19.

Beverages	No. of days in a week	Quantity
Tea Coffee Fruit juice Bottle drinks Others		

20. Your 3 day's Menu (Recall)

Items	1st day	Qty	2nd day	Qty	3rd day	Qty
Early Morning						
Break fast						
Mid- Morning						
Lunch						
Mid -Noon						
Dinner						
Bed time						

APPENDIX II

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

S AND Q VALUE OBTAINTED FOR ATTITUDE TEST

Statements		Scoring categories											Scale value	Q value
		A	B	C	D	E	F	G	H	I	J	K		
		1	2	3	4	5	6	7	8	9	10	11		
1.	F	0	0	0	0	0	0	0	0	0	3	7		
	P	0	0	0	0	0	0	0	0	0	0.3	0.7		
	Cp	0	0	0	0	0	0	0	0	0	0.3	1.0	10.7	0.8
2.	F	1	0	0	1	1	1	0	0	2	2	2		
	P	0.1	0	0	0.1	0.1	0.1	0	0	0.2	0.2	0.2		
	Cp	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.6	0.8	1.0	9	5.3
3.	F	1	1	0	0	2	0	1	1	0	1	3		
	P	0.1	0.1	0	0	0.2	0	0.1	0.1	0	0.1	0.3		
	Cp	0.1	0.2	0.2	0.2	0.4	0.4	0.5	0.6	0.6	0.7	1.0	8	5.8
4.	F	0	0	0	0	1	4	0	0	0	1	4		
	P	0	0	0	0	0.1	0.4	0	0	0	0.1	0.4		
	Cp	0	0	0	0	0.1	0.5	0.5	0.5	0.5	0.6	1.0	7	5
5.	F	0	0	0	0	0	1	0	0	2	2	5		
	P	0	0	0	0	0	0.1	0	0	0.2	0.2	0.5		
	Cp	0	0	0	0	0	0.1	0.1	0.1	0.3	0.5	1.0	11	1.8
6.	F	0	1	0	1	0	2	0	0	1	2	2		
	P	0.1	0.1	0	0.1	0	0.2	0	0	0.1	0.2	0.2		
	Cp	0.1	0.2	0.2	0.3	0.3	0.5	0.5	0.5	0.6	0.8	1.0	7	6.3

APPENDIX II –CONTINUED

Statements		Scoring categories											Scale value	Q value
		A	B	C	D	E	F	G	H	I	J	K		
		1	2	3	4	5	6	7	8	9	10	11		
7.	F	0	0	0	0	0	0	0	0	0	2	8		
	P	0	0	0	0	0	0	0	0	0	0.2	0.8		
	Cp	0	0	0	0	0	0	0	0	0	0.2	1.0	10.8	0.6
8.	F	0	0	0	0	1	0	1	0	1	2	5		
	P	0	0	0	0	0.1	0	0.1	0	0.1	0.2	0.5		
	Cp	0	0	0	0	0.1	0.1	0.2	0.2	0.3	0.5	1.0	11	2
9.	F	0	0	0	0	0	1	0	0	1	4	4		
	P	0	0	0	0	0	0.1	0	0	0.1	0.4	0.4		
	Cp	0	0	0	0	0	0.1	0.1	0.1	0.2	0.6	1.0	10.3	1.3
10..	F	0	0	0	0	1	4	0	0	0	1	4		
	P	0	0	0	0	0.1	0.4	0	0	0	0.1	0.4		
	Cp	0	0	0	0	0.1	0.5	0.5	0.5	0.5	0.6	1.0	9.8	4.6
11.	F	0	0	0	0	1	2	0	0	1	3	3		
	P	0	0	0	0	0.1	0.2	0	0	0.1	0.3	0.3		
	Cp	0	0	0	0	0.1	0.3	0.3	0.3	0.4	0.7	1.0	9.8	4.3
12.	F	0	0	0	1	0	1	0	0	1	3	4		
	P	0	0	0	0.1	0	0.1	0	0	0.1	0.3	0.4		
	Cp	0	0	0	0.1	0.1	0.2	0.2	0.2	0.3	0.6	1.0	10	1.8
13.	F	0	1	0	0	0	2	0	0	1	3	2		
	P	0	0.1	0	0	0	0.2	0	0.1	0.1	0.3	0.2		
	Cp	0	0.1	0.1	0.1	0.1	0.3	0.3	0.4	0.5	0.8	1.0	10	4.0
14.	F	0	0	0	0	0	2	0	0	5	0	2		
	P	0	0	0	0	0	0.2	0	0.1	0.5	0	0.2		
	Cp	0	0	0	0	0	0.2	0.2	0.3	0.8	0.8	1.0	8.9	1.4
15.	F	0	0	0	0	0	3	1	0	1	1	4		
	P	0	0	0	0	0	0.3	0.1	0	0.1	0.1	0.4		
	Cp	0	0	0	0	0	0.3	0.4	0.4	0.5	0.6	1.0	10	4.5

APPENDIX- III
KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

Attitude of Respondents towards Foods and Supplements which lower Cholesterol

Read the statements given below and specify whether you agree or disagree

Statements	Agree	Disagree
1. Excess consumption of fatty foods leads to health problems.		
2. Combination of oils can be used for cooking.		
3. Salads included in daily diets help to lower cholesterol.		
4. Oils used can be reheated and used again and again.		
5. Excess consumption of alcohol leads to cardiac problems.		
6. Including fish to your daily diet helps to lower cholesterol.		
7. Daily consumption of egg is good for health.		
8. Women should check their cholesterol levels at Menopausal stage.		
9. Smoking increases cholesterol levels.		
10. Daily consumption of Flaxseed helps to lower cholesterol.		
11. Food supplements are considered as medicines.		
12. Food supplements are costly.		
13. Consumption of fruits and vegetable soups daily promote health.		
14. Spirulina supplementation is good for reducing weight and lower cholesterol.		
15. Dietary modifications and Exercise helps to lower Cholesterol and helps to improve health.		

APPENDIX - IV

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

Age and Anthropometric measurements of respondents

SL.NO.	AGE (yrs)	HEIGHT (cm)	WEIGHT (kg)	BMI	WC	HC	WHR
1	54	150	75	33.3	25	30	0.83
2	54	160	60	23.4	23	28	0.82
3	55	158	62	24.8	26	31	0.84
4	51	150	62	27.5	27	32	0.84
5	49	159	65	25.7	29	32	0.9
6	36	175	65	21.2	26	32	0.81
7	54	160	56	21.8	22	27	0.81
8	55	170	76	26.3	24	28	0.86
9	51	160	51	19.9	25	30	0.83
10	54	162	62	24.2	27	31	0.87
11	55	180	79	25.9	23	28	0.82
12	52	162	60	22.9	25	31	0.8
13	49	155	68	28.3	26	30	0.87
14	38	150	52	23.1	30	34	0.88
15	45	165	70	25.71	29	34	0.85
16	54	175	85	27.7	26	31	0.83
17	46	178	79	25	28	31	0.9
18	35	159	65	25.7	28	32	0.87
19	44	167	72	25.8	28	35	0.8
20	43	169	75	26.3	27	33	0.82
21	35	177	88	28.1	30	35	0.85
22	53	157	60	24.3	25	31	0.8
23	50	158	75	30.1	24	28	0.85
24	46	156	66	27.1	26	32	0.81
25	44	165	78	28.6	28	33	0.84
26	44	162	60	22.9	23	25	0.92
27	50	160	60	23.4	24	29	0.83
28	35	160	65	25.3	22	26	0.84
29	35	152	78	33.7	29	35	0.82
30	53	159	62	24.6	25	31	0.8
31	55	170	72	24.9	28	32	0.87
32	55	158	63	25.3	29	34	0.85

APPENDIX - IV CONTINUED

SL.NO.	AGE (yrs)	HEIGHT (cm)	WEIGHT (kg)	BMI	WC	HC	WHR
33	53	169	78	27.3	26	29	0.89
34	49	158	63	25.3	26	31	0.83
35	55	160	59	23	27	32	0.84
36	47	172	79	2.77	28	31	0.9
37	36	170	75	25.95	29	34	0.85
38	38	159	64	25.39	27	33	0.81
39	44	166	70	25.45	32	35	0.91
40	49	155	50	20.8	33	35	0.94
41	52	175	82	26.79	31	35	0.88
42	37	172	92	31.18	30	34	0.88
43	52	162	70	26.71	26	32	0.81
44	36	170	80	27.68	24	29	0.82
45	52	160	65	25.39	28	34	0.82
46	53	162	75	28.62	30	35	0.85
47	40	177	83	26.5	29	34	0.85
48	54	157	62	25.2	26	30	0.86
49	43	160	75	29.2	24	29	0.82
50	51	161	65	25	28	30	0.93
51	40	155	68	28.3	25	31	0.8
52	36	175	80	26.14	24	30	0.8
53	38	168	80	28.36	27	33	0.81
54	52	168	63	22.34	24	29	0.82
55	36	166	73	26.5	26	31	0.83
56	38	162	70	26.7	29	34	0.85
57	43	163	55	20.75	25	31	0.81
58	51	172	70	28.72	26	30	0.87
59	50	148	65	29.7	31	35	0.88
60	44	156	60	27	24	28	0.85
61	35	168	60	23	26	32	0.81
62	39	162	62	24.2	28	33	0.84
63	40	154	69	36.1	23	25	0.92
64	53	148	61	30	24	29	0.82
65	37	166	73	26.5	32	35	0.91
66	55	155	57	24	28	35	0.8
67	44	154	40	16.8	27	32	0.84
68	50	162	62	24.2	29	32	0.9
69	55	150	62	27.5	27	32	0.84

APPENDIX - IV CONTINUED

SL.NO.	AGE (yrs)	HEIGHT (cm)	WEIGHT (kg)	BMI	WC	HC	WHR
70	48	155	57	24	26	31	0.83
71	50	168	62	21.9	24	29	0.82
72	55	162	49	18.7	27	32	0.84
73	49	160	65	25.39	26	29	0.89
74	36	165	65	23.8	25	31	0.81
75	46	156	78	28.36	28	30	0.93
76	38	152	68	25.9	24	29	0.82
77	38	155	68	28.3	25	29	0.86
78	40	149	55	24.77	26	31	0.83
79	51	157	63	25.6	28	35	0.8
80	49	163	72	28	26	31	0.84
81	51	170	69	23.87	27	32	0.84
82	49	148	55	25	29	32	0.9
83	50	157	62	25.2	26	32	0.81
84	49	161	67	26	22	27	0.82
85	49	160	72	28.1	24	28	0.85
86	52	150	52	26	25	30	0.83
87	48	148	61	38	27	31	0.87
88	45	146	55	28	26	31	0.84
89	39	156	65	26.7	27	32	0.84
90	38	162	62	24.2	28	35	0.8
91	40	155	68	30	28	34	0.82
92	43	155	68	30	30	35	0.86
93	52	152	58	25.7	29	34	0.85
94	39	150	52	26	25	29	0.86
95	38	150	70	31	24	28	0.85
96	54	165	69	25.34	26	32	0.81
97	35	160	75	29.2	24	29	0.83
98	55	158	63	25.3	25	29	0.86
99	42	150	75	33.3	26	31	0.84
100	47	170	78	26.98	27	32	0.84

APPENDIX V

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

BLOOD LIPID PROFILE OF RESPONDENTS

SL.No.	AGE (Yrs)	TC (mg/dl)	TG (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	VLDL (mg/dl)
1	54	239	198	165	40	49
2	54	235	195	162	46	32
3	55	287	178	169	41	39
4	51	288	230	163	37	39
5	49	267	215	159	38	43
6	36	288	215	161	36	35
7	54	237	143	152	40	27
8	55	264	158	158	41	14
9	51	225	178	150	43	35
10	54	237	175	162	35	45
11	55	288	160	152	33	32
12	52	258	151	149	40	40
13	49	201	112	142	44	21
14	38	239	154	148	38	37
15	45	180	94	106	40	18
16	54	220	210	193	49	18
17	46	242	210	161	50	28
18	35	233	132	160	43	26
19	44	238	219	193	42	24
20	43	160	95	93	49	20
21	35	227	180	186	45	23
22	53	215	124	162	53	24
23	50	245	175	145	39	47
24	46	290	190	138	40	38
25	44	255	220	145	41	50
26	44	253	158	167	41	31
27	50	156	112	102	39	22
28	35	282	231	196	40	46
29	35	185	93	106	45	18
30	53	176	93	106	43	18
31	55	170	220	74	42	44
32	55	292	124	162	48	24

APPENDIX V -CONTINUED

SL.No.	AGE (Yrs)	TC (mg/dl)	TG (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	VLDL (mg/dl)
33	53	290	230	142	35	28
34	49	292	190	157	50	42
35	55	185	117	147	49	17
36	47	200	106	106	40	24
37	36	215	180	189	48	29
38	38	201	206	106	45	41
39	44	220	105	155	44	38
40	49	292	190	162	50	24
41	52	235	186	154	44	35
42	37	140	63	78	48	12
43	52	185	120	176	47	20
44	36	290	150	135	45	43
45	52	190	180	149	49	17
46	53	320	285	147	36	29
47	40	200	152	132	44	24
48	54	245	220	147	38	25
49	43	270	220	159	42	37
50	51	245	167	121	49	22
51	40	250	132	78	45	26
52	36	210	210	185	39	19
53	38	227	180	154	45	44
54	52	255	233	164	45	46
55	36	252	254	200	39	40
56	38	238	132	157	43	26
57	43	250	190	147	38	49
58	51	237	200	165	49	23
59	50	212	124	162	54	24
60	44	220	172	143	47	34
61	35	268	160	188	48	32
62	39	244	205	156	47	41
63	40	202	142	140	42	28
64	53	196	114	111	51	22
65	37	220	105	101	38	21
66	55	201	105	161	42	24
67	44	251	102	171	40	20
68	50	255	183	184	42	38
69	55	210	105	155	44	24

APPENDIX V -CONTINUED

SL.No.	AGE (Yrs)	TC (mg/dl)	TG (mg/dl)	LDL (mg/dl)	HDL (mg/dl)	VLDL (mg/dl)
70	48	201	105	161	42	24
71	50	209	102	143	45	21
72	55	259	189	190	42	40
73	49	260	207	195	44	39
74	36	170	99	160	39	18
75	46	202	120	172	50	22
76	38	198	150	130	40	30
77	38	150	132	78	45	26
78	40	276	163	175	45	38
79	51	220	225	145	45	49
80	49	264	114	186	43	32
81	51	200	145	122	49	29
82	49	180	130	104	5	26
83	50	201	160	119	50	21
84	49	233	201	137	46	40
85	49	195	145	125	40	29
86	52	165	98	153	52	21
87	48	196	114	111	48	22
88	45	177	110	114	37	26
89	39	178	98	112	39	19
90	38	188	112	112	39	21
91	40	245	117	160	44	23
92	43	197	210	124	44	22
93	52	240	163	178	39	12
94	39	169	97	120	44	18
95	38	202	192	174	45	22
96	54	230	120	156	50	36
97	35	165	98	153	48	21
98	55	210	160	152	44	26
99	42	220	225	145	45	42
100	47	235	145	144	42	26

APPENDIX - VI

KERALA AGRICULTURAL UNIVERSITY
COLLEGE OF AGRICULTURE, VELLAYANI
DEPARTMENT OF HOMESCIENCE

Blood lipid profile values of Experimental Group
TOTALCHOLESTEROL [TC]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1	239	225	208
2	235	222	200
3	287	265	245
4	288	267	243
5	267	242	225
6	288	275	264
7	237	220	196
8	264	250	235
9	225	200	189
10	237	215	200
11	288	275	262
12	258	245	228
13	239	216	195
14	200	188	172
15	245	228	205
16	290	288	275
17	255	242	230
18	290	278	255
19	292	272	257
20	220	196	179
21	235	215	190
22	290	270	255
23	200	185	169
24	245	230	218
25	270	252	230
26	227	205	189
27	238	218	192
28	250	232	211
29	210	195	188
30	220	209	194

APPENDIX – VI CONTINUED

Blood lipid profile values of Experimental Group

TRIGLYCERIDES [TG]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1	198	152	172
2	195	175	165
3	178	155	169
4	230	157	225
5	215	209	206
6	215	210	208
7	143	139	135
8	158	152	148
9	178	175	169
10	175	155	142
11	160	157	152
12	151	149	145
13	154	152	148
14	150	145	140
15	175	169	165
16	190	182	175
17	220	210	200
18	230	224	219
19	190	187	180
20	105	90	85
21	186	100	105
22	150	148	145
23	152	150	147
24	220	210	196
25	220	212	198
26	180	176	170
27	132	128	122
28	190	175	164
29	160	152	148
30	225	215	200

APPENDIX – VI CONTINUED

Blood lipid profile values of Experimental Group

LOW DENSITY LIPOPROTEIN [LDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1	165	159	156
2	162	157	153
3	169	167	161
4	163	158	155
5	159	156	150
6	161	159	148
7	152	148	142
8	158	154	149
9	150	147	145
10	162	159	157
11	152	150	147
12	149	145	139
13	148	144	138
14	155	147	140
15	145	139	131
16	138	135	129
17	145	135	130
18	142	138	132
19	157	152	149
20	155	146	140
21	154	150	148
22	135	130	128
23	132	129	125
24	147	145	139
25	159	155	150
26	154	152	149
27	157	154	150
28	147	144	142
29	152	150	149
30	145	150	140

APPENDIX – VI CONTINUED

Blood lipid profile values of Experimental Group

HIGH DENSITY LIPOPROTEIN [HDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1	40	42	47
2	46	49	50
3	41	45	49
4	37	37	43
5	38	38	44
6	36	36	49
7	40	40	48
8	41	41	49
9	43	43	50
10	35	35	45
11	33	33	42
12	40	40	48
13	38	38	46
14	40	40	48
15	39	39	45
16	40	40	49
17	41	41	49
18	35	35	42
19	50	50	52
20	44	40	44
21	44	46	49
22	45	46	48
23	44	47	49
24	38	40	45
25	42	47	50
26	45	49	50
27	43	46	48
28	38	42	49
29	44	47	50
30	45	49	51

APPENDIX – VI CONTINUED

Blood lipid profile values of Experimental Group

VERY LOW DENSITY LIPOPROTEIN [VLDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1	49	35	30
2	32	25	23
3	39	32	25
4	39	30	28
5	43	38	35
6	35	28	25
7	27	22	19
8	14	18	20
9	35	32	27
10	45	37	29
11	32	28	25
12	40	35	30
13	37	34	25
14	49	40	36
15	47	41	35
16	38	35	30
17	50	44	36
18	28	24	22
19	42	37	30
20	38	35	30
21	35	32	27
22	43	37	30
23	24	18	15
24	25	19	12
25	37	30	25
26	44	35	32
27	26	22	18
28	49	38	25
29	26	20	18
30	42	32	28

APPENDIX - VII

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DEPARTMENT OF HOMESCIENCE

Blood lipid profile values of Control Group
TOTAL CHOLESTEROL [TC]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1.	282	285	287
2.	268	268	270
3.	244	246	250
4.	251	253	258
5.	255	258	260
6.	259	259	260
7.	260	263	265
8.	276	276	279
9.	264	268	269
10.	255	259	263
11.	252	256	258
12.	233	239	243
13.	245	248	252
14.	240	243	245
15.	235	239	242

APPENDIX – VII CONTINUED

Blood lipid profile values of Control Group

TRIGLYCERIDES [TG]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1.	157	165	188
2.	154	160	195
3.	176	157	145
4.	139	149	143
5.	186	192	158
6.	145	148	155
7.	143	154	160
8.	158	163	201
9.	165	178	149
10.	175	185	163
11.	254	187	145
12.	201	210	217
13.	149	154	168
14.	163	176	186
15.	145	154	168

APPENDIX – VII CONTINUED

Blood lipid profile values of Control Group

LOW DENSITY LIPOPROTEIN [LDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1.	196	200	200
2.	188	187	190
3.	156	159	162
4.	171	179	182
5.	184	164	184
6.	190	200	148
7.	195	137	168
8.	175	179	175
9.	186	189	186
10.	164	170	185
11.	200	206	209
12.	137	148	156
13.	160	168	174
14.	178	179	182
15.	144	149	153

APPENDIX – VII CONTINUED

Blood lipid profile values of Control Group

HIGH DENSITY LIPOPROTEIN [HDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1.	40	40	40
2.	42	41	38
3.	41	35	36
4.	40	40	40
5.	42	41	41
6.	42	43	43
7.	43	35	39
8.	45	33	35
9.	43	40	33
10.	45	38	40
11.	39	40	40
12.	35	39	39
13.	33	40	40
14.	40	41	41
15.	42	35	35

APPENDIX – VII CONTINUED

Blood lipid profile values of Control Group

VERY LOW DENSITY LIPOPROTEIN [VLDL]

SL.No.	Initial values (mg/dl)	Intermediate values (mg/dl)	Final values (mg/dl)
1.	35	25	49
2.	25	32	32
3.	32	20	41
4.	20	38	39
5.	38	38	43
6.	28	35	40
7.	22	27	39
8.	14	28	38
9.	32	32	35
10.	37	45	35
11.	45	32	28
12.	32	38	22
13.	38	29	14
14.	29	27	32
15.	32	39	37

ABSTRACT

EFFICACY OF FLAXSEED SUPPLEMENT ON THE LIPID PROFILE OF HYPERLIPIDEMIC SUBJECTS

LAKSHMI. V

Abstract of the
thesis submitted in partial fulfilment of the requirement
for the degree of

Master of Science in Home Science
(Food Science and Nutrition)

Faculty of Agriculture
Kerala Agricultural University, Thrissur

2007

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ABSTRACT

The present study entitled "Efficacy of flaxseed supplement on the lipid profile of hyperlipidemic subjects" was undertaken with an objective to assess the impact of flaxseed supplement on the blood lipid profile of hyperlipidemic subjects.

The supplement was formulated with flaxseed as the basic ingredient along with rice and jaggery. Ten combinations of varying proportions were formulated and the best combination was selected based on overall acceptability, nutritional adequacy and cost. Out of the ten combinations C4 (with flaxseed: 25g, Rice: 10g, Jaggery: 5g) obtained the highest score for overall acceptability, nutritional adequacy and cost was selected for the conduct of feeding trial.

A list of hyperlipidemic respondents was collected from three hospitals of Thiruvanathapuram city (SK Hospital, PRS Hospital and Chelsa Hospital). From the list, one hundred respondents who fulfilled the inclusion criteria (such as subjects willingness and Co-operation, age (between 35 to 55yrs), Serum cholesterol level 200mg/dl and above, persons who are free from other degenerative diseases and who are not under medication for hyperlipidemia) were selected for the study. Details on their medical and health history, socio-economic background, dietary and lifestyle pattern were collected using standard procedures.

The medical and health history of respondents revealed that 11per cent had family history for Hyperlipidemia. Their BMI ranged from 25.0 - 30.0 and WHR from 0.8- 0.85. Most of the respondents (59per cent) were overweight.

The socio economic survey explained that monthly income ranged from Rs5000 to Rs10, 000. 65per cent had some types of stress and strain. 87percent of them had adequate family and social support.

Diet counselling was imparted to the hundred respondents and their attitude towards foods and food supplements was tested using attitude test. Based on the scores obtained and also their willingness to participate in the study 45subjects were selected for the feeding trial.

The study group was further divided into experimental and control group. The formulated flaxseed supplement (40g) was distributed to the experimental group in the form of laddus for three months. The blood lipid profile was estimated initially intermediately and finally for both the groups.

The results revealed a significant difference in the blood lipid values of experimental group after flaxseed supplementation. The lipid values of the experimental group were compared with the values of the control group to test the significance of flaxseed supplementation using t-test and analysis of variance (ANOVA).

The results showed significant difference in the TC, HDL, LDL, and VLDL values between two groups at 5percent level of significance except for TG which was statistically insignificant. This study revealed that flaxseed supplementation can bring down the total cholesterol in hyperlipidemics and improve their lipid profile. Flaxseed can very well be recommended as a functional food for hyperlipidemics.