Hypolipidemic Effect of Flaxseed and Garlic

Thilaga,B

(12PFN021)

Thesis submitted to the
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore - 641 043

In Partial Fulfilment of the Requirements for the Degree of

Master of Science in Food Science and Nutrition

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H. Amirtham 28/3/14
Signature of the
Supervisor

Signature of the
Head of the Department

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INTRODUCTION

Hyperlipidemia is one of the most prominent causes for atherosclerosis characterized by hardening of any artery due to ‘atheroma or plaque formation’. A sedentary life style along with high calorie consumption is one of the major causes of hyperlipidemia. Management of hyperlipidemia with pharmacotherapy with a bare minimum side effect is still a challenge for the current medical system. Several mechanisms have been proposed for atheroma formation, low density lipoprotein oxidation is one of the pivotal steps in several of these mechanisms. (Kumar *et al.*, 2013).

Hyperlipidemia**,** hyperlipoproteinemia**, or** dyslipidemiais the presence of raised or abnormal levels of lipids and/or lipoproteins in the blood. Lipids (fatty molecules) are transported in a protein capsule, and the density of the lipids and type of protein determines the fate of the particle and its influence on metabolism. (www.news-medical.net)

LDL cholesterol (Low Density Lipoprotein) is considered the 'bad' cholesterol. This is the type that can block arteries. Cholesterol builds up inside the blood vessel walls in the form of plaques (known as arteriosclerosis). The plaques can restrict blood flow to the heart and if they burst the contents spill out, clots can form and travel around the body in the blood stream. The clots can block the small blood vessels in the heart leading to a heart attack. If they block vessels in the brain they cause a stroke. (Schoenstadt *et al*., 2013)

Hyperlipidemias may basically be classified as either familial (also called primary caused by specific genetic abnormalities, or acquired (also called secondary) when resulting from another underlying disorder that leads to alterations in plasma lipid and lipoprotein metabolism. Also, hyperlipidemia may be idiopathic, that is, without known cause. Hyperlipidemias are also classified according to which types of lipids are elevated, that is hypercholesterolemia, hypertriglyceridemia or both in combined hyperlipidemia. Elevated levels of Lipoprotein(a) may also be classified as a form of hyperlipidemia.Familial hyperlipidemias are classified according to the Fredrickson classification which is based on the pattern of lipoproteins on electrophoresis or ultracentrifugation. It was later adopted by the World Health Organization (WHO). It does not directly account for HDL, and it does not distinguish among the different genes that may be partially responsible for some of these conditions. (http://doylestowninternal medicine.com)

High cholesterol levels can lead to hardening of the arteries also called atherosclerosis. This occurs when fat, cholesterol and other substances build up in the walls of arteries and form hard structures called plaques. Overtime, these plaques can block the arteries and cause heart disease, stroke and other symptoms or problems throughout the body. Disorders that are passed down through families often lead to higher cholesterol levels that are harder to control. (Daniels and Greer., 2008)

Medicines such as certain birth control pills, diuretics (water pills), beta-blockers and some medicines used to treat depression may also raise cholesterol levels. Several disorders that are passed down through families lead to abnormal cholesterol and triglyceride level. They include familial combined hyperlipidemia, familial dysbetalipoproteinemia, familial hypercholesterolemia and familial hypertriglyceridemia. Smoking does not cause higher cholesterol levels, but it can reduce your HDL ("good") cholesterol. It is important to work with health care providers to set cholesterol goals. General targets are: LDL: 70-130 mg/dl (lower numbers are better), HDL: more than 40-60 mg/dl (high numbers are better), Total cholesterol: less than 200 mg/dl (lower numbers are better), Triglycerides: 10-150 mg/dl (lower numbers are better). (www.nlm. nih.gov)

Cross population, within population and clinical studies have shown that a high serum cholesterol level causes coronary heart disease and mortality. In the last 30 years, the carriers of blood lipids and their carrier protein lipoproteins have come to the fore front as predictors of risk. Each class of lipoproteins actually represents a continuum of particles. The ratio of protein to fat determines the density; thus, particles with more protein are denser (e.g., High density lipoprotein have more protein than LDL). (Mahan, 2011)

Hypercholesterolemia increases the risk of cardiovascular diseases, the principal causes of mortality as well as morbidity. Coronary Heart Disease

(CHD) is the most common cardiovascular disease, and atherosclerosis is considered the most frequent cause of CHD. Epidemiological, clinical, genetic, and experimental studies indicate that high serum levels of LDL cholesterol are associated with atherosclerosis and an increased risk of CHD (Jung, 2009)

Linolenic acid (LNA) is reported to have beneficial effects on blood lipid profiles and inflammation, which may responsible for the protection against CVD bestowed by Flaxseed Oil (FO). FO is the main component of the flaxseed and one of the world's most important vegetable sources of alpha-LNA. As a nutritionally essential Poly Unsaturated Fatty Acid (PUFA), LNA can act as the precursor of longer chain n-3 PUFA or compete with linolenic acid or direct interaction with ion channels and nuclear receptors, and thus may exert various biological functions in the human body, such as accelerating brain growth in preterm and neonates and, antiarrhythmic functions and neuroprotective functions. (Barcelo-Coblijn and Murphy, 2009).

As hyperlipidemia, including hypercholesterolemia (HC) and Hyper Triglyceridemia (HT), continue to challenge North America's healthcare systems, patients continue to seek efficacious and safe natural therapies that complement pharmaceutical interventions. However, despite the ever-growing body of research supporting the use of Functional Foods and Nutraceuticals (FFN) for the prevention and treatment of hyperlipidemia, reception amongst the medical community regarding the implementation of FFN into clinical guidelines continues to lag. Research demonstrates that specific FFN target and modulate molecular processes that perpetuate hyperlipidemia. In addition, studies consistently demonstrate that combining certain FFN such as marine-derived omega-3 fatty acids or plant sterols/stanols with statins enhances triglyceride and cholesterol-lowering efficacy, respectively (Marinangeli and Jones, 2010).

Flax is making its mark in the world's food supply as a functional food. It delivers a health boost beyond what might be expected from their traditional nutrient content. Flax fits this description perfectly, being rich in Alpha-Linolenic Acid (ALA), the essential omega-3 fatty acid, and phytochemicals such as lignans. Flaxseed has been the focus of increased interest in the field of diet and disease research due to the potential health benefits associated with some of its biologically active components: oil containing approximately 59% a-linolenic acid) and the presence of plant lignan Secoisolariciresinol Diglucoside (SD). (Toure and Xueming, 2010)

Lignans, derived from flaxseed, are phyto-oestrogens being increasingly studied for their health benefits. To date, a number of clinical trials have been conducted using dietary flaxseed which suggested that Secoisolarisinol Diglucoside lignan may lower plasma cholesterol concentrations. Attribution of lipid-lowering effects in whole flaxseed and flax flour studies solely to SDG is confounded by the presence of other potential lipid-lowering components. Flaxseed commonly contains 34-45.6 per cent fat and alpha linolenic acid represents 45-60 per cent of the total fat content in flax oil. (Zhang *etal*, 2008)

Garlic is extensively used as a spice having a characteristic flavor and is also valued for its diverse medicinal properties such as carminative, anti-helmenthic, diuretic, and tonic. It is now well understood both by studies on experimental animals and clinical trials that garlic has favorable physiological influence on the course of several diseases including heart disease, cancer, and cell damage caused by external agents. Prompted by the many reports documenting hypolipidemic activity of garlic, several studies have been specifically undertaken to elucidate the mechanism(s) underlying the cholesterol-lowering effects of garlic. (Srinivasan*et al.,*2004)

Several studies have attempted to clarify the exact role that garlic has on serum cholesterol, LDL-C, HDL-C and triglycerides as these might be the signal of protections. While some studies have reported that garlic reduces LDL concentrations. The average decrease in total cholesterol was 24.8 mg/dl (9.9 %), LDL-C 15.3 mg/dl (11.4 %) and triglyceride 38 mg/dl (9.9 %). (Robert and Wildman, 2007)

Thus, the present study is entitled "**Hypolipidemic Effect of Flaxseed and Garlic**" is a small foot print in this direction with the following objectives:

- To elicit information on the socio-economic background, dietary pattern, lifestyle pattern, health status knowledge and usage of omega 3 fatty acids and dietary fiber rich foods.
- To assess the prevalence of hyperlipidemia in adults.
- To assess the hypocholesterolemic effect of flaxseed and garlic mix on blood cholesterol levels among hyperlipidemics.

REVIEW OF LITERATURE

The literature pertaining to the study titled **“Hypolipidemic Effect of Flaxseed and Garlic”** is reviewed under the following headings.

A. Prevalence of hyperlipidemia
B. Risk factors for hyperlipidemia
C. Prevention and management of hyperlipidemia
D. Role of functional foods in hyperlipidemia
E. Hypocholesterolemic effect of flaxseed and garlic

Hyperlipidemia is common in the worldwide population, and is considered as a highly modifiable risk factor for cardiovascular disease such as coronary heart disease and peripheral artery diseases. Elevated blood lipid levels, especially increased serum Low - Density Lipoprotein (LDL) level, can accelerate atherosclerosis. Therefore, reducing high lipid levels has been regarded to be an important approach to prevent or slow the progression of atherosclerosis (Arsenault *et al.,* 2009). Oxidised LDL play a pivotal role in the progression of atherosclerotic coronary artery disease (Adnan *etal*. 2009).

A. <u>PREVALENCE OF HYPERLIPIDEMIA</u>

Dyslipidemia is emerging as major public health challenge in South Asian countries. Increasing dyslipidemia in South Asians is primarily driven by nutrition, lifestyle and demographic transitions, increasingly faulty diets and physical inactivity, in the background of genetic predisposition (Misra and Shrivastava, 2013).

Raised cholesterol increases the risks of heart disease and stroke. Globally, a third of ischaemic heart disease is attributable to high cholesterol. Overall, raised cholesterol is estimated to cause 2.6 million deaths (4.5per cent of total) and 29.7 million Disability Adjusted Life Years (DALYS), or 2.0per cent of total DALYS. Raised total cholesterol is a major cause of disease burden in both the developed and developing world as a risk factor for Ischemic heart disease and stroke (WHO, 2014).

In 2011–2012, it was estimated that 12.9 per cent of U.S. adults aged 20 and over (11.1 per cent of men and 14.4 per cent of women) had high total cholesterol, which is unchanged since 2009–2010. Approximately 17 per cent of adults (just over one-quarter of men and less than 10 per cent of women) had low high-density lipoprotein (HDL) cholesterol during 2011–2012. The percentage of adults with low HDL cholesterol has decreased 20 per cent since 2009–2010. Nearly 70 per cent of adults (67 per cent of men and nearly 72 per cent of women) had been screened for cholesterol, which is unchanged since 2009–2010.

A 10 per cent reduction in serum cholesterol in men aged 40 has been reported to result in a 50per cent reduction in heart disease within 5 years; the same serum cholesterol reduction for men aged 70 years can result in an average 20per cent reduction in heart disease occurrence in the next 5 years. In Ireland, a 30per cent reduction in the heart disease death rate has been attributed to 4.6per cent reduction of the population mean for total cholesterol. In Finland, 50per cent of the decline in IHD mortality has been explained by the reduction of population blood cholesterol level (WHO, 2014).

There is a paucity of studies on dyslipidemia in South Asians. The overall prevalence of dyslipidemia in India in various studies ranges from 10 per cent to 73 per cent depending on area of residence (rural *vs.* urban), socio-economic stratum (high *vs.* middle or low), diet and physical activity patterns and age (Misra *et al.,* 2004).

The prevalence of hypertriglyceridemia varied from 73 per cent in obese and 61 per cent in non-obese Asian Indians in urban areas and migrant Asians, the levels were relatively lower in rural areas but still higher than white Caucasians. The results from a recent cross-sectional study in urban New Delhi (north India) showed the prevalence of hypertriglyceridemia to be 42.7 per cent (Bhardwaj *et al.,* 2011).

A population-based survey of cohort of subjects in the metropolitan city of Mumbai. A total of 548 subjects, who attended. fasting lipid profile was evaluated for them. Increased hypertriglyceridemia and decreased levels of HDL-C were found to be more in males in urban India (Sawant *et al.,* 2011).

In rural areas, the prevalence figures were lower than urban areas; In particular, HDL levels are lower in South Asians than in White Caucasians (Misra *et al*., 2011).

According to the National Health and Nutrition Examination Survey (2009), From 1959-1962 to 2007-2008, the average total cholesterol level among adults aged 20-74 years declined from 222 mg/dl to 197 mg/dl.

In 2010, high total cholesterol was the second greatest attributor to the total burden of heart disease, accounting for more than a third (36.3per cent) of the total burden (GBD, 2010).

In 2008 the global prevalence of raised total cholesterol among adults (≥ 5.0 mmol/l) was 39per cent (37per cent for males and 40per cent for females). Globally, mean total cholesterol changed little between 1980 and 2008, falling by less than 0.1 mmol/L per decade in men and women. The prevalence of elevated total cholesterol was highest in the WHO Region of Europe (54per cent for both sexes), followed by the WHO Region of the Americas (48per cent for both sexes). The WHO African Region and the WHO South East Asian Region showed the lowest percentages (22.6per cent for AFR and 29.0per cent for SEAR) (WHO, 2014).

In the investigation of prevalence of obesity and cardio metabolic risk factors in urban population of New Delhi, India(n=459), Hypertriglyceridemia, hypercholesterolemia and low levels of HDL-c were prevalent in 42.7 per cent, 26.6 per cent and 37 per cent of the subjects, respectively. The prevalence of hypertriglyceridemia was significantly higher in males (p□=□0.007); however, low levels of HDL-c were more prevalent in females as compared to males (p□=□0.00) (Bhardwaj *et al.,* 2011).

From 1999 - 2000 to 2005 - 2006, the mean age-adjusted serum total cholesterol level for all U.S. adults aged $\geq$20 years declined significantly from

204 mg/dl to 199 mg/dl. The level among men decreased from 203 mg/dl to 195 mg/dl and among women decreased from 205 to 201 mg/dl. ‘The Healthy People 2010’objective to reduce mean serum cholesterol levels among adults to <200 mg/dl (objective 12-14) was met in 2005--2006 for the overall adult population aged ≥20 years and for men but not for women (National Health and Nutrition Examination Survey, 2008).

The Healthy People 2020 target for high total cholesterol of no more than 13.5per cent was achieved in all adults and in all sex and racial and ethnic groups except for women overall, Hispanic men, and non-Hispanic white women. However, none of the sex and race and Hispanic origin groups attained the Healthy People 2020 target for cholesterol screening of at least 82.5per cent (Carroll *et al.,* 2012).

The prevalence of raised total cholesterol increased noticeably according to the income level of the country. In low income countries around a quarter of adults had raised total cholesterol, in lower middle income countries this rose to around a third of the population for both sexes. In high-income countries, over 50per cent of adults had raised total cholesterol; more than double the level of the low-income countries (WHO, 2014).

Between 1999 and 2010, the percentage of American adults with high total cholesterol decreased from 18.3per cent to 13.4per cent (CDC, 2011).

In India, there is a gradual transition from infectious to chronic diseases as the population grows older, richer and more urbanized. Sedentary lifestyles and increased consumption of high-fat foods such as fast food are contributing to the growing prevalence of chronic diseases Diet is an important factor in certain diseases in India. In 2011, anemia was the most prevalent disease in India, followed by hypercholesterolemia (high cholesterol). It is estimated that there are almost 224 million people with high cholesterol in India (www.medtechinsight.com).

A study by The Hindu (2010) aimed at studying the prevalence of dyslipidemia (high cholesterol) in the Tamil Nadu population, prevalence is actually higher (20.1 per cent). This means, approximately about 86 lakh people have high cholesterol.

In 2011/12, 5.6 million people aged 18 and older had high total cholesterol. Overall, 33 per cent of Australians had high total cholesterol. More than 2.7 million Australian men had high total cholesterol in 2011/12, or approximately 32 per cent of all males aged 18 and over. Close to 2.9 million Australian women had high total cholesterol in 2011/12, or approximately 33 per cent of all females aged 18 and over (Australian Health Survey 2011/12).

The prevalence of high cholesterol was highest amongst the 55 to 64 year age group, with almost one in two having high total cholesterol. Close to one in five Australians aged 18 to 34 had high total cholesterol, representing more than one million. The prevalence of high total cholesterol was highest in Tasmania and South Australia, with Northern Territory having the lowest prevalence rate. Australians residing in regional and remote areas were more likely to have high total cholesterol than those living in major cities. More than one in three (37.3per cent) Australians who were overweight or obese had high total cholesterol, significantly higher than those with a BMI of under 25 (www.heartfoundation.org).

Global variations in the prevalence of elevated cholesterol among patients with history of hyperlipidemia are associated with country-level economic development and health system indices. These results support the need for strengthening efforts toward effective cardiovascular disease prevention and control and may provide insight for health policy setting at the national level. Recently World Health Organization (WHO) has declared that, by 2020, 60 per cent of cardiovascular cases will be of Indian origin (Kumar and Kapoor, 2005).

B. <u>RISK FACTORS FOR HYPERLIPIDEMIA</u>

In many patients hyperlipidemia is caused by some underlying "non-lipid" etiology rather than a primary disorder of lipid metabolism. The secondary causes of dyslipidemia will be,

- Type 2 diabetes mellitus
- Excessive alcohol consumption
- Cholestatic liver diseases

- Nephrotic syndrome
- Chronic renal failure
- Hypothyroidism
- Cigarette smoking
- Obesity
- Drugs

The most common conditions that were felt to be contributing to dyslipidemia were excessive alcohol intake (10 percent) and uncontrolled diabetes mellitus (8 percent) (Rosenson., 2014).

The factors increase the chance of developing hyperlipidemia are, Advancing age, sex (male), post menopause, lack of exercise, Tobacco Use Disorder, stress and alcohol abuse and alcoholism (www.thirdage.com).

Secondary causes of hyperlipidemia are, Medical conditions, for example hypothyroidism, obstructive jaundice, Cushing's syndrome, anorexia nervosa, nephrotic syndrome, diabetes mellitus, and renal failure and some Drugs, for example, thiazide diuretics, glucocorticoids, cyclosporine, antiretroviral therapy, beta-blockers, combined oral contraceptive pill, atypical antipsychotics, and retinoic acid derivatives and some conditions such as pregnancy, obesity, alcohol abuse. (NICE clinical guideline, 2008)

Hyperlipidemia is an associated complication of diabetes mellitus (Palaniab *et al.,* 2010).

Increments of BMI, waist circumference, and WHR increased the frequency of hyperlipidemia. Specifically, Waist Hip Ratio was the most informative determinant of the expression of hyperlipidemia, in particular, hypertriglyceridemia. The data indicate that FCH develops against a background of abdominal obesity (Kallen *et al.,* 2012).

Inherited forms of hypercholesterolemia can also cause health problems related to the buildup of excess cholesterol in other tissues (U.S. National Library of Medicine, 2014).

Stearic acid, in contrast to other Saturated Fatty Acids (SFA) (lauric, myristic, and palmitic), does not increase TC levels. Trans unsaturated fatty acids can be found in limited amounts (usually, 5per cent of total fat) in dairy products and in meats from ruminants. ‘Partially hydrogenated fatty acids’ of industrial origin represent the major source of trans fatty acids in the diet; the average consumption of trans fatty acids in western countries is between 2 and 5per cent of the total energy intake. Quantitatively, dietary trans fatty acids have a similar raising effect on LDL-C to that of SFAs (Mozaffarian *et al.,* 2009).

A positive relationship exists between dietary cholesterol and Coronary Artery Disease (CAD) mortality, which is partly independent of TC levels. Several experimental studies on humans have evaluated the effects of dietary cholesterol on cholesterol absorption and lipid metabolism and have revealed marked variability among individuals (Ordovas *et al.,* 2009).

For many people, abnormal cholesterol levels are partly due to an unhealthy lifestyle most commonly, eating a diet that is high in fat. Other lifestyle factors are, being overweight, heavy alcohol use, lack of exercise and leading an inactive lifestyle. Certain health conditions can also lead to high cholesterol, including, underactive thyroid gland, polycystic ovary syndrome and other conditions that increase levels of female hormones. Medicines such as certain birth control pills, diuretics (water pills), beta-blockers, and some medicines used to treat depression may also raise cholesterol levels (www.nlm.nih.gov).

Ruixing *et al.,* (2008) compared the differences in hyperlipidemia prevalence and its risk factors between the Guangxi Bai Ku Yao and Han populations, both populations (1170 healthy subjects of Bai Ku Yao and 1173 participants of Han Chinese aged 15–89 years) were from Lihu and Baxu villages in Nandan County, Guangxi Zhuang Autonomous Region, People’s Republic of China and information on demographic, dietary and lifestyle characteristics was collected. The prevalence rates of hypercholesterolemia, hyper-triacyl glycerolaemia and hyperlipidemia in Bai Ku Yao and Han were 12.4per cent v. 26.2per cent ($P<0.001$), 15.0per cent v. 14.8per cent ($P<0.05$) and 24.4per cent v. 33.9per cent ($P<0.001$), respectively. The prevalence of hypercholesterolemia and hyperlipidemia was varied in both populations, which might result from different dietary habits, lifestyle choices and physical activity level, as well as genetic factors between the two ethnic groups.

C. PREVENTION AND MANAGEMENT OF HYPERLIPIDEMIA

Diet and lifestyle change are the primary focus for most cholesterol problems. (News Medical, 2014)

Dietary modification, increased physical activity, and weight management are the cornerstones of initial management for mild hypertriglyceridemia Retinoic acid derivative action, lipid metabolism, and treatment of incident dyslipidemia are reviewed to empower prescribers in management of adverse lipid effects (Lilley *et al.,* 2013).

Pharmacologic treatment of hyperlipidemia in conjunction with therapeutic lifestyle changes can be used for both primary and secondary prevention of cardiovascular disease. Statins have the most convincing data for primary prevention, especially for higher risk patients. Therefore, risk stratification is essential. Statin therapy is also recommended for secondary prevention in all patients with known cardiovascular disease or the risk equivalent. There is good evidence for using statins in the secondary prevention of stroke and peripheral arterial disease (Last., 2011).

The study by Olive (2009) was determined that, focused educational interventions can improve the management of hypercholesterolemia by internal medicine residents. The study sample consisted of 106 patients with lipid elevations who had been educated by distribution of printed materials, lectures, identification of an attending physician as a resource for questions, and emphasis on management of hypercholesterolemia by clinic staff preceptors. In patients with hypercholesterolemia, the mean reduction in cholesterol was 7per cent. Focused educational interventions were associated with a significant increase in the frequency with which internal medicine residents treated hypercholesterolemia.

Treatment targets of dyslipidemia are primarily based on results from clinical trials. In nearly all lipid-lowering trials the LDL-C level has been used as an indicator of response to therapy. Therefore, LDL-C remains the primary target of therapy in most strategies of dyslipidemia management. The most recent Cholesterol Treatment Trialists' Collaboration (CTT) meta-analysis of several trials involving .170 000 patients confirmed the dose-dependent reduction in CVD with LDL-C lowering (Lancet, 2010).

According to Mente *et al.,* (2009) clinical judgement is required before a final treatment plan is implemented. Clinicians again should exercise judgement to avoid premature or unnecessary implementation of lipid-lowering therapy. Lifestyle interventions will have an important long-term impact on health, and the long-term effects of pharmacotherapy must be weighed against potential side effects. For subjects at moderate risk, an LDL-C target of, 3 mmol/L (less than 115 mg/dl) should be considered. The role of nutrition in the prevention of CVD has been extensively reviewed.

Shaw *et al.,* (2006) body weight reduction also influences TC and LDL-C, but the magnitude of the effect is rather small; in grossly obese subjects a drop in LDL-C concentration of 0.2 mmol/L (8 mg/dl) is observed for every 10 kg of weight loss. Even smaller is the reduction of LDL-C levels induced by regular physical exercise.

Vitamin D deficiency has been linked to several cardiovascular risk factors but information regarding vitamin D concentrations in Familial Combined Hyperlipidemia (FCH) is lacking. The objective was to examine vitamin D concentrations in patients with FCH and to study the effects of lipid-lowering therapy. A cross sectional study was conducted by Minambres *et al.,* (2014) on 59 patients with FCH and 48 healthy controls. 25-hydroxyvitamin D (25(OH) D) concentrations and their association with lipid parameters, anthropometric measures, C-reactive protein and Homeostasis Model Assessment (HOMA) index was analyzed. The findings suggested that FCHL is associated with decreased vitamin D concentrations.

Little is known about the potential adherence to and the effectiveness of a Low-Carbohydrate (LC) diet on weight loss and cardio metabolic risk factors in Chinese adults with a habitually high carbohydrate intake. In the controlled feeding trial, fifty overweight or obese women (age 47.9 years; BMI 26.7 kg/m2) were randomly assigned to a LC non-energy-restricted diet (initial carbohydrate intake 20 g/d, with a 10 g increase weekly) or an Energy-Restricted (ER) diet (carbohydrate intake 156–205 g/d, ER to 5021 or 6276 kJ/d, 35per cent average energy reduction) for 12 weeks. Over the intervention period, participants in the

LC group had greater reductions in the ratio of total cholesterol:HDL-cholesterol (P¼0·03) and also in the ratio of TAG:HDL-cholesterol (P¼0·01) than those in the ER group. This trial suggested that both a LC non-energy-restricted diet and an ER diet were acceptable to Chinese women and both diets were equally effective in reducing weight and fat mass. Moreover, the LC diet showed beneficial effects on blood lipid profiles (Liu *et al.,* 2013).

American Heart Association (AHA) guidelines for cholesterol and triglycerides levels in adults.

TABLE I

LIPID PROFILE GUIDELINES OF AMERICAN HEART ASSOCIATION

	Total-C	**LDL – C**	**HDL – C**	**TG**
Optimal	-	<100mg/dl*	> 60 mg/dl	-
Near optimal/above optimal	<200mg/dl	100-129mg/dl	40-50mg/dl (men) 50-60mg/dl (women)	< 150 mg/dl
Borderline high	200-239mg/dl	130-159mg/dl	-	150-199 mg/dl
High	-	160-189mg/dl	-	200-499 mg/dl
Very high	≥240mg/dl	> 190mg/dl	<40mg/dl (men) <50mg/dl (women)	≥ 500 mg/dl

* If the patient has additional risk factors LDL levels are recommended under 70 mg/dl. (Stapleton et al., 2010)

To identify persons who may be at risk for developing coronary heart disease, adults are advised to have their cholesterol checked at least once every 5 years (i.e., to be screened for cholesterol) (NCEP., 2001).

D. ROLE OF FUNCTIONAL FOODS IN HYPERLIPIDEMIA

Functional food is any food or food ingredients that may provide a health benefit through prevention or treatment of diseases and disorders (Al-Okbi, 2008).

Pre-clinical studies suggest that sesame and its lignans induce beneficial changes in risk factors related to cardiovascular disease. The effects of sesame on reducing serum lipids and enhancing antioxidant capacity was investigated in 38 hyperlipidemic patients who were divided into two groups randomly. For all individuals along the 60 days of study period, the same drug treatments were considered. Intervention group patients were supposed to eat 40 g white sesame seeds daily, and instead of these calories, 240 kcal was removed from their diet. Anthropometric measurements were measured and lipid profile was assessed before and after the intervention. The results showed that the diet with sesame significantly decreased the levels of serum Total Cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) and TC/HDL-C ratio. The results suggested that sesame seed supplementation decreased serum TC, LDL-C and lipid peroxidation, and increased antioxidant status in hyperlipidemic patients (Alipoor *et al.,* 2012).

Fuzhuan brick tea is a kind of microbial fermented tea, which has received increasing attention in recent years owing to its benefits for human health. The anti-obesity and hypolipidemic effects of Fuzhuan brick Tea water Extracts (FTEs) were investigated by Li *et al.,* (2012) demonstrated that FTEs have anti-obesity and hypolipidemic functions, suggesting that it might be effective for treatment of obesity and hyperlipemia.

The spices fenugreek, garlic, ginger, onion, red pepper, and turmeric are effective as hypocholesterolemics under conditions of experimentally induced hypercholesterolemia and hyperlipidemia. Furthermore, fenugreek is effective in human diabetics, whereas garlic and onion are effective in humans with induced lipemia. Capsaicin and curcumin, the active principles of red pepper and turmeric, respectively, are also documented to be efficacious even at doses comparable to calculated human intake. Capsaicin, curcumin, fenugreek, ginger, and onion are understood to cause an enhanced biliary secretion of bile acids also. Considerable human experimentation has been done with garlic and onion. Among these six spices, beneficial effects on lipid metabolism would probably be in the order: garlic > onion > red pepper/ capsaicin > turmeric / curcumin> fenugreek > ginger. The mechanisms underlying the hypocholesterolemic and hypotriglyceridemic influence of these spices have also been fairly well understood. (Srinivasan *et al.,* 2004)

Mahonia Leschenaultia Takeda (*Berberidaceae*) (MLT) is a traditional medicinal plant that is commonly used against diseases in India and other Asian countries. Anti-hyperlipidemic effects of the ethanol extract of MLT on Streptozotocin (STZ)-induced diabetic rats were identified. Phyto-constituents like oleic acid, 9,12-octadecadienoic acid (Z, Z)-n-hexadecanoic acid were identified as high per cent peak when compared with other compounds by GC–MS. STZ induced diabetic animals were fed with plant extracts at different doses (250 or 500mg kg_1 body wt) of ethanol extract of MLT. The results of the study revealed a significant increase in total hemoglobin and glycosylated hemoglobin along with the reduction in hyperlipidemia effects in MLT-treated STZ-induced diabetic rats compared to diabetic only rats. (Palaniab *et al.,* 2010)

The hypocholesterolaemic activity of buckwheat protein products is far stronger than that of soya protein isolate and corn. (Zhang *et al.,* 2007)

In the study by Claudia *et al.,* (2012), sixteen subjects with mild plasma lipid abnormalities were studied in 2-week run-in period, they followed a diet containing baked products enriched with active nutrients (active diet) or a diet containing the same products but without active nutrients (control diet) for 1 month and then crossed over to the other diet. At the end of each period, a test meal of the same composition as the corresponding diet was administered, and plasma samples were obtained before and for 6 hours after the meal. Fasting plasma triglycerides were significantly lower after the active versus the control diet ($p<0.05$), as was the postprandial level of chylomicron triglycerides and the insulin peak ($p<0.05$). The active diet also reduced fasting homocysteine ($p<0.05$) and the feeling of hunger at the fifth and sixth hour ($p<0.05$). Baked functional products enriched with n-3 fatty acids, folates, Beta-glucans, and tocopherols within the context of a balanced diet lower fasting and postprandial plasma triglycerides.

Okara is a by-product generated during tofu or soymilk production processes. It contains about 50 per cent dietary fiber, 25 per cent protein, 10 per cent lipid, and other nutrients. It could also be used as a dietary supplement to prevent diabetes, obesity, and hyperlipidemia. (Li *et al.,* 2012)

Kumar *et al.,* (2013) explored the anti-dyslipidemic activity of active component and metabolite of sesamolin (sesamol), by using acute models of hyperlipidemia viz., a fat tolerance test, a tyloxapol induced hyperlipidemia model and a chronic model of hyperlipidemia viz., a high-fat diet-induced hyperlipidemia model in Swiss albino mice. The hypolipidemic effect of sesamol at 200 mg/kg was equivalent to 10 mg/kg of orlistat. In the tyloxapol-induced hyperlipidemia model, Sesamol at 200 mg/kg reversed the elevated levels of cholesterol and triacylglycerol compared with the tyloxapol group at 12 and 24 h, which indicates its probable effect on cholesterol synthesis. Elevated levels of cholesterol and triacylglycerol were significantly ($P<0.05$) reversed by the sesamol (50 and 100 mg/kg), implying that it might reduce the absorption and increase the excretion of cholesterol as well.

A diet rich in fat is considered a primary risk factor for CVD. Hyperlipidemia generates oxidative stress and weakens antioxidant defenses as well as metabolic detoxification systems. Brassicaceae are vegetables rich in glucosinolates and isothiocyanates, affecting enzymatic antioxidant as well as phase II enzymes and conceivably counteracting High-Fat Diet (HFD)-associated pathologies. The protective role of Tuscan Black Cabbage (a variety of kale) Sprout Extract (TBCSE) intake against HFD alterations was studied and the effects on rat hepatic antioxidant as well as detoxifying enzymes, and serum lipid- and body weight lowering properties of TBCSE, were investigated. Feeding the animals with a HFD for 21 d increased body as well as liver weights, and induced hyperlipidemia, as confirmed by a higher serum lipid profile v. control diet. Daily intragastric administration of TBCSE to HFD-fed rats lowered serum total cholesterol. TBCSE intake emerges to be an effective alimentary strategy to counteract the perturbations associated with a diet rich in fat. (Melega *et al.,* 2013)

Disodium ascorbyl phytostanol phosphate (FM-VP4) is a synthetic compound derived from sitostanol and campestanol that has proved to be efficient as a cholesterol-lowering therapy in mice and human subjects. This is the first phytosterol or stanol that affects bile acid metabolism and lowers plasma cholesterol levels in normo-cholesterolaemic mice. (Mendez-Gonzalez *et al.,* 2010)

Recently, there has been an increasing interest in tea as a protective agent against CVD. Ramadan *et al.,* (2009) compared the modulatory effects of two different doses (50 and 100 mg/kg body weight given orally for 28 consecutive days) of black tea aqueous extract (BTE, rich in theaflavins and thearubigins) and green tea aqueous extract (GTE, rich in catechins) on experimentally induced hyperlipidaemia in male Wistar albino rats. Both tea extracts significantly alleviated most signs of the metabolic syndrome including hyperglycaemia (resulting from type 1 and 2 diabetes), dyslipidemia in the animals. The study supported the hypothesis that both black and green teas may have beneficial effects against the risks of the metabolic syndrome and CVD as shown in rat models of human obesity and diabetes.

Rape Seed Oil (RSO) is a novel source of plant sterols, containing the unique brassicasterol in concentrations higher than allowed for plant sterol blends in food products in the European Union. RSO stanol and sterol esters with a high concentration of brassicasterol were hypocholesterolemic (Schroder *et al.,* 2009).

There are nine studies reported in the literature which have investigated the response of blood lipids (usually total and LDL-cholesterol and triacylglycerol) to inulin or oligofructose supplementation in human volunteers. Three have observed no effects of inulin or oligofructose on blood levels of cholesterol or triacylglycerol, three have shown significant reductions in triacylglycerol whilst four have shown modest reductions in total and LDL-cholesterol. (Williams and Jackson., 2002)

Hyperlipidemic animals were used for the study and were treated with 100, 200 and 400 mg/kg Ethanol Extract (EE) of Amaranthaceae aspera seeds huskrespectively, while Saponins (SAPN) at a dose of 10 mg/kg by gavage for 28 days. Serum Total Cholesterol (TC), Triglyceride (TG), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), And Atherogenic Index (A.I.) level were estimated on 0^{th}, 14^{th} and 42^{th} day by using autoanalyser. EE of husks decreases TC 40.71-46.77 per cent, TG 23.95-37.27 per cent, LDL 56.49-65.50 per cent, and A.I. 51.27-77.05 per cent significantly ($P<0.01$). SAPN (10 mg/kg bodyweight) decreased TC, TG, LDL, and A.I. by 48.21 per cent, 29.47 per cent, 72.26 per cent, and 82.29 per cent respectively ($P<0.01$). EE and SAPN increased HDL level significantly ($P<0.01$). The findings indicated the reversal of elevated A.I., TC, TG, LDL, serum glucose and AI level significantly associated with atherosclerosis. (Sharma *et al.,* 2013)

Experimental studies have suggested that tea consumption could lower the risk of dyslipidaemia. However, epidemiological evidence is limited, especially in southern China, where oolong tea is the most widely consumed beverage. Yi *et al.,* (2013) conducted a population-based case–control study to evaluate the association between consumption of tea, especially oolong tea, and risk of dyslipidemia in Shantou, southern China, from 2010 to 2011. Information on tea consumption, lifestyle characteristics and food consumption frequency of 1651 patients with newly diagnosed dyslipidemia and 1390 controls was obtained and anthropometric variables and serum biochemical indices were determined. Drinking more than 600 ml (2 paos) of green, oolong or black tea daily was found to be associated with the lowest odds of dyslipidaemia risk ($P<0{\cdot}001$) when compared with non-consumption, but only oolong tea consumption was found to be associated with low HDL-cholesterol levels. Consumption of oolong tea for the longest duration was found to be associated with 3.22, 11.99 and 6.69per cent lower blood total cholesterol, TAG and LDL-cholesterol levels, respectively. The findings indicated that long-term oolong tea consumption may be associated with a lower risk of dyslipidemia in the population of Shantou in southern China.

Attempts are being made worldwide for the search of effective antioxidants that can prevent oxidation of LDL. Role of fermented milk and culture containing dairy products as effective antioxidants and their potential hypocholesterolemic effect is the focus of research. Keeping this in view, the various *lactobacilli* cultures especially L. casei were screened for their in vivo antioxidative activity. Six groups of Wistar albino rats were fed on diets containing 20 per cent fresh or oxidized soybean oil supplemented with 5 per cent lyophilized culture or fermented milk prepared using *L. casei sp* for a period of 90 days. The plasma was analyzed for different lipoprotein fractions and cholesterol content. The cholesterol levels were less in plasma of groups fed on fermented milk by 2-11per cent and by 15-25per cent in groups fed on lyophilized culture as compared to group fed on skim milk. The results have depicted the cholesterol-lowering and antioxidative potential of *Lactobacillus casei ssp casei* for their application as dietary adjunct. (Suman *et al.,* 2006)

The bioactive F-3 fraction from rhizomes of *Acorus calamus* were evaluated for its effect on the lipid profile and fibrinogen levels in diet-induced hyperlipidemia. At doses of 20 and 40 mg/kg, the bioactive fraction significantly ($P < 0.05$) decreased the Total Cholesterol (TC) and Low-Density Lipoprotein (LDL) levels. Additionally, the bioactive F-3 fraction could have a potentially beneficial effect in atherosclerosis associated with hyperlipidemia. (Souza *et al.,* 2007)

Forty healthy 7 weeks old male Sprague Dawley (SD) rats were randomly divided into four groups with 10 rats in each group: control group, hyperlipidemic group, Alfalfa Saponin Extract (ASE) treatment group, ASE prevention group. The body weight gain, relative liver weight and serum lipid levels of rats were determined. Total Cholesterol (TC) and Total Bile Acids (TBA) levels in liver were also measured. The results showed the abnormal serum lipid levels in hyperlipidemic rats were ameliorated by ASE administration (both ASE prevention group and treatment group) ($P<0.05$). The findings suggested ASE had great potential usefulness as a natural agent for treating hyperlipidemia. (Shi*et al.,* 2014)

E. HYPOCHOLESTEROLEMIC EFFECT OF FLAXSEED AND GARLIC:

Flaxseed has been the focus of increased interest in the field of diet and disease research due to the potential health benefits associated with some of its biologically active components: oil containing approximately 59per cent a-linolenic acid) and the presence of plant lignan Secoisolariciresinol Diglucoside (SD) Lignans are found in most fiber-rich plants, including grains, legumes and vegetables such as garlic, asparagus, broccoli, and carrots. Plant lignans are phenolic compounds (Harris., 2010)

Karen *et al.,* (2009) conducted a randomized crossover study, with 16 postmenopausal women supplemented their diets with food bars containing either 25 g unground flaxseed, sesame seed, or their combination (12.5 g each) (flaxseed and sesame seed bar, FSB) for 4wk each, separated by 4wk washout periods. Total serum n-3 fatty acids increased with flaxseed ($p<0.05$) and FSB ($p<0.064$) Plasma lipids and several antioxidant markers were unaffected by all treatments, except serum G-Tocopherol (GT), which increased with both sesame seed ($p<0.0001$) and FSB ($p<0.01$). Fatty acids and lignans from unground seed in food bars are absorbed and metabolized;

Dietary fibers have been proposed to play a role in cardiovascular risk as well as body weight management. Flaxseeds are a good source of dietary fiber, and a large proportion of these are water-soluble viscous fibers. Kristensen *etal*., (2012) examined the effect of flaxseed dietary fibers in different food matrices on blood lipids and fecal excretion of fat and energy in a double-blind randomized crossover study with 17 subjects. Three different 7 day diets were tested: a low-fiber control diet (Control), a diet with flaxseed fiber drink (3/day) (Flax drink), and a diet with flaxseed fiber bread (3/day) (Flax bread). Compared to control, Flax drink lowered fasting total-cholesterol and LDL-cholesterol by 12 and 15per cent, respectively, ($p < 0.01$), whereas Flax bread only produced a reduction of 7 and 9per cent, respectively ($p < 0.05$). Both Flax drink and Flax bread resulted in decreased plasma total and LDL-cholesterol. Viscous flaxseed dietary fibers may be a useful tool for lowering blood cholesterol.

Inflammation and lipid abnormalities are two important risk factors for cardiovascular disease in hemodialysis (HD) patients. An unblinded, randomized clinical study was designed to investigate the effects of flaxseed consumption on systemic inflammation and serum lipid profile in 30 HD patients with Dyslipidemia. Patients in the flaxseed group received 40g/day ground flaxseed for 8 weeks, whereas patients in the control group received their usual diet, without any flaxseed. At baseline and at the end of week 8, 7ml of blood was collected after a 12- to 14-hour fast and serum concentrations of triglyceride, total cholesterol, low-density lipoprotein-cholesterol (LDL-C), HDL-C, and C-Reactive Protein (CRP) were measured. Serum concentrations of triglyceride ($P<0.01$), total cholesterol ($P<0.01$), LDL-C ($P<0.01$), and CRP ($P<0.05$) decreased significantly in the flaxseed group at the end of week 8 compared with baseline, whereas serum HDL-C showed a significant increase ($P<0.01$). These changes in the flaxseed group were significant in comparison with the control group. The study indicates that flaxseed consumption improves lipid abnormalities and reduces systemic inflammation in HD patients with lipid abnormalities. (Soltani *et al.*, 2013)

Flaxseed (*Linum usitatissimum* L) is known for its high content of lignans relative to other grains and legumes, of which secoisolariciresinol diglucoside (SDG) is the most important. Flaxseed lignans and their mammalian metabolites are known to have a number of potential health benefits, including reducing the risk of breast, prostate and colon cancers, which has been attributed to its (anti)-estrogenic and antioxidant properties and they can lower the total cholesterol, LDL cholesterol and glucose concentrations in the blood, which could prevent cardiovascular diseases. Depending on the rate of SD metabolism by the intestinal microflora, intestinal epithelial cells can be exposed to relatively high concentrations of SD. (Hu *et al.,* 2007)

Flaxseed Oil (FO) is the main component of the flaxseed and one of the world's most important vegetable sources of α-linolenic acid (LNA, 18:3n-3). As a nutritionally essential polyunsaturated fatty acid (PUFA), LNA can act as the precursor of longer chain n-3 PUFA (EPA and DHA) or compete with linoleic acid or direct interaction with ion channels and nuclear receptors, and thus may exert various biological functions in the human body. (Barcelo-Coblijn and Murphy, 2009)

Most nutrition experts recommend ground over whole flaxseed because the ground form is easier for the body to digest. Whole flaxseed may pass through the intestine undigested, which means all the benefits cannot be get. Flaxseed's health benefits come from the fact that it's high in fiber and omega-3 fatty acids, as well as phytochemicals called lignans. One tablespoon of ground flaxseed contains 2 grams of polyunsaturated fatty acids (includes the omega 3s) and 2 grams of dietary fiber and 37 calories. Flaxseed is commonly used to improve digestive health or relieve constipation. Flaxseed may also help lower total blood cholesterol and low-density lipoprotein (LDL, or "bad") cholesterol levels, which may help reduce the risk of heart disease. (http://www.mayo clinic.com)

Oral garlic supplementation may be effective in decreasing serum cholesterol levels as much as 15per cent to 20per cent. Garlic indirectly effect atherosclerosis by reduction of hyperlipidaemia, hypertension and probably diabetes mellitus and prevents thrombus formation. The study was undertaken to test the hypothesis that garlic powder with a prolonged mode of action promises potent biological effects into hypercholesterolemia. Fifty albino rats were randomly divided into 5 equal groups (n=10). All rats were initially fed normal diet for at least 7 days. Then Group A was control and was fed a normal diet + 0.5per cent cholesterol, Group B was fed normal diet and 3 mg garlic per 10 g of feed and Group C was fed normal diet and 10 mg garlic per 10 g of feed. The experiment lasted for 12 weeks. Body weight and serum cholesterol were noted before and after giving garlic with cholesterol. Effect of serum cholesterol level was significantly decreased after taking 3 and 10 mg of garlic. However it was observed that the body weight was increased after taking garlic. Garlic consumption although can decrease the level of serum cholesterol but it increases the body weight. Garlic consumption alone can decrease serum cholesterol level, but it cannot be used as the main therapeutic agent for hyperlipidemia. (Farnaz *et al.,* 2011)

In a meta-analysis of 29 trials garlic was found to significantly reduce total cholesterol (95per cent) but exhibited no significant effect on LDL-C or HDL-C levels (Reinhart *et al.,* 2009). However, in a later meta-analysis of 13 trials there was no significant difference in effects on all outcome measures examined when compared with placebo (Khoo*et al.,* 2009)

One hundred and fifty hyperlipidemic patients in cardiology outpatient department of Shiraz University of Medical Sciences were divided into three equal groups randomly (each composing of 50 patients). They were given enteric-coated garlic powder tablet (equal to 400 mg garlic, 1 mg allicin) twice daily, anethum tablet (650 mg) twice daily, and placebo tablet. In garlic group: total cholesterol (decreased by 26.82 mg/dl, 12.1 per cent reduction, and P-value:0.000), and LDL-cholesterol (decreased by 22.18 mg/dl, 17.3 per cent reduction, and P-value:0.000) dropped. HDL-cholesterol (increased by 10.02 mg/dl, 15.7 per cent increase, and P-value:0.000) increased. Although triglyceride dropped by 13.72 mg/dl (6.3 per cent) but this was not significant statistically (P-value:0.222). garlic tablet has significant favorable effect on cholesterol, LDL-cholesterol, and HDL-cholesterol. Garlic may play an important role in therapy of hypercholesterolemia. (Kojuri *et al.,* 2007)

Clinical and experimental evidence indicates that garlic ingestion lowers blood cholesterol levels, and treatment of cells in culture with garlic and garlic-derived compounds inhibits cholesterol synthesis. Garlic extract reduced cholesterol synthesis by up to 75per cent without evidence of cellular toxicity. Of 9 garlic-derived compounds tested for their ability to inhibit cholesterol synthesis, only diallyl disulfide, diallyl trisulfide, and allyl mercaptan proved inhibitory, each yielding a pattern of sterol accumulation identical with that obtained with garlic extract. The results indicated that compounds containing an allyl-disulfide or allyl-sulfhydryl group are most likely responsible for the inhibition of cholesterol synthesis by garlic and that this inhibition is likely mediated at sterol 4alpha-methyl oxidase. (Singh and Porter., 2006)

Lau., (2006) presented a paper on experimental evidence showing that several garlic compounds can suppress LDL oxidation in vitro. Short-term supplementation of garlic in human subjects has demonstrated an increased resistance of LDL to oxidation. These data suggest that suppressed LDL oxidation may be one of the mechanisms that accounts for the beneficial effects of garlic in cardiovascular health.

Sobenin *et al.,* (2008) evaluated the effects of a new time-released garlic powder formulation in mildly hyperlipidemic men. The randomized, double-blind, placebo controlled trial included 42 men aged 35–70. Prior to randomization, participants underwent 4 weeks of treatment with a hypolipidemic diet, followed by a 4-week phase of hypolipidemic diet in addition to placebo (one tablet twice daily). Thereafter, they were randomized to either time released garlic powder tablets (Allicor) 600 mg twice daily or placebo for 12 weeks. Randomization was stratified by age, total and LDL cholesterol, fasting glucose values, systolic and diastolic blood pressure, smoking history, family history, BMI, alcohol consumption, and cardiovascular history. Fasting lipid levels were measured at baseline, following 4 weeks of diet, at randomization, and following 4, 8, and 12 weeks of study medication. After the 8-week run in phase, mean LDL values were mildly reduced (P=NS). Following 12 weeks of treatment, garlic reduced LDL values more significantly compared to placebo (169.8 mg/dl vs. 196.6 mg/dl, $p<0.05$). HDL concentrations decreased significantly in the garlic group compared to baseline, but not compared to placebo. Total cholesterol values decreased by 2.4per cent in the garlic group compared to at randomization (95per cent CI 2.7–12.5, $p=0.004$), and were 11.5per cent lower than the placebo group ($p=0.003$) at the end of the study.

According to Zeng a *et al.,* (2011) garlic has long been the focus of experimental and clinical attentions due to its promising lipid-lowering effects. Numerous animal studies as well as in vitro ones have demonstrated the hypolipidemic effects of garlic. Based on some double-blind, randomized, placebo-controlled clinical trials which denied the hypolipidemic effects of garlic. The type of the garlic products may be another important factor responsible for the conflicting outcomes, as different garlic products are composed of different organo sulfur compounds. Moreover, some studies indicated that different people might have a different response to garlic, and thus garlic may be more beneficial for some specific groups. Collectively, it may be inappropriate to draw a conclusion that garlic does not benefit for hyperlipidemia. Future studies with larger samples are needed to further clarify the effects of garlic used at higher but non-toxic doses on specific groups.

Flax is an attractive nutrition crop because of the high content of alpha-linolenic acid in the flaxseed oil and its dietary fibre and high quality proteins. Flaxseed contains 40–45per cent oil, 20–25per cent fibre, 20–25per cent proteins, and 1per cent lignans secoisolariciresinol Diglucoside. (Rabetafika *et al.,* 2011)

At present time, flaxseed has new prospects in food because of the growing consumers' interest for functional food with health benefits. Indeed, flaxseed is a raw material rich in biologically active compounds such as polyunsaturated fatty acids (omega-3) protective of the cardiovascular system and lignans with antioxidant and anti-cancer properties (Tarpila et al., 2005).

The low ratio of lysine:arginine in flaxseed protein is also indicative of anti-cholesterol and anti-tumour properties. Marambe *etal*. (2008) demonstrated this cholesterol- lowering property by their bile acid binding ability.

The health benefits of flaxseed protein are also enhanced by the presence of other components like unsaturated fatty acid omega-3 known to control the metabolism of prostaglandins and reduce triglycerides and cholesterol in the blood (Tolkachev & Zhuchenko, 2000).

METHODOLOGY

The methodology pertaining to the study on **"Hypolipidemic Effect Of Flaxseed And Garlic"** is discussed under the following headlines:

A) Selection of the locale
B) Selection of the target group
C) Formulation of the tool and collection of data
D) Assessment of nutritional status.
    1. Anthropometric measurements
    2. Dietary assessments
    3. Biochemical estimations
E) Supplementation of flaxseed and garlic
F) Analysis of data and interpretation of results

A) SELECTION OF THE LOCALE:

The area selected for the study was Enbest Pumps India Pvt Ltd., K.N.G Pudhur, Coimbatore, this place was selected because of easy access and availability of adequate number of hyperlipidemics for the study who working in this industry and convenience of the investigator. The purpose and procedure involved in the study were explained to the authorities of the industry for the present study. The authorities and subjects rendered their full support to conduct the present study. The co-operation and willingness of the selected subjects also facilitated to complete this study in an effective manner.

B) SELECTION OF THE TARGET GROUP:

People who were having hypercholesterolemia in this industry were selected by the investigator for the conduct of the present study. They were selected based on their willingness to participate in the study. A sample of 100 hypercholesterolemic people including males and female subjects free from serious complications aged 30-60 years were selected. The subjects were selected by purposive sampling method from the area. Among the 100 hyperlipidemics selected, 10 were in the experimental group supplemented with flaxseed and garlic mix for a period of 45 days and 10 acts as control subjects without any supplementation.

C) FORMULATION OF THE TOOL AND COLLECTION OF DATA:

Interview method was chosen due to its convenience comprehensiveness and possibly of obtaining genuine information for collecting data. Hence an interview schedule was selected. An interview schedule is the set of questions that helps to collect data from the field. This generally filled up by the researcher or the interviewer himself. (Gupta, 2007).

A specially designed interview schedule was used to collect information regarding age, sex, educational status, income of the family, dietary pattern, exercise pattern, problems associated with hypercholesterolemia, family and personal history, related symptoms of hyperlipidemia and details about the knowledge about omega-3 fatty acids and dietary fiber and use of flaxseeds among subjects. The interview schedule also has the details about the anthropometric measurements such as height, weight, circumference of waist and hip were recorded and also the biochemical parameters such as blood total cholesterol, LDL cholesterol, HDL cholesterol, Triglycerides, VLDL in fasting were recorded in the same interview schedule.

D) ASSESSMENT OF NUTRITIONAL STATUS:

Nutrition assessments may lead to recommendations for improving nutrition status or recommendations for re-screening. Nutrition assessment has been defined by American Society for Parental and Enteral Nutrition (ASPEN) as “a comprehensive approach to diagnosing nutrition problems that uses a combination of the following: medical, nutrition, and medication histories; physical examination; anthropometric measurements; and laboratory data”. A nutrition assessment provides the basis for a nutrition intervention. (Chada, 2013).

1. Anthropometric Measurements:

Anthropometry involves in obtaining physical measurements of an individual and relating them to standards that reflect the growth and development of the individual. Those physical measurement and useful for evaluating over nutrition or under nutrition. (Mahan, 2011)

HEIGHT

WEIGHT

LIPID PROFILE ESTIMATION

WAIST CIRCUMFERENCE

HIP CIRCUMFERENCE

PLATE I

ANTHROPOMETRIC MEASUREMENTS AND BIOCHEMICAL ESTIMATION

Anthropometric measurements namely height, weight, Body Mass Index, waist to Hip Ratio were measured for all the 100 subjects.

Nutritional anthropometry is measurement of human body at different ages and levels of nutritional status. It is based on the concept that an appropriate measurement should reflect any morphological variation occurring due to significant functional physiological change. (Bamji, 2009)

Measurement of height:

Subjects were asked to stand erect on a leveled surface, without shoes, looking straight with heels together and toes apart. The anthropometer rod should be placed behind the subject in the centre of the heels perpendicular to the ground. The investigator standing on the left side of the subject should firmly hold the chin of the subject with his/her left hand and the occiput of the subject with his right little finger to maintain the Frankfurt horizontal plane (an imaginary line joining the tragus of the ear and infra orbital margin of the eye). The moving head piece of the anthropometer should be placed in the sagital plane over the head of the subject applying a slight pressure to reduce the thickness of hair. The reading should be taken when the anthropometer rod is still in portion. An average of three successive measurements is taken as the final measurement . (Bamji, 2009).

Using above procedure height was recorded for the selected one hundred hyperlipidemics.

Measurement of weight:

Weight is the most popular and reliable indicative of recent nutritional status. The zero error of the weighing scale was checked before taking the weight and the sensitivity of the balance was tested as and when required. The individuals were weighed with minimum clothing and without shoes. The individual should not lean against or hold any support, while the weight was recorded. The measurement should preferably be taken under basal conditions in early mornings. (Bamji et al, 2009)

By this way the weight of the selected 100 hyperlipidemics were recorded.

Body Mass Index:

The Body Mass Index was calculated by dividing the individual's weight in kilogram by the square of his or her height in meters. BMI was calculated for all the selected subjects.

Body Mass Index is the simple and widely used method for estimating body fat mass and an accurate reflection of body fat percentage in the majority of the selected population (Umaito, 2006)

BMI classification for Adult Asians (WHO, 2009)

BMI Classes	**Perspective Diagnosis**
Below 18.5	Underweight
18.5 – 22.9	Normal
23- 24.9	Over weight
Above 25	Obese

The subjects were graded as per the above table given by WHO, 2009.

Measurement of Waist circumference:

Waist circumference is measured using fiber reinforced plastic tape. The tape should pass mid way between the lower rib region and iliac crest. Adult men with waist circumference greater than or equal to 102cms and adult women with greater than equal to 88cms considered as having abdominal obesity. The Asian cut offs for the same is 90cms and 80cms respectively.

Measurement of Hip circumference:

Hip circumference is measured with tape passing over maximum protuberance on buttocks. According to Mahan (2011) the hip circumference was defined as the largest circumference between waist and knees.

Waist to Hip Ratio:

$$\text{WHR} = \frac{\text{Waist Circumference (cm)}}{\text{Hip Circumference (cm)}}$$

The ratio of waist to hip is an indicator of central obesity. Adult men with waist to hip ratio of greater than or equal to 0.95 and women with greater than or equal to 0.80 are considered as having central obesity. (Bamji et al, 2009).

For all the selected subjects WHR was calculated and compared with the standard values suggested by ICMR.

Anthropometric data were recorded for the control and experimental group before and after the study period to evaluate the effect of supplementation.

2. Dietary Assessment:

Dietary assessment information is central feature for many public health studies for Nutritionists, epidemiologists interested to study the influence of diet on health and disease. Dietary intakes are useful to assess the nutritional status, dietary habits of the population regional traditions customs related to food. Qualitative assessment includes food habits, attitudes attached to foods, cultural significance, and food practices during disease, different physiological conditions. Qualitative assessment is to estimate the amount foods and beverages consumed and calculating the nutrients obtained through food (Damayanti, 2013).

For the one hundred selected hyperlipidemics qualitative and quantitative assessment was done and individual dietary consumption was done using 24-hour recall method. This method is followed to assess the nutritional status for the specific individual.

A number of diet survey methods are available. Each method has its strengths and weaknesses. The 24- hour recall method is more appropriate for assessing the intake of large populations than of individuals and it is the most commonly used method since it requires less training than other methods and also memory of food quantities may be recalled more accurately (Damayanti, 2013).

3. Biochemical Estimation:

Laboratory tests based on blood and urine can be important indicators of nutritional status , but they are influenced by non-nutritional factors as well. Laboratory results can be altered by medications, hydration status, and disease states or other metabolic processes, such as stress. As with other areas of nutrition assessment, biochemical data need to be viewed as a part of the whole. (Chada, 2013).

For the total one hundred selected subjects, the blood analysis for total cholesterol and lipid profile was recorded. Among the 100 subjects whose total cholesterol level above 200 mg/dl were selected for the in depth study (10 as experimental group and 10 as control group). Before and after supplementation period total cholesterol, HDL-C, LDL-C, VLDL-C and TG were analyzed for the experimental and control group after 45 days to evaluate the effect of supplementation.

E) SUPPLEMENTATION OF MIX:

Flaxseed known as *Golden flax, Annula flax, linicmen, kahtan, Lin, Linaza, Lino Linseed* and in Hindi '*Alsi*' is an oilseed. It is known for good nutritional characteristic. It is most noted for high levels of alpha-linolenic acid, phyto-estrogenic compound known as lignan and soluble and insoluble fiber. Flax seed is rich sources of the lignin Secoisolariciresionol Diglucoside(SDG).

Chronic administration of equimolar amounts of SDG and SECO caused similar dose dependant reductions in rate of body-weight gain and in serum total and LDL cholesterol levels and hepatic lipid accumulation. The lignan component of flaxseed consumption observed in humans and animals. Identification of the mechanism through which flaxseed lignans improve lipid parameters, an understanding of lignan pharmacokinetics, and additional investigations into the comparative efficacy and safety of plant and mammalian lignans may lead to the emergence of flaxseed or its purified lignan forms, as an invaluable therapeutic strategy in the management of hyperlipidemic patients. (Felmler et al., 2009).

To take advantage of unique fatty acid profile, other health and nutritional benefits and storage properties of this functional food, its level of consumption should be increased. This can be achieved by regular inclusion of flaxseed in the diet. It is possible if products are developed with flaxseeds which are the part of day to day dietary of the people.

Flaxseed has been selected for supplementation study due to its hypocholesterolemic effect.

Preparation of mix:

Ingredients: (for 20g pack)

Flaxseed	-	17.6g
Garlic	-	1.2 g
Cumin seeds	-	1.2 g
Pepper corns	-	2 No.
Dry chilly	-	0.4 g
Salt	-	as required

Dry roast flaxseed, pepper, cumin seeds and dry chillies each separately. Using a blender, grind all the ingredients mentioned above into a powder form and 20 g of this powder is packed in a zip lock polythene cover very hygienically. The packed powders were distributed to the selected 10 subjects in the experimental group once in a week. The packets were distributed to the subjects personally and the subjects were asked to consume this each pack daily and they were advised to add this mix to the cooked rice, mix and consume. And also they were instructed to mix this along with the chappathi dough and prepare as chappathi and consume.

An ethical clearance was approved from the Institutional Human Ethics Committee of Avinashilingam university, Coimbatore (approval no. HEC.2011.30) to conduct the study

PREPARATION OF FLAXSEED AND GARLIC MIX

SUPPLEMENTATION OF FLAXSEED AND GARLIC MIX

PLATE II

PREPARATION AND SUPPLEMENTATION OF FLAXSEED AND GARLIC MIX

Nutrient Content of Flaxseed and Garlic Mix:

The nutrient content of flaxseed and garlic mix is presented in Table III.

TABLE II

NUTRIENT CONTENT OF FLAXSEED AND GARLIC MIX

NUTRIENTS	Per 100g	NUTRIENTS	Per 100g
Energy (Kcal)	501.4	Thiamine (mg)	0.26
Protein (g)	19.9	Riboflavin (mg)	0.11
Fat (g)	33.8	Niacin (mg)	1.25
Calcium (mg)	228.6	Carbohydrate (g)	31.0
Iron (mg)	3.5	Fiber (g)	5.9
Beta-Carotene (mcg)	86.3	Vitamin C (mg)	1.96

The flaxseed and garlic mix contains energy, protein, fat, calcium, iron, beta-carotene in more amounts such as 501.4Kcal, 19.9g, 33.8g, 228.6mg, 3.5mg and 86.3mcg respectively. This mix also contains B vitamins such as thiamine 0.26mg, riboflavin 0.11mg and 1.25mg niacin. It also contributes 31g carbohydrate, 5.9g fiber and 1.96mg vitamin C.

F) ANALYSIS OF DATA AND INTERPRETATION OF RESULTS:

Data collected were classified, tabulated and analyzed and the results were interpreted with statistical appraisal.

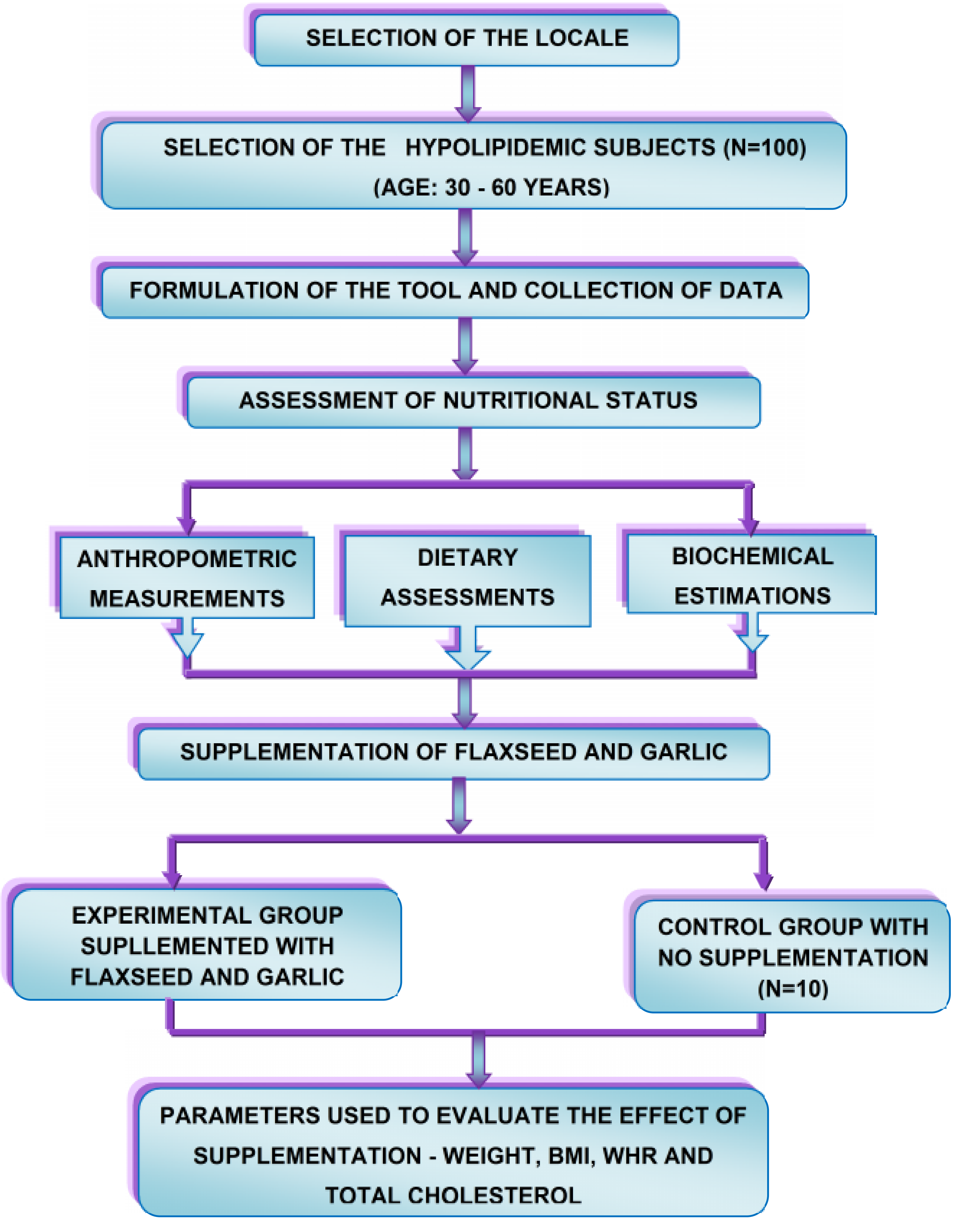

FIGURE II

RESEARCH DESIGN

RESULTS AND DISCUSSION

The results pertaining to the study on "**Hypolipidemic Effect of Flaxseed and Garlic"** is discussed under the following headings:

A) SOCIO ECONOMIC PROFILE OF THE SELECTED HYPERLIPIDEMICS

1. Age and sex wise distribution of the selected hyperlipidemics
2. Educational status
3. Occupational status
4. Type of activity
5. Income level
6. Type of the family

B) DIETARY PATTERN OF THE SELECTED HYPERLIPIDEMICS

1. Dietary habits
2. Meal pattern
3. Dietary consumption pattern of the selected hyperlipidemic subjects
    a) Frequency of food consumed
    b) Quantity of food consumed
4. Type of oils used for cooking
5. Consumption pattern of the snacks

C) LIFESTYLE PATTERN OF THE SELECTED HYPERLIPIDEMICS

1. Exercise pattern
2. Smoking pattern of selected male subjects
3. Alcohol consumption pattern of the selected male subjects
4. Consumption pattern of hot beverages

D) PERSONAL AND FAMILY HISTORY OF THE HYPERLIPIDEMICS

1. Personal history of the disease
    a) Duration of the disease
    b) Symptoms among the selected hyperlipidemics
2. Family history of the disease

E) NUTRITIONAL ASSESSMENT OF THE SELECTED HYPERLIPIDEMICS

1. Anthropometric measurements
    a) Height
    b) Weight
    c) Body Mass Index

d) Waist – Hip Ratio

2. Food and nutrient intake of the selected hyperlipidemics
   a) Mean food intake of the selected male subjects
   b) Mean food intake of the selected female subjects
   c) Mean nutrient intake of the selected male subjects
   d) Mean nutrient intake of the selected female subjects
3. Biochemical profile of the selected hyperlipidemics
   a) Lipid profile of the selected hyperlipidemics

F) EFFECT OF SUPPLEMENTATION OF FLAXSEED AND GARLIC ON HYPERLIPIDEMICS:

1. Body Mass Index
2. Waist – Hip Ratio
3. Lipid Profile

A) SOCIO – ECONOMIC PROFILE OF THE SELECTED HYPERLIPIDEMICS:

Socioeconomic status is an economic and sociological combined total measure of a person's work experience and of an individual's or family's economic and social position in relation to others, based on income, education, and occupation. When analyzing a family's socio economic status, the household income, earners' education, and occupation are examined, as well as combined income, versus with an individual, when their own attributes are assessed.

Among the risk factors socio - economic status is said to be associated with the hyperlipdemia which in turn causes cardiovascular diseases. (Prasanthi and Amirthaveni, 2013)

1. Age and sex wise distribution of the selected hyperlipidemics

Age and sex wise distribution of the selected hyperlipidemic subjects is shown in Table III.

TABLE III

AGE AND SEX WISE DISTRIBUTION

AGE IN YEARS	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
30 – 40	19	33.3	13	30.2	32	32
41 – 50	17	29.8	8	18.6	25	25
51 – 60	21	36.9	22	51.2	43	43
TOTAL	**57**	**100**	**43**	**100**	**100**	**100**

The above Table III revealed that out of 100 subjects surveyed, majority (57 per cent) was male, followed by female (43 per cent). Between the age of 30 – 40 years, there were 32 per cent of hyperlipidemic subjects and 25 per cent of hyperlipidemics in the age range of 41 – 50 years. Finally, in 51 – 60 years age range, there were 43 per cent of hyperlipidemics.

2. Educational status:

The educational status of the selected hyperlipidemics is given in Table IV

TABLE IV

EDUCATIONAL STATUS

EDUCATIONAL STATUS	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Primary	18	31.6	10	23.2	28	28
High school	31	54.4	19	44.2	50	50
Higher secondary	8	14	13	30.2	21	21
Under Graduate	Nil	Nil	1	2.4	1	1
TOTAL	**57**	**100**	**43**	**100**	**100**	**100**

From the above Table it was clear that 31.6 per cent of male and 23.2 per cent of female were studied only up to primary school level and 54.4 per cent of male and 44.2 per cent of female had their education up to high school, 14 per cent of male and 30.2 per cent of female had their education up to higher secondary level. Among the female hyperlipidemics selected only 2.4 per cent were graduates. No one had studied above under graduate level and also none of them were illiterates.

Education plays a major role in skill sets for acquiring jobs, as well as specific qualities that stratify people with higher socioeconomic status from lower socioeconomic status. Lower income families can have children who do not succeed to the levels of the middle income children, who can have a greater sense of entitlement, be more argumentative, or be better prepared for adult life. (Lareau and Annette, 2003).

3. Occupational status:

The occupational status of the selected hyperlipidemics is presented in Table – V.

TABLE V

OCCUPATIONAL STATUS

N=100

OCCUPATIONAL STATUS	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Government sector	4	7	1	2.4	5	5
Private sector	30	52.6	13	30.2	43	43
Business	23	40.4	Nil	Nil	23	23
Coolie	Nil	Nil	1	2.4	1	1
House wife	Nil	Nil	24	55.8	24	24
Retired	Nil	Nil	4	9.2	4	4
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the one hundred selected hyperlipidemic subjects, 7 per cent of male and 2.4 per cent female belong to Government sector, 52.6 per cent of male and 30.2 per cent female were doing their job in private sectors. 40.4 per cent of the male doing their own business. 2.4 per cent female were coolies, 9.2 per cent of female were retired, remaining 55.8 per cent female were housewives. None of the female was doing business.

Majority of researchers agree that income, education and occupation together best represent socio-economic status, while some others feel that changes in family structure should also be considered (Milne and Plourde., 2006).

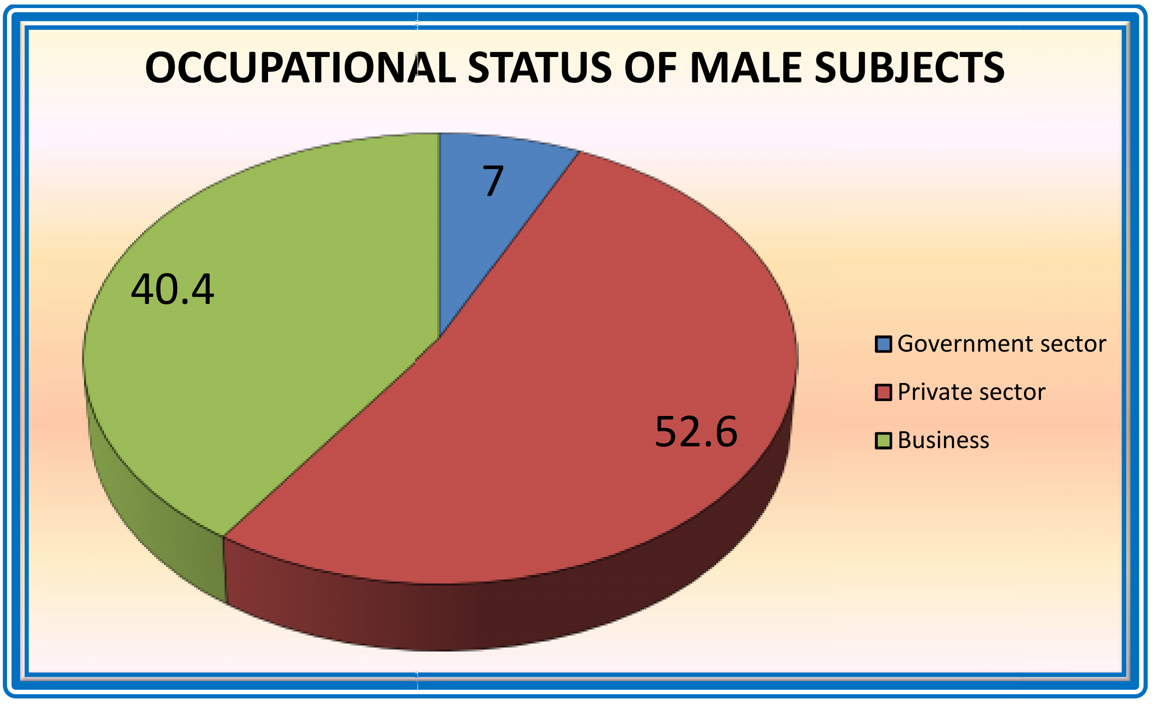

FIGURE II

OCCUPATINAL STATUS OF SELECTED MALE HYPERLIPIDEMICS

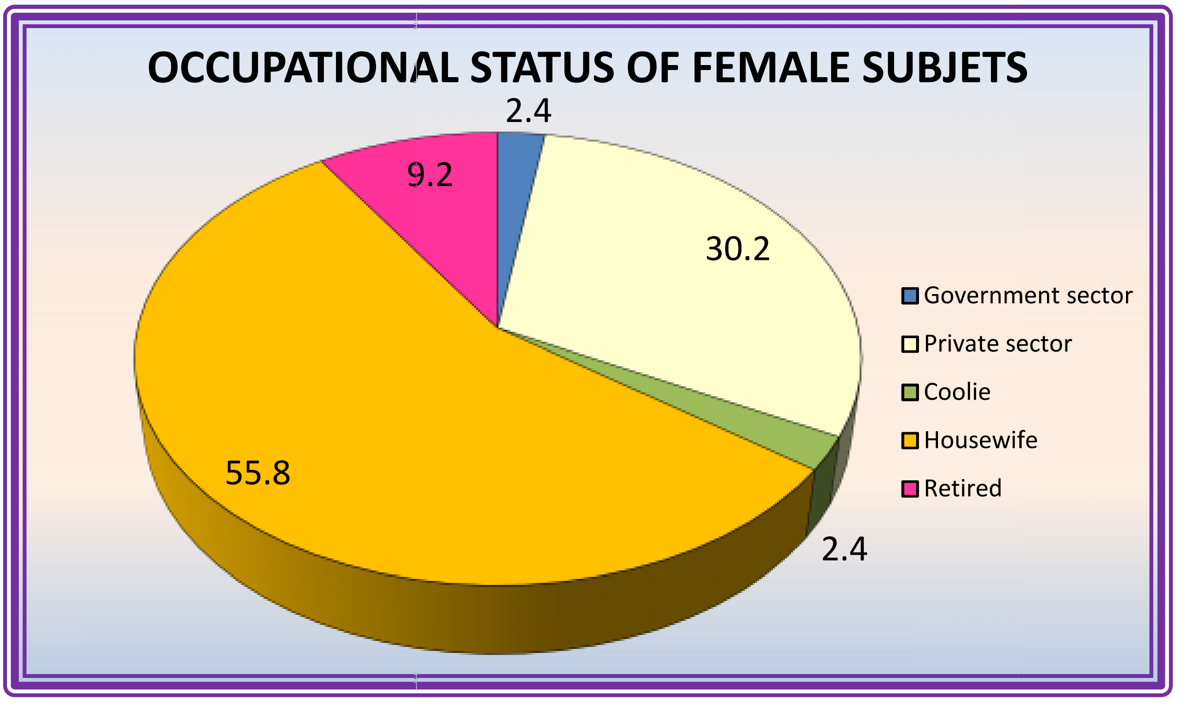

FIGURE III

OCCUPATIONAL STATUS OF SELECTED FEMALE SUBJECTS

4. Type of activity:

The type of activity of the selected hyperlipidemics is given in Table VI

TABLE VI

TYPE OF ACTIVITY

TYPE OF ACTIVITY	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Sedentary	24	42.1	30	69.8	54	54
Moderate	29	50.9	10	23.2	39	39
Heavy	4	7	3	7	7	7
Total	**57**	**100**	**43**	**100**	**100**	**100**

Among the selected 100 hyperlipidemics, majority of the female subjects (69.8 per cent) and male subjects (42.1 per cent) were doing sedentary type of activity, 50.9 per cent of male and 23.2 per cent female subjects were doing moderate type of activity. Remaining 7 per cent male and 7 per cent female subjects belongs to heavy activity group.

A sedentary activity level describes someone who gets little to no exercise. If anyone do exercise but get less than the two and a half hours per week of the moderate aerobic activity that the Centers for Disease Control and Prevention recommends, who are at a moderate activity level. If anyone works out vigorously for at least one hour and 15 minutes every week, it means they are at a high activity level. (www.livestrong.com)

5. Income level:

The monthly income level of the selected hyperlipidemics is shown in Table VII

TABLE – VII

INCOME LEVEL

N=100

INCOME LEVEL (World Bank, 2013)	**MALE**		**FEMALE**		**TOTAL**	
	N	**%**	**N**	**%**	**N**	**%**
Low income (<5192)	8	14	34	72.1	42	42
Middle income (5193-20493)	35	61.4	9	20.9	44	44
Upper middle income (20494-63287)	14	24.6	Nil	Nil	14	14
High income (>63287)	Nil	Nil	Nil	Nil	Nil	Nil
Total	**57**	**100**	**43**	**100**	**100**	**100**

According to World Bank, (2013) classification, families with income range of below Rs.5192 belong to low income, income range Rs. 5193 to Rs. 20493 belong to middle income,income range Rs. 20494 to Rs. 63287 belong to upper middle income and above Rs. 63287 belong to high income group.

The data given in the Table VII revealed that majority (44 per cent) of the families had earned their monthly income of Rs. 5193 to Rs. 20493 (middle income) and 14 per cent of families had earned their family income of Rs. 20494 to Rs. 63287 (upper middle income) per month. This study showed that the prevalence of hyperlipidemia is tremendously increased in middle income groups than the low and high income groups.

Income is a commonly used measure of socio economic status because it is relatively easy to figure for most individuals (www.wisdomsupreme.com).

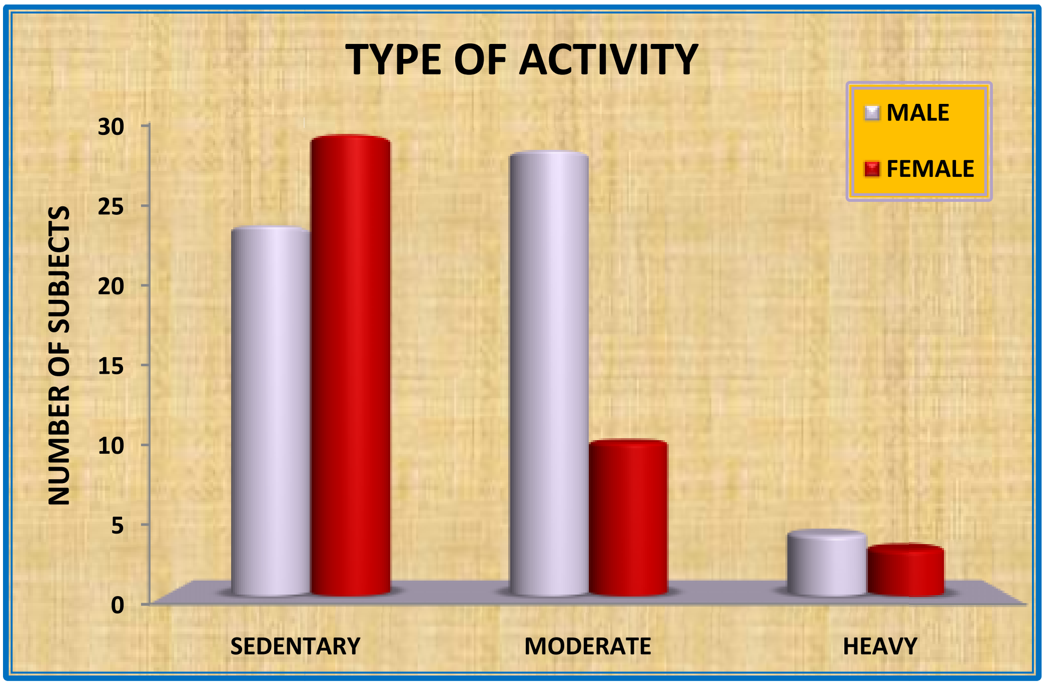

FIGURE IV

TYPE OF ACTIVITY OF THE SELECTED HYPERLIPIDEMIC SUBJECTS

FIGURE V

INCOME LEVEL OF THE SELECTED HYPERLIPIDEMICS

6. **Type of family:**

The type of family of the selected hyperlipidemics is shown in Table VIII.

TABLE VIII

TYPE OF FAMILY

TYPE OF FAMILY	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Nuclear	48	84.2	36	83.7	84	84
Joint	9	15.8	7	16.3	16	16
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the data given in the above Table it was showed that, among the hundred subjects surveyed, 84 per cent of hyperlipidemic subjects lived in nuclear families, while 16 per cent of the subjects lived in joint families.

On the basis of size or structure and the depth of generations family can be classified into two main types-Nuclear family and joint family. (www.sociologyguide. com).

B) DIETARY PATTERN OF THE SELECTED HYPERLIPIDEMICS

1. **Dietary habits:**

Dietary habits of the selected hyperlipidemics is given in Table IX

TABLE IX

DIETARY HABITS

DIETARY HABITS	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Vegetarian	10	17.5	7	16.3	17	17
Non – vegetarian	47	82.5	36	83.7	83	83
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the Table IX it is clear that, among the one hundred hyperlipidemics, the majority of male (82.5 per cent) and female (83.7 per cent) were consuming non – vegetarian diet, only 17.5 per cent of the male and 16.3 per cent female were consuming vegetarian diet.

The findings show that only 31 per cent of Indians are vegetarians. The late Professor Kumar Suresh Singh analyzed the data of the People of India project to show that a majority of our communities are non-vegetarians. Vegetarians who take eggs 9 per cent,60% people are non vegetarians in India, more women are vegetarians (Yadav and Kumar., 2006)Vegetarians tend to have lower levels of cholesterol, lower blood pressure, and less incidence of heart disease, hypertension, type II diabetes, renal disease, metabolic syndrome. (Rizzo *et al.,* 2011)

2. Meal pattern:

From the survey of selected hyperlipidemics, it is recorded that majority of the diabetic male 100 per cent and female 93 per cent had the habit of consuming 2 – 3 meals per day, only 2.3 per cent female of the selected subjects were consuming less than 2 meals per day and only 4.7 per cent of the female were consuming more than three meals per day.

3. Dietary consumption pattern of selected hyperlipidemics:

a) Frequency of food consumed by the selected hyperlipidemics

Food frequency of the selected hyperlipidemics is given in Table X

TABLE X

FREQUENCY OF FOOD CONSUMED BY THE SELECTED HYPERLIPIDEMICS

FOOD GROUPS	FREQUENCY	MALE		FEMALE		TOTAL	
		N	%	N	%	N	%
Cereals	Daily	57	100	43	100	100	100
Pulses	Daily	57	100	43	100	100	100
Green leafy vegetables	Daily	2	3.5	3	7	5	5
	Weekly	50	87.7	40	93	90	90
	Monthly	5	8.8	Nil	Nil	5	5
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Other vegetables	Daily	55	96.5	40	93	95	95
	Weekly twice	2	3.5	3	7	5	5
	Total	**57**	**100**	**43**	**100**	**100**	**100**

Roots and tubers	Daily	57	100	43	100	100	100
Fruits	Daily	10	17.5	9	21	19	19
	Weekly	27	47.4	20	46.5	47	47
	Weekly twice	20	35.1	10	23.2	30	30
	Occasional	Nil	Nil	4	9.3	4	4
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Milk and milk products	Daily	57	100	43	100	100	100
Non – vegetarian	Weekly	40	70.2	30	69.8	70	70
	Monthly	7	12.3	6	14	13	13
	Never	10	17.5	7	16.3	17	17
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Nuts and oilseeds	Weekly	50	87.7	39	90.7	89	89
	Weekly twice	7	12.3	4	9.3	11	11
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Fats and oils	Daily	57	10	43	100	100	100

Among the surveyed hyperlipidemics, 100 per cent of male and female subjects were consuming cereals and pulses every day. Among the hyperlipidemics selected, only 7 per cent of the female 3.5 per cent male were consuming green leafy vegetables every day and 87.7 per cent of male and 93 per cent female were consuming green leafy vegetables once in a week, 8.8 per cent of male were consuming green leafy vegetables once in a month. Other vegetables were consuming by male (96.5 per cent) daily and3.5 per cent of male and 7 per cent of female were consuming vegetables twice in a week.

All type of roots and tubers are not included daily by hyperlipidemic subjects, because of the regular consumption of onion, 100 per cent of male and female were consuming this roots and tubers. There were 17.5 per cent of male and 21 per cent female were consuming fruits every day, 47.4 per cent of male and 46.5 per cent of female were consuming fruits twice in a week, 9.3 per cent of female were consuming fruits occasionally. Hundred per cent and female were consuming milk and milk products every day.

In the 100 subjects surveyed, most of them were non-vegetarian, so 70.2 per cent male and 69.8 per cent female were consuming non-vegetarian foods once in a week. 12.3 per cent male and14 per cent female subjects were consuming non-vegetarian foods once in a month, 17.5 per cent male 16.3 per cent female were not consuming non-vegetarian foods because of they were vegetarian.

Nuts and oilseeds consumption by the male (87.8 per cent) and female (90.7 per cent) weekly. 12.28 per cent of male and 9.3 per cent of female were consuming twice in a week. Mostly fats and oils consumption by the male and female was 100 per cent every day.

b) Quantity of food were consuming by the selected hyperlipidemics

Quantity of foods were consuming by the selected hyperlipidemics is presented in Table XI

TABLE XI

QUANTITY OF FOOD CONSUMED

FOOD GROUPS	QUANTITY (g)	MALE		FEMALE		TOTAL	
		N	%	N	%	N	%
Cereals	100 – 150	10	17.5	15	34.9	25	25
	150 – 200	40	70.2	20	46.5	60	60
	200 – 250	7	12.3	8	18.6	15	15
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Pulses	20- 30	50	87.7	43	100	93	93
	30 – 40	7	12.3	Nil	Nil	7	7
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Green leafy vegetables	20 – 30	2	3.5	3	7	5	5
	30 – 40	5	8.8	10	23.2	15	15
	40 – 50	50	87.7	30	69.8	80	80
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Other vegetables	50 – 100	50	87.7	41	95.3	91	91
	100 – 150	4	7	1	2.3	5	5
	150 – 200	3	5.3	1	2.3	4	4
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Roots and tubers	50 – 100	55	96.5	42	97.7	97	97
	100 – 150	2	3.5	1	2.3	3	3

	Total	**57**	**100**	**43**	**100**	**100**	**100**
Fruits	50 – 100	2	3.5	25	58	27	27
	100 – 150	45	78.9	10	23	55	55
	150 – 200	10	17.5	8	19	18	18
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Milk and milk products	100 – 200	52	91.2	42	97.7	94	94
	200 – 300	5	8.8	1	2.3	6	6
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Non – vegetarian	50 – 100	37	64.9	6	13.9	43	43
	100 – 150	5	8.8	30	69.8	35	35
	150 – 200	5	8.8	Nil	Nil	5	5
	Never	10	17.5	7	16.3	17	17
	Total	**57**	**99.9**	**43**	**100**	**100**	**100**
Nuts and oilseeds	10 - 20	50	87.7	39	90.7	89	89
	20 - 30	7	12.3	4	9.3	11	11
	Total	**57**	**100**	**43**	**100**	**100**	**100**
Fats and oils	<10	15	26.3	13	30.2	28	28
	10 – 20	42	73.7	30	69.8	72	72
	Total	**57**	**100**	**43**	**100**	**100**	**100**

Quantity of cereals were consuming by the male (17.5 per cent) and female (34.9 per cent) within a range of 100 – 150g, 70.2 per cent of male and 46.5 per cent of female were consuming cereals within a range of 150-200g. 12.3 per cent of male and 18.6 per cent of the female were consuming cereals within the range of 200-250g per day. Quantity of pulses were consuming by the male (87.7 per cent) and female (100 per cent) within the range 30-40g/day, 12.3 per cent of male were consuming pulses within the range of 30-40g per day.

Green leafy vegetables consumption by the male (3.5 per cent) and female (7 per cent) within the range of 20-30g per day. 8.8 per cent of male and 23.2 per cent of female were consuming green leafy vegetables within a range of 30-40g per day. 87.7 per cent of male and 69.8 per cent of female were consuming 40-50 g green leafy vegetables.

Vegetables consumption by the male was 87.7 per cent and female was 95.3 per cent within the range of 50-100g. 7 per cent male and 2.3 per cent of female were consuming vegetables within the range 100-150g. 5.3 per cent of male and 2.3 per cent of female were consuming vegetables within the range of 150-200g per day.

Roots and tubers consumption by the male (96.5 per cent) and female (97.7 per cent) within the range 50-100g. 3.5 per cent of male and 2.3 per cent of female were consuming 100-150g of roots and tubers.

Fruits consumption by the male subjects and female subjects was 3.5 per cent and 58 per cent respectively. Majority of male 78.9 per cent and female 23 per cent were consuming 100-150 g of fruits. 17.5 per cent of male and 19 per cent of female were consuming fruits within the range of 150-200 g/day.

Majority of the male (91.2 per cent) and female (97.7 per cent) were consuming 100-200ml of milk per day. 8.8 per cent of male and 2.3 per cent of female were consuming 200-300ml of milk per day.

Non-vegetarian foods consumption by the male (64.9 per cent) and female (13.9 per cent) within the range of 50-100g per day, 8.8 per cent of male and 69.8 per cent of female were consuming 100-150g of non-vegetarian foods, 8.8 per cent of male subjects were consuming 150-200g of non-vegetarian foods.17.5 per cent of male subjects and 16.3 per cent of female not consume non-vegetarian foods because they were non-vegetarians.

Nuts and oilseeds consumption by the male (87.8 per cent) and female (90.7 per cent) with the quantity of 10-20g. 12.28 per cent of male and 9.3 per cent of female were consuming with the quantity of 20-30g/day.

Quantity of fats and oils consumption by male (26.3 per cent) and female (30.2 per cent) within the range of less than 10 ml. 73.7 per cent of male and 69.8 per cent of female were consuming 10-20 ml of fats and oils per day.

4. Type of oils used for cooking:

Types of oils used for cooking by the selected hyperlipidemics is presented in Table XII

TABLE XII

TYPES OF OILS USED FOR COOKING

TYPE OF OIL	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Sunflower oil	10	17.5	26	60.5	36	36
Gingelly oil	Nil	Nil	6	13.9	6	6
Refined oil	47	82.5	11	25.6	58	58
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the above table, it was observed that male (17.5 per cent) and female (60.5 per cent) were consuming sunflower oil, where as 13.9 per cent of female were consuming gingelly oil, only male (82.5 per cent) and female (25.6 per cent) used refined oil for cooking.

Consuming fats is an essential nutritional need, most of which is met through visible fat sources - vegetable oil, ghee, butter, etc. In view of this, a certain increase was necessary to meet the challenges of malnutrition. But the rise in consumption has surpassed the country's nutritional needs by a wide margin. An average fat intake of 29 grams per person per day is enough to meet the nutritional requirements of Indians, which translates into an annual vegetable oil requirement of 10.585kg per person. (Sharma., 2012)

5. Consumption pattern of snacks:

Consumption pattern of snacks of the selected hyperlipidemics is given in Table XIII.

TABLE XIII

CONSUMPTION PATTERN OF SNACKS

CONSUMPTION OF SNACKS	FREQUENCY	MALE		FEMALE		TOTAL	
		N	%	N	%	N	%
Vada / Bajji / Bonda	Daily	25	43.9	7	16.3	32	32
	Weekly	19	33.3	5	11.6	24	24
Chips	Weekly	Nil	Nil	2	4.6	2	2
	Monthly	Nil	Nil	9	20.9	9	9
Murukku / Mixture	Occasionally	Nil	Nil	14	32.6	14	14
Nil		13	22.8	6	14	19	19
Total		**57**	**100**	**43**	**100**	**100**	**100**

Majority of male subjects (43.9 per cent) and female (16.3 per cent) were consuming Vada or Bajji or Bonda every day, 33.3 per cent of male subjects and 11.6 per cent of female were consuming Vada or Bajji or Bonda once in a week. 4.6 per cent of female subjects are consuming chips once in a week and 20.9 per cent of female subjects were consuming chips once in a month. Murukku or mixture type of snacks were consuming occasionally by the 32.6 per cent of female subjects. Remaining 22.8 per cent of male and 14 per cent of female subjects are not were consuming any type of snacks.

The major type of snacks were consuming by the people was found to be shallow fried foods, bakery products and deep fried foods. Thus, there is a need to promote healthy snacking habits among the people. (Dhruv *et al.,* 2011)

C) LIFESTYLE PATTERN OF THE SELECTED HYPERLIPIDEMICS

1. Exercise pattern of the selected hyperlipidemics:

Table XIV shows the exercise pattern of the selected hyperlipidemics.

TABLE XIV

EXERCISE PATTERN OF THE SELECTED HYPERLIPIDEMICS

TYPES OF EXERCISE	MALE (%)			FEMALE(%)			TOTAL (%)
	30 mins	45 mins	1 hour	30 mins	45 mins	1 hour	
Moderate activity							
Walking	12.3	5.3	Nil	16.3	7	Nil	20
Gardening	1.7	Nil	Nil	7	Nil	Nil	4
Vigorous intensity							
Cycling	1.7	Nil	Nil	Nil	Nil	Nil	1
Nil	78.9	Nil	Nil	69.7	Nil	Nil	45
Total	**94.7**	**5.3**	Nil	**93**	**7**	Nil	**100**

From the Table XIV, it was observed that 12.3 per cent of male subjects and 16.3 per cent of female subjects had the habit of walking about 30 minutes daily, 5.3 per cent of male and 7 per cent of female subjects had the habit of walking about 45 minutes every day. About 1.7 per cent of male and 7 per cent of female subjects had the habit of maintaining the garden for the frequency of 30 minutes daily.

About 1.7 per cent of male subjects had the habit of doing cycling. Remaining 78.9 per cent of male and 69.7 per cent of female do not have the habit of doing any exercise.

Majority (45 per cent) of the hyperlipidemics do not have the habit of doing exercise even after the onset of hyperlipidemia.

2. Smoking pattern of the selected male hyperlipidemics:

Table XV represents the smoking pattern of the selected male hyperlipidemics

TABLE XV

SMOKING PATTERN OF THE SELECTED MALE HYPERLIPIDEMICS

S. No	SMOKING PATTERN	N	%
1.	Yes	20	35.1
	No	37	64.9
	Total	**57**	**100**
2.	**Type**		
	Cigarette	15	75
	Beedi	5	25
	Total	**20**	**100**
3.	**Number / Day**		
	1 – 5	7	35
	6 – 10	9	45
	11 – 20	4	20
	Total	**20**	**100**
4.	**Duration of smoking**		
	1 – 3 years	2	10
	4 – 6 years	1	5
	7 – 9 years	5	25
	>9 years	12	60
	Total	**20**	**100**
5.	**Frequency**		
	Twice in a week	9	45
	Once in a week	6	30
	Daily	5	25
	Total	**20**	**100**

From the Table XV it was revealed that among 57 selected male hyperlipidemics, 35.1 per cent of male had the habit of smoking and 64.9 per cent of the male subjects did not have the habit of smoking. Among the smokers, 75 percent had the habit of smoking cigarette and 25 per cent had the habit of smoking beedi.

Among the 20 smokers, 35 per cent of them are smoked 1-5 cigarettes per day, 45 per cent of them smoked 6-10 cigarettes per day, and 20 per cent of them smoked 21-30 cigarettes daily.

Among the 20 male subjects, 10 per cent of male had the habit of smoking within 1-3 years, 5 per cent of male had the habit of smoking within 4-6 years, and 25 per cent of them had the habit of 7-9 years and remaining 60 per cent of male had the habit of smoking more than 9 years.

Forty five per cent of the male had the habit of smoking twice in a week, 30 per cent of the male had the habit of smoking once in a week and remaining 25 per cent of male subjects had the habit of smoking every day.

One study showed that 59 percent of non-smokers were alive at age 80, compared to 26 percent of smokers. Another study showed that those who had quit before the age of 40 had the same death rates as those who had never smoked. Quitting smoking, even after 60, may boost longevity. (Castillo., 2012)

3. Alcohol consumption pattern of the selected male hyperlipidemics:

Table XVI represents the alcohol consumption pattern of the male subjects.

TABLE XVI

ALCOHOL CONSUMPTION PATTERN OF THE MALE HYPERLIPIDEMICS

S. No	ALCOHOL PATTERN	N	%
1.	Yes	14	24.6
	No	43	75.4
	Total	**57**	**100**
2.	**Amount / Day**		
	100 – 200 ml	8	57.1
	200 -300 ml	6	42.9
	Total	**14**	**100**
3.	**Frequency**		
	Daily	3	21.4
	Weekly	4	28.6
	Monthly	1	7.1
	Occasionally	6	42.9
	Total	**14**	**100**

From the above Table XV it was revealed that among the 57 selected male hyperlipidemics, 24.6 per cent of male had the habit of consuming alcohol and 75.4 per cent of the male subjects do not have the habit of consuming alcohol. Among the alcoholics, 57.1 per cent of them were consuming alcohol 100-200ml per day, remaining 42.9 per cent of them were consuming 200-300ml of alcohol per day.

Among the 14 alcoholics, 21.4, 28.6, 7.1 and 42.9 per cent of male had the habit of consuming alcohol daily, weekly, monthly and occasionally respectively.

Moderate alcohol intake is associated with lower risk for coronary heart disease in men. (Mukamal *et al.,* 2006)

4. **Consumption pattern of hot beverages:**

Details regarding the consumption of the hot beverages by the selected hyperlipidemics are given in Table XVII

TABLE XVII

CONSUMPTION PATTERN OF THE HOT BEVERAGES

PARTICULARS	QUANTITY	MALE		FEMALE		TOTAL	
		N	%	N	%	N	%
Milk	2 cups	4	7	3	7	7	7
	3 cups	5	8.8	1	2.3	6	6
	> 4 cups	17	29.7	7	16.3	24	24
Coffee	4 cups	5	8.8	Nil	Nil	5	5
	> 4 cups	14	24.6	1	2.3	15	15
Tea	4 cups	5	8.8	3	7	8	8
	> 4 cups	4	7	26	60.5	30	30
	Nil	3	5.3	2	4.6	5	5
	Total	**57**	**100**	**43**	**100**	**100**	**100**

From the Table XVII it was predicted that 7 per cent of male and female respectively had the habit of drinking 2 cups of milk every day and 8.8 per cent of male and 2.3 per cent female had the habit of drinking 3 cups of milk every day. Around 29.7 per cent of male and 16.3 of female had the habit of drinking more than 4 cups of milk every day.

About 8.8 per cent of male had the habit of drinking 4 cups of coffee every day. About 24.6 per cent of male and 2.3 per cent of female subjects had the habit of drinking coffee more than 4 cups every day.

About 8.8 per cent of male and 7 per cent of female had the habit of drinking 4 cups of coffee every day. About 7 per cent of male and 60.5 per cent of female subjects had the habit of drinking coffee more than 4 cups every day, 5.3 per cent of male and 4.6 per cent of female did not have the habit of drinking any hot beverages.

D) PERSONAL AND FAMILY HISTORY OF THE SELECTED HYPERLIPIDEMICS

1. Personal history of the disease

a) Duration of the disease:

The duration of hyperlipidemia of the subjects is presented in TableXVIII.

TABLE XVIII

DURATION OF THE DISEASE

PERIOD	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
1 – 5 years	20	35.1	12	27.9	32	32
6 – 10 years	25	43.9	20	46.5	45	45
11 – 20 years	12	21	11	25.6	23	23
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the Table XVIII, it was observed that among the 57 male and 43 female hyperlipidemics, 35.1 per cent of male and 27.9 per cent of female are suffering from hyperlipidemia for the period of 1-5 years. Majority of the male (43.9 per cent) and female (46.5 per cent) are suffering from hyperlipidemia for 6-10 years. Only 21 per cent of male and 25.6 per cent of female are suffering from hyperlipidemia for the duration of 11-20 years.

b) Symptoms among the selected hyperlipidemic subjects:

The common symptoms among the selected hyperlipidemic subjects are given in Table XIX.

TABLE XIX

SYMPTOMS AMONG THE SELECTED HYPERLIPIDEMICS

S. No	SYMPTOMS	MALE		FEMALE		TOTAL	
		N	%	N	%	N	%
1.	Hypertension	6	10.5	4	9.3	10	10
2.	High blood pressure	4	7	4	9.3	8	8
3.	High Cholesterol	3	5.3	4	9.3	7	7
4.	Nausea	8	14	Nil	Nil	8	8
5.	Shortness of breath	12	21	13	30.2	25	25
6.	Diabetes	10	17.5	4	9.3	14	14
7.	Depression	1	1.7	Nil	Nil	1	1
8.	More than one symptoms	13	22.8	14	32.6	27	27
	Total	**57**	**100**	**43**	**100**	**100**	**100**

From the above Table, it was obvious that 10.5 per cent of male and 9.3 per cent of female are suffering from hypertension, 7 per cent of male and 9.3 per cent of female are suffering from high blood pressure, 5.3 per cent of male and 9.3 per cent of female are suffering from high cholesterol, 14 per cent of male are suffering from nausea, 21per cent of male and 30.2 per cent of female are suffering from shortness of breath, 17.5 per cent of male and 9.3 per cent of female are suffering from diabetes along with hyperlipidemia.

About 1.7 per cent of male are suffering from depression, remaining 22.8 per cent of male and 32.6 per cent female subjects are suffering from more than one symptom along with hyperlipidemia.

2. Family history of the disease

The family history of hyperlipidemics is discussed in Table XX.

TABLE XX

FAMILY HISTORY OF THE SELECTED HYPERLIPIDEMICS

FAMILY MEMBERS	MALE		FEMALE		TOTAL	
	N	%	N	%	N	%
Father	8	14	8	18.6	16	16
Mother	10	17.5	15	34.9	25	25
Grand father	7	12.3	Nil	Nil	7	7
Grand Mother	1	1.7	Nil	Nil	1	1
Nil	31	54.4	20	46.5	51	51
Total	**57**	**100**	**43**	**100**	**100**	**100**

From the above Table XX, it was revealed that there is a prevalence of family history of the subjects. About 14 per cent of male and 18.6 per cent of female subjects had their family history of this disorder from their father, 17.5 per cent of male and 34.9 per cent of female subjects had their family history from their mother, 12.3 per cent of male had their family history from their grandfather, 1.7 per cent of male had their family history of the condition from their grandmother. Remaining 54.4 per cent of male and 46.5 of female subjects do not have their family history of the disease.

E) NUTRITIONAL ASSESSMENT OF THE SELECTED HYPERLIPIDEMICS:

1. Anthropometric measurements:

Anthropometry is the science that defines physical measures of a person's size, form, and functional capacities. (www.cdc.gov)

a) Height:

Table XXI gives the height wise distribution of the selected hyperlipidemic subjects.

TABLE XXI

HEIGHT OF THE SELECTED SUBJECTS

HEIGHT (cm)	MALE		FEMALE		STANDARD (ICMR,2010)
	N	%	N	%	
140 – 149	Nil	Nil	15	35	Male – 172.3cm Female – 161.0cm
150 – 159	6	10.5	19	44.1	
160 – 169	27	47.5	9	20.9	
170 – 179	24	42	Nil	Nil	
Total	**57**	**100**	**43**	**100**	

Among the one hundred selected hyperlipidemics, it was recorded that 35 per cent of female had their height ranged between 140-149cm which is below the standard value and 10.5 per cent of male and 44. 1 per cent of female had their height ranged 150-159 cm. Among the subjects selected, 47.5 per cent of male and 20.9 per cent of female had their height ranged from 160-169cm. forty two per cent of male had their height ranged from 170-179cm. 58 per cent of male and 79.1 per cent of female had their height below the normal height.

Height is an important correlate of early life health; Indians are among the shortest people in the world. Although height is usually believed to be entirely genetically determined, experts have concluded this is not the case, and populations considered short have over time grown far taller with rising incomes and quality of life. (Rukmini, 2013)

b) Weight:

Table XXIV shows the distribution of the selected hyperlipidemic subjects as per their body weight.

TABLE XXII

BODY WEIGHT OF THE SELECTED SUBJECTS

WEIGHT (Kg)	**MALE**		**FEMALE**		**STANDARD (ICMR,2010)**
	N	**%**	**N**	**%**	
50 – 55	2	3.5	9	21	Male – 60 kg Female – 55 kg
56 – 60	5	8.8	6	13.9	
61 – 65	4	7	6	13.9	
66 – 70	8	14	4	9.3	
71 – 75	11	19.3	4	9.3	
76 – 80	14	24.6	4	9.3	
81 – 85	6	10.5	3	7	
86 – 90	3	5.3	4	9.3	
91 – 95	4	7	2	4.6	
96 – 100	Nil	Nil	1	1.7	
Total	**57**	**100**	**43**	**100**	

Among the one hundred selected hyperlipidemics, 3.5 per cent of male and 21 per cent of female had their weight ranged between 50 – 55kg, 8.8 per cent of male and 13.9 per cent of female had their weight ranged between 56 - 60kg, 7 per cent of male and 13.9 per cent of female had their weight ranged between 61-65kg, 14 per cent of male and 9.3 per cent of female had their weight ranged between 66-70kg, 19.3 per cent of male and 9.3 per cent of female had their weight ranged between 71-75kg, 24.6 per cent of male and 9.3 per cent of female had their weight ranged between 76-80kg, 10.5 per cent of male and 7 per cent of female had their weight ranged between 81-85kg, 5.3 per cent of male and 9.3 per cent of female had their weight ranged between 86-90kg.

Seven per cent of the male and 4.6 per cent of female had their weight ranged between 91-96kg,and remaining 1.7 per cent of female had their weight ranged between 96-100kg. 12.3 per cent of the male and 21 per cent of female had their body weight below the normal body weight. More than 80 per cent of male and more than 65 per cent of the female had their weight above the normal measurement.

From the above table, it was concluded that male subjects (80 per cent) had over weight more than female subjects(65 per cent).

c) Body Mass Index:

Table XXIIIpresents the body mass index of the selected hyperlipidemic subjects.

TABLE XXIII

BODY MASS INDEX

BMI (WHO, 2009)	**OBESITY GRADE**	**MALE (%)**	**FEMALE (%)**	**TOTAL (%)**
Below 18.5	Underweight	3.5	Nil	2
18.5 – 22.9	Normal	12.3	11.6	12
23 – 24.9	Overweight	15.8	11.6	14
Above 25	Obese	68.4	76.7	72
	Total	**100**	**100**	**100**

From the selected one hundred hyperlipidemic subjects, 3.5 per cent of male had BMI below 18.5, which belong to underweight category. Around 12.3 per cent of male and 11.6 per cent of female subjects had the BMI in the normal range from 18.5 – 22.9 that is normal grade, 15.8 per cent of male and 11.6 per cent of female had the BMI 23-24.9 which belongs to overweight category and 39 per cent of male and 76.7 per cent of female had the BMI above 25 which belongs to obesity category.

From the above table it was predicted that, 14 per cent of selected hyperlipidemics are overweight and 72 per cent of subjects are obese. This is concluded that obesity is the fundamental risk factor for the progression of hyperlipidemia. Body Mass Index is used to estimate your total amount of fat. It is only an approximate measure of the best weight for your health (www.better health.vic.gov).

d) Waist – Hip Ratio:

Table XXIV predicts the waist hip ratio of the selected hyperlipidemic subjects.

TABLE XXIV

WAIST – HIP RATIO

WAIST – HIP RATIO	MALE (%)	FEMALE (%)	STANDARD WHO (2012)
<0.80	14	7	Male – 0.85 Female – 0.90
0.80 - 0.85	7	Nil	
0.86 – 0.90	35.1	44.2	
0.91 – 0.95	24.6	37.2	
0.96 – 1.0	14	11.6	
>1.0	5.3	Nil	
TOTAL	**100**	**100**	

According to WHO (2012), Abdominal obesity is further defined as waist–hip ratio above 0.90 for males and above 0.85 for females. From the data given in the table, majority of the male (35.1 per cent) and female (44.2 per cent) were in the range of 0.86 - 0.90 which is above the normal value. Waist-Hip Ratio of the 14 per cent of male and 7 per cent of female were in the range of below 0.80 and 24.6 per cent of male and 37.2 per cent of female were in the range of 0.91 – 0.95. Besides that, fourteen per cent of the male and 11 per cent of female were in the range of 0.96 – 1.0 waist-hip ratio and 5.3 per cent of male were in the range of above 1.0 category.

2. FOOD AND NUTRIENT INTAKE OF THE SELECTED HYPERLIPIDEMICS

a) Mean food intake of the selected male hyperlipidemics:

Table XXV gives information on the mean food intake of selected male hyperlipidemics

TABLE XXV

MEAN FOOD INTAKE OF THE SELECTED MALE HYPERLIPIDEMICS

FOOD GROUPS	RDA (g) (ICMR, 2010)	EXPERIMENTAL GROUP (N=8)		CONTROL GROUP (N=8)	
		Actual Intake (g)	%Deficit /Excess	Actual Intake (g)	%Deficit /Excess
Cereals	450	234	-48	289	-35.7
Pulses	90	42	-53.3	35	-61.2
Greens	100	10	-90	60	-40
Roots and tubers	200	159	-20.5	48	-76
Other vegetables	200	46	-77	55	-72.5
Fruits	100	95	-5	56	-44
Milk and milk products	300	156	-48	210	-30
Fats and oils	25	15.4	-38.4	15	-40
Sugar	30	10	-66.6	20	-33.3
Meat	25	30	+20	65	+160

From the above Table, it was depicted that, consumption of cereals was less than the recommended dietary allowance by 48 per cent in the experimental group and 35.7 per cent in the control group. Consumption of pulses was 53.3 per cent lesser than recommended intake in the experimental group and 61.2 per cent less in the control group. The intake of green leafy vegetables, was deficit by 90 per cent than the recommended intake in the experimental group and 40 per cent in the control group. Consumption of roots and tubers was less than the recommended dietary allowance by 20.5 per cent in experimental group and 76 per cent in the control group. Consumption of other vegetables was less than recommended intake by 77 per cent in the experimental group and 72.5 per cent in the control group. Intake of fruits was deficit by 5 per cent than recommended intake in experimental group and 44 per cent in the control group. Intake of milk and milk products was less than the recommended dietary allowance by 48 per cent in experimental group and 30 per cent in the control group. Consumption of fats and oils was lesser than recommended intake by 38.4 per cent in the experimental group and 40 per cent in the control group. Intake of sugars was deficit by 66.6 per cent than recommended intake in experimental group and 33.3 per cent in the control group.Intake of meat was higher than therecommended intakeby 20 per cent experimental group and 160 per cent in the control group.

b) Mean food intake of the selected female hyperlipidemics:

Table XXVI gives information on the mean food intake of the selected female hyperlipidemics.

TABLE XXVI

MEAN FOOD INTAKE OF THE SELECTED FEMALE HYPERLIPIDEMICS

FOOD GROUPS (g)	RDA (ICMR, 2010)	EXPERIMENTAL GROUP (N=2)		CONTROL GROUP (N=2)	
		Actual Intake	%Deficit /Excess	Actual Intake	%Deficit /Excess
Cereals	400	207.5	-48.1	259	-35.25
Pulses	75	69	-8	35	-53.3
Greens	100	16.7	-83.3	60	-40
Roots and tubers	200	82	-59.0	48	-76
Other vegetables	100	31.7	-68.3	55	-45
Fruits	100	58.7	-41.3	56	-44
Milk and milk products	300	121.7	-59.4	210	-30
Fats and oils	25	10	-60	15	-40
Sugar	30	12	-60	7.8	-74
Meat	25	31.7	+26.8	60	+140

From the above table, it was depicted that, consumption of cereals was less than the recommended dietary allowance by 48.1 per cent in experimental group and 35.25 per cent in the control group. Consumption of pulses was less than recommended intake by 8 per cent in the experimental group and 53.3 per cent in the control group. The intake of green leafy vegetables, was deficit by 83.3 per cent than recommended intake in experimental group and 40 per cent in the control group. Consumption of roots and tubers was less than the recommended dietary allowance by 59 per cent in experimental group and 76 per cent in the control group. Consumption of other vegetables was less than recommended intake by 68.3 per cent in the experimental group and 45 per cent in the control group. The intake of fruits was deficit by 41.3 per cent than recommended intake in experimental group and 44 per cent in the control group. The intake of milk and milk products was lesser than the recommended dietary allowance by 59.4 per cent in experimental group and 30 per cent in the control group. Consumption of fats and oils was less than recommended intake by 60 per cent in the experimental group and 40 per cent in the control group. The intake of sugars was deficit 60 per cent than recommended intake in experimental group and 74 per cent in the control group.Intake of meat was higher than the recommended intake by 26.8 per cent in experimental group and 140 per cent in the control group.

c) Mean nutrient intake of the selected male hyperlipidemics:

Mean nutrient intake of the selected male hyperlipidemics as determined by 24 hours recall method is presented in Table XXVII.

TABLE XXVII

MEAN NUTRIENT INTAKE OF THE SELECTED MALE HYPERLIPIDEMICS

N=16

NUTRIENTS	RDA (ICMR, 2010)	EXPERIMENTAL GROUP (N=8)		CONTROL GROUP (N=8)	
		Actual Intake	%Deficit /Excess	Actual Intake	%Deficit /Excess
Energy (Kcal)	2730	1260.4	-53.8	1458.45	-46.6
Protein (g)	60	37.0	-38.3	46.83	-21.9
Fat (g)	30	17.9	-40.3	18.11	-39.6
Carbohydrate (g)	-	241.0	-	260.62	-
Fiber (g)	41	3.23	-92.1	3.85	-90.6
Calcium (mg)	600	417.0	-30.5	550.50	-8.2

Iron (mg)	17	8.19	-51.8	7.53	-55.7
β-carotene (μg)	4800	899.5	-81.3	1717.00	-64.2
Thiamine (mg)	1.4	0.98	-30	1.02	-27.1
Riboflavin (mg)	1.6	0.70	-56.2	1.11	-30.6
Niacin (mg)	18	10.73	-40.4	15.84	-12
Vitamin C (mg)	40	34.3	-14.2	10.31	-74.2

From the above table, it was observed that, intake of calories was less than the recommended dietary allowance by 53.8 per cent in experimental group and 46.6 per cent in the control group. Intake of protein was less than recommended intake by 38.3 per cent in the experimental group and 21.9 per cent in the control group. The inclusion of fat was deficit by 40.3 per cent than recommended intake in experimental group and 39.6 per cent in the control group. Intake of fiber was less than the recommended dietary allowance by 92.1 per cent in experimental group and 90.6 per cent in the control group. The mean intake of calcium was less than recommended intake by 30.5 per cent in the experimental group and 8.2 per cent in the control group.Intake of iron, was deficit by 51.8 per cent than recommended intake in experimental group and 55.7 per cent in the control group. Intake of beta-carotene was less than the recommended dietary allowance by 81.3 per cent in experimental group and 64.2 per cent in the control group. Intake of B vitamins such as thiamine, riboflavin and niacin was less than recommended intake by 30, 56.2 and 40.4 per cent in the experimental group and 27.1, 30.6 and 12 per cent in the control group respectively. Intake of vitamin C, was deficient more than 14.2 per cent than recommended intake in experimental group and 74.2 per cent more than the recommended level in the control group.

According to the United Nation’s Food and Agricultural Organization, Indians’ average per capita calorie consumption rose from 2000 calories in 1963 to nearly 2500 calories in 2003 (compared with 2900 calories in China and 3760 in the United States). (FAO, 2005).

d) Mean nutrient intake of the selected female hyperlipidemics:

Mean nutrient intake of the selected female hyperlipidemics as determined by 24 hours recall method is presented in Table XXVIII.

TABLE XXVIII

MEAN NUTRIENT INTAKE OF THE SELECTED FEMALE HYPERLIPIDEMICS

NUTRIENTS	RDA (ICMR, 2010)	EXPERIMENTAL GROUP (N=2)		CONTROL GROUP (N=2)	
		Actual Intake	%Deficit /Excess	Actual Intake	%Deficit /Excess
Energy (Kcal)	2230	1288.5	-42.2	1458.45	-34.6
Protein (g)	55	45.8	-16.7	46.83	-14.8
Fat (g)	25	17.28	-30.8	18.11	-27.6
Carbohydrate (g)	-	240.2	-	260.6	-
Fiber (g)	31	3.75	-87.9	3.85	-90.2
Calcium (mg)	600	432	-28	550.50	-8.2
Iron (mg)	21	9.70	-53.8	7.53	-64.1
β-carotene (μg)	4800	887.9	-81.5	1717	-64.2
Thiamine (mg)	1.1	0.98	-10.9	1.02	-7.3
Riboflavin (mg)	1.3	0.54	-58.5	1.11	-14.6
Niacin (mg)	14	11.7	-16.4	15.84	+13.1
Vitamin C (mg)	40	34.63	-13.4	71.01	+77.5

From the above table, it was observed that, intake of calories was less than the recommended dietary allowance by 42.2 per cent in experimental group and 34.6 per cent in the control group. Intake of protein was less than recommended intake by 16.7 per cent in the experimental group and 14.8 per cent in the control group. The inclusion of fat was deficit by 30.8 per cent than recommended intake in experimental group and 27.6 per cent in the control group. Intake of fiber was less than the recommended dietary allowance by 87.9 per cent in experimental group and 90.2 per cent in the control group. The mean intake of calcium was less than recommended intake by 28 per cent in the experimental group and 8.2 per cent in the control group. Intake of iron was deficit by 53.8 per cent than recommended intake in experimental group and

64.1 per cent in the control group. Intake of beta-carotene was less than the recommended dietary allowance by 81.5 per cent in experimental group and 64.2 per cent in the control group. Intake of B vitamins such as thiamine, riboflavin and niacin was less than recommended intake by 10.9, 58.5 and 16.4 per cent in the experimental group and 7.3, 14.6 and 13.1 per cent in the control group respectively. Intake of vitamin C was 13.4 per cent lesser than recommended intake in experimental group and 77.5 per cent higher in the control group.

3. Biochemical profile of the selected hyperlipidemics:

a) Lipid profile:

Serum lipid profile of the subjects is presented in Table XXIX

TABLE XXIX

LIPID PROFILE OF THE SELECTED HYPERLIPIDEMICS

LIPID PROFILE (mg/dl)	MEAN ± SD	NORMAL VALUES
Total Cholesterol	202.8 ± 29.38	<200 mg/dl
LDL – Cholesterol	122.0 ± 30.84	<100 mg/dl
HDl – Cholesterol	43.70 ± 16.16	>60 mg/dl
Triglycerides	168.7 ± 50.88	<150 mg/dl
VLDL – Cholesterol	34.60 ± 11.32	<30 mg/dl

The mean lipid profile of selected one hundred hyperlipidemics was given in above Table. The mean total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides and VLDL cholesterol of the hyperlipidemics were 202.8mg/dl, 122mg/dl, 43.7mg/dl, 168.7mg/dl and 34.6mg/dl respectively. But the normal values for total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides and VLDL cholesterol are below 200mg/dl, below 100mg/dl, above 60mg/dl, below 150mg/dl and below 30mg/dl respectively.

F) EFFECT OF SUPPLEMENTATION OF FLAXSEED AND GARLIC ON HYPERLIPIDEMICS:

1. Body Mass Index:

Table XXX gives the Body Mass Index of the hyperlipidemic subjects in the experimental and control group before and after supplementation.

TABLE XXX

BODY MASS INDEX OF THE EXPERIMENTAL AND CONTROL GROUP

BMI WHO, 2009	GRADE	EXPERIMENTAL GROUP		CONTROL GROUP	
		INITIAL (%)	FINAL (%)	INITIAL (%)	FINAL (%)
Below 18.5	Underweight	Nil	Nil	Nil	Nil
18.5 – 22.9	Normal	20	30	Nil	Nil
23 – 24.9	Overweight	30	20	20	20
Above 25	Obese	50	50	80	80
Total		**100**	**100**	**100**	**100**

From the selected 100 hyperlipidemic subjects, initially, in the experimental group, around 20 per cent of subjects had BMI in the normal range from 18.5 – 22.9, 30 per cent of subjects had BMI 23-24.9 which belongs to overweight category and 50 per cent of subjects had the BMI above 25 which belongs to obesity category, and finally, after the supplementation for forty five days, around 30 per cent of subjects had BMI in the range from 18.5 – 22.9 that is normal grade, 20 per cent of subjects had BMI 23-24.9 which belongs to overweight category and 50 per cent of subjects had the BMI above 25 which belongs to obesity category.

Initially, in the control group, 20 per cent of subjects had BMI 23-24.9 which belongs to overweight category and 80 per cent of subjects had the BMI above 25 which belongs to obesity category, and finally, without any supplementation, around 20 per cent of subjects had BMI 23-24.9 which belongs to overweight category and 80 per cent of subjects had the BMI more than 25 which belongs to obesity category.

Results recorded for the BMI grade clearly depicted that, due to the supplementation in the experimental group subjects from overweight category, 10 per cent of subjects shifted to normal grade, this may be due to the effect of supplementation of flaxseed and garlic.

2. Waist-Hip Ratio:

Table XXXI gives the waist-hip ratio of the hyperlipidemic subjects in the experimental and control group before and after supplementation.

TABLE XXXI

WAIST-HIP RATIO OF THE EXPERIMENTAL AND CONTROL GROUP

WHR WHO(2012)	EXPERIMENTAL GROUP		CONTROL GROUP	
	INITIAL (%)	FINAL (%)	INITIAL (%)	FINAL (%)
<0.80	10	10	20	10
0.80 - 0.85	10	20	20	20
0.86 – 0.90	10	20	10	10
0.91 – 0.95	40	20	30	20
0.96 – 1.0	20	20	10	30
>1.0	10	10	10	10
Total	**100**	**100**	**100**	**100**

According to WHO (2012), waist–hip ratio of reference man and woman are above 0.90 and above 0.85 respectively. From the data given in the table, initially before supplementation, majority of the subjects 40per cent were in the range of 0.91 – 0.95 which is above the normal value. Waist-hip ratio of the 10 per cent of subjects were in the range of below 0.80 and 10 per cent of subjects were in the range of 0.80 – 0.85. Besides that, 10 per cent of the subjects had the waist-hip ratio in the range of 0.86 – 0.90 and 20 per cent of thesubjects were in the range of 0.96 – 1.0. Around 10 per cent of subjects were in the range of above 1.0 level.

Finally after supplementation, 20 per cent of the subjects were in the range of 0.91 – 0.95which is above the normal value. Waist-hip ratio of the 10 per cent of subjects were in the range of below 0.80 and 20 per cent of subjectshad their waist-hip ratio in the range of 0.80 – 0.85. Besides that, 20 per cent of the subjects were fall in the range of 0.86 – 0.90 as the waist-hip ratio and 20 per cent of subjects were in the range of 0.96 – 1.0. Around 10 per cent of subjects were in the range of above 1.0 level.

Initially, in the control group, 20per cent of the subjects were in the range of below 0.80 which is below the normal value. Waist-hip ratio of the 20 per cent of subjects were in the range of 0.80-0.85 and 10 per cent of subjectshad their waist-hip ratio in the range of 0.86 – 0.90. Besides that, 30 per cent of the subjects were in the range of 0.90 – 0.95 waist-hip ratio and 10 per cent of subjects were in the range of 0.96 – 1.0. Around 10 per cent of subjects were in the range of above 1.0 level.

Finally after the period of 45 days without any supplementation, majority of the subjects 20 per cent were in the range of 0.91 – 0.95which is above the normal value. Waist-hip ratio of the 10 per cent of subjects had their waist-hip ratio in the range of below 0.80 and 20 per cent of subjects were in the range of 0.80 – 0.85. Besides that, 10 per cent of the subjects were in the range of 0.86 – 0.90 waist-hip ratio and 30 per cent of subjects were in the range of 0.96 – 1.0. Around 10 per cent of subjects were in the range of above 1.0 level.

Results depicted that, 20 per cent of subjects in the experimental group were in the range of 0.91-0.95 were shifted to 0.80-0.90 level that is normal category it may be due to the effect of supplementation of flaxseed and garlic.

3. Lipid profile before and after supplementation:

The lipid profile of the selected hyperlipidemics before and after supplementation is presented in Table XXXII.

TABLE XXXII

LIPID PROFILE BEFORE AND AFTER SUPPLEMENTATION

LIPID PROFILE (mg/dl)	EXPERIMENTAL GROUP			CONTROL GROUP		
	INITIAL MEAN±SD	FINAL MEAN±SD	't'value	INITIAL MEAN±SD	FINAL MEAN±SD	't' Value
Total-C	218.6±24.6	191.9±18	4.086**	221.52±21.4	224.2±27.5	-0.54^{NS}
LDL-C	142.9±27.2	114.3±12.5	4.530**	139.7±28.1	139.7±26.1	0.002^{NS}
HDL-C	39.7±8.8	44±11.8	-2.24^{NS}	38.8±11.2	42.6±14.6	-1.01^{NS}
TG	179.4±55.6	168.1±61.6	0.669^{NS}	179.4±56.5	168.1±66.1	0.669^{NS}
VLDL-C	35.9±11.12	33.62±12.3	0.675^{NS}	43±21.5	42±25.4	0.129^{NS}

**significant at p (<0.01) level, NS – Not Significant

The mean total cholesterol level of experimental group before the supplementation was 218.6 mg/dl and had reduced to 191.9 mg/dl after the supplementation period of 45 days. Thedifference showing statistical significance at p (<0.01) level. The mean total cholesterol level of control group before supplementation was 221.5 mg/dl and had reduced to 224.2 mg/dl through the difference was found be statistically not significant.The mean LDL cholesterol level of experimental group before the supplementation was 142.9 mg/dl and had reduced to 114.3 mg/dl after the supplementation period. The difference showing statistically significant at P (<0.01) level. The mean LDL cholesterol level of control group before supplementation was 139.7 mg/dl and finally the value recorded was 139.7 mg/dl though the difference was not found to be significant.

The mean HDL cholesterol level of experimental group before the supplementation was 39.7 mg/dl and had increased to 44 mg/dl after the supplementation. The difference wasnot significantstatistically. The mean HDL cholesterol level of control group before supplementation was 38.8 mg/dl and had increased to 42.6 mg/dl through the difference was statistically not significant.The mean triglycerides level of experimental group before the supplementation was 179.4 mg/dl and had reduced to 168.1 mg/dl after the supplementation of 45 days. The difference showing statistically not significant. The mean triglycerides level of control group before supplementation was 179.4 mg/dl and had reduced to 168.1 mg/dl though the difference was found to be not statistically significant.

The mean VLDL cholesterol level of the experimental group before the supplementation was 35.9 mg/dl and had reduced to 33.62 mg/dl after the supplementation period. The difference showing not significant statistically. The mean VLDL cholesterol level of control group before supplementation was 43 mg/dl and had reduced to 42 mg/dl through the difference was not statistically significant.

From the results obtained for the lipid profile, it is concluded that, supplementation of flaxseed and garlic as a mix is highly helpful to control the blood lipid levelsparticularly Total Cholesterol and LDL Cholesterol among the hyperlipidemics.

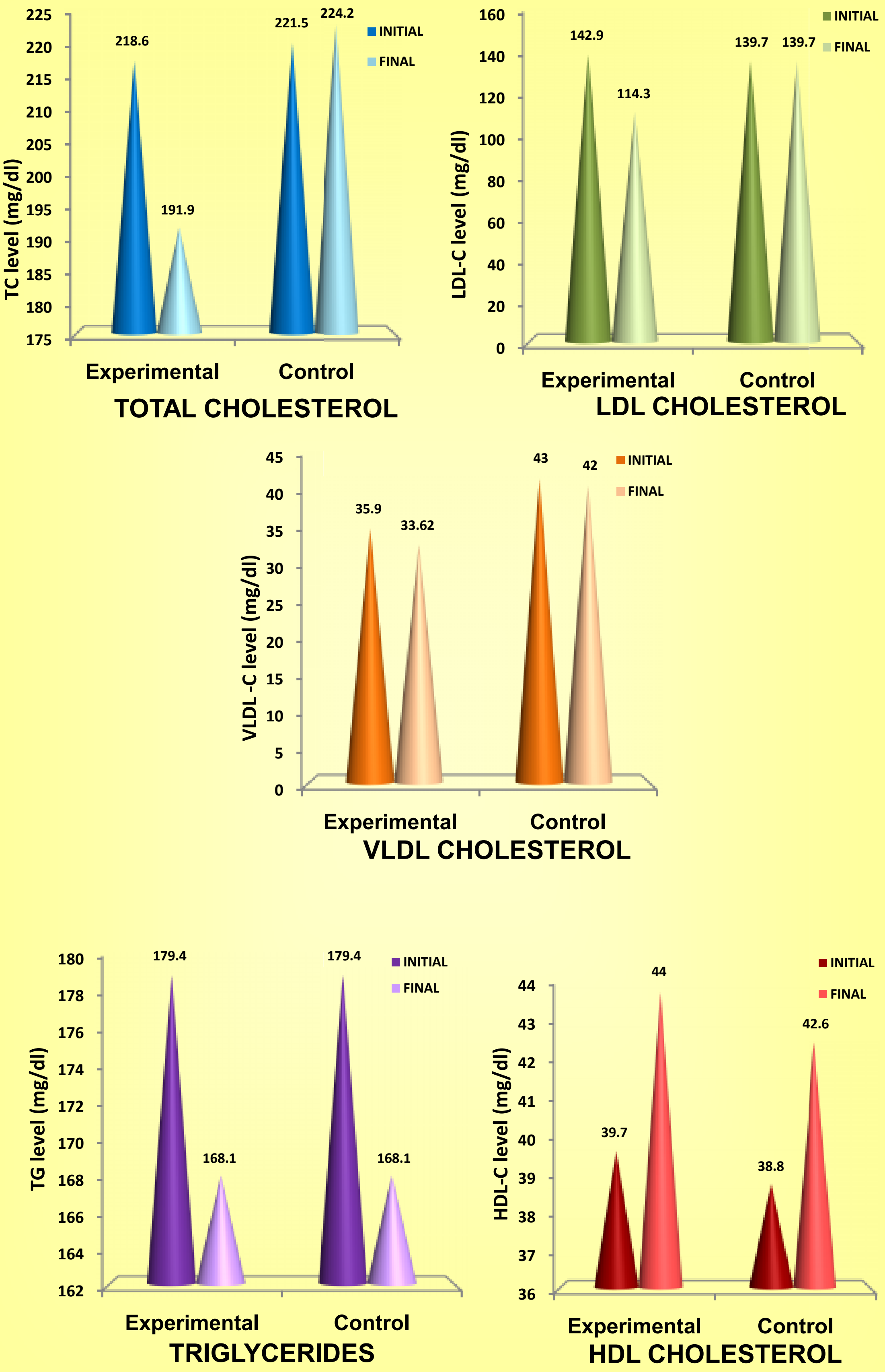

FIGURE V

LIPID PROFILE BEFORE AND AFTER SUPPLEMENTATION

SUMMARY AND CONCLUSION

The summary and conclusion for the present study entitled "**Hypolipidemic Effect of Flaxseed and Garlic"** is presented below.

As high total cholesterol levels are considered to be a major independent risk factor for the development of coronary artery disease, considerable attention has been directed toward evaluating the impact and mechanisms of cholesterol lowering therapies and interventions for cardiovascular outcomes. (Jones, 2009).

Flaxseed has recently gained attention in the area of cardiovascular disease primarily because it is the richest known source of both Alpha Linolenic Acid (ALA) and the phytoestrogen, lignans, as well as being a good source of soluble fiber. Human studies have shown that flaxseed can modestly reduce serum total and low-density lipoprotein cholesterol concentrations, reduce postprandial glucose absorption, decrease some markers of inflammation, and raise serum levels of the omega-3 fatty acids, ALA and eicosapentaenoic acid. (LeAnne *et al.*, 2008). Many studies conducted by Gardner *et al.,* (2007)on garlic (Allium Sativum) for its lipid lowering effects by reduced LDL oxidation and inhibition cholesterol synthesis.

A hyperlipidemic subject in the Enbest Pumps India Pvt Ltd., at K.N.G Pudhur, in Coimbatore was selected with the permission of the authorities of the industry. An interview schedule was formulated and a direct personal interview method was adopted to elicit information regarding the socio-economic status including age, educational status, income and type of activity, dietary habits, lifestyle pattern such as exerciseand habits of smoking, alcohol drinking and also health status.

Dry roast flaxseed, pepper, cumin seeds and dry chillies each separately. Using a blender, grind all the ingredients mentioned above into a powder form and 20 g of this powder is packed in a zip lock polythene cover very hygienically. The packed powders were distributed to the selected 10 subjects in the experimental group once in a week. The packets were distributed to the subjects personally and the subjects were asked to consume this each pack daily and they were advised to add this mix to the cooked rice, mix and consume. And also they were instructed to mix this along with the chappathi dough and prepare as chappathi and consume.

Before and after supplementation period total cholesterol, HDL-C, LDL-C, VLDL-C and TG were analyzed for the experimental and control group after 45 days to evaluate the effect of supplementation.

The salient findings of the study are summarized as follows:

- Out of 100 subjects surveyed, majority (57 per cent) were male, followed by female (43 per cent). Majority of the hyperlipidemic female (51.2 per cent) and male (36.9 per cent) subjects were between the age of 51-60 years.
- It was noted that, 50 per cent of hyperlipidemics were studied only upto high school level and 28 per cent of hyperlipidemics had their education up to primary school, 21 per cent of subjects had their education up to higher secondary level. Among the female hyperlipidemics selected only 2.4 per cent were graduates. No one had studied above under graduate level and also none of them were illiterates.
- From the one hundred selected hyperlipidemic subjects, 5 per cent of subjects belong to Government sector, 43 per cent of the subjects were doing their job in private sectors. 23 per cent of the subjects were doing their own business. One per cent subjects were coolies, four per cent of subjects were retired and remaining 24 per cent subjects were housewives. None of the female was doing business.
- Among the selected 100 hyperlipidemics, majority of the subjects (54 per cent) were doing sedentary type of activity, 39 per cent of subjects were doing moderate type of activity. Remaining only 7 per cent subjects belongs to heavy activity group.
- It was noted that majority of 84 per cent of hyperlipidemics subjects lived in nuclear families, while 16 per cent of the subjects lived in joint families.
- Among the one hundred hyperlipidemics, the majority of 83 per cent of subjects were consuming non – vegetarian diet, only 17 per cent of the subjects were consuming vegetarian diet.
- Majority of the diabetic male 97 per cent subjects were consuming 2 – 3 meals per day, only 1 per cent of the selected subjects were consuming

less than 2 meals per day and only 2 per cent of the subjects were consuming more than three meals per day.

- From the survey carried out it was found that 100 per cent of male and female subjects were consuming cereals (150-200g) and pulses (20-30g) every day. Among the hyperlipidemics selected, 90 per cent of subjects were consuming green leafy vegetables once in a week with the quantity of 40-50g. Other vegetables consumption by 95 per cent of subjects daily with the quantity of 50-100g.
- All type of roots and tubers are not included daily by hyperlipidemics subjects, because of the regular consumption of onion, 100 per cent of subjects were consuming this roots and tubers with the quantity of 50-100g. There were 47.4 per cent of male and 46.5 per cent female were consuming fruits within the range of 100-150g/day and 50-100g/day respectively once in a week. Hundred per cent of hyperlipidemics were consuming milk and milk products every day within the range of 100-200ml/day.
- In the 100 subjects surveyed, most of them were non-vegetarian, hence 70.2 per cent male and 69.8 per cent female were consuming non-vegetarian foods once in a week with a range of 50-100g/day and 100-150g/day respectively, 17.5 per cent of male 16.3 per cent of female were vegetarian.
- Nuts and oilseeds consumption by the male was 87.8 per cent with a range of 10-20 g and female was 90.7 per cent with a range of 10-20g weekly once. Mostly fats and oils consumption by all the male and female with the quantity of 10-20ml/day.
- Majority of subjects (58 per cent) were using refined oil every day followed by sunflower oil (36 per cent) for cooking.
- About 43.9 per cent were consuming vada or bajji or bonda every day, 32.6 per cent of female subjects were consuming fried snacks like Murukku, mixture occasionally and 22.8 per cent of male and 14 per cent of female subjects are not consuming any type of snacks.
- It was noted that 20 per cent of the subjects had the habit of walking daily, four per cent of the subjects had the habit of maintaining the garden daily,

about one per cent of subjects had the habit of doing cycling. Remaining 45 per cent of subjects do not have the habit of doing any exercise, even after the onset of hyperlipidemia.

- Among the selected male hyperlipidemics, 35.1 per cent of male had the habit of smoking and 64.9 per cent of the male subjects did not have the habit of smoking. Among the smokers, 75 percent had the habit of smoking cigarette 6-10 numbers per day for the frequency of twice in a week. About 60 per cent of male had the habit of smoking more than 9 years.
- Among the male hyperlipidemics surveyed, 24.6 per cent of male had the habit of consuming alcohol occasionally with a quantity of 100-200 ml/day and 75.4 per cent of the male subjects do not have the habit of consuming alcohol.
- Majority (30 per cent) of subjects respectively had the habit of drinking more than 4 cups of tea every day and 24 per cent of subjects had the habit of drinking more than 4 cups of milk every day. Around 15 per cent of subjects had the habit of drinking more than 4 cups of coffee every day.
- Among theselected hyperlipidemics, most of the subjects (45 per cent) are suffering from hyperlipidemia for the period of 6-10 years.
- With regard to symptoms around 25 per cent of subjects suffering from the shortness of breath and 14 per cent are suffering from diabetes and 27 per cent are suffering from more than one symptom such as hypertension, high blood pressure, nausea and depression along with hyperlipidemia.
- It was noted that there is a prevalence of family history among the selected subjects. About 25 per cent of subjects had their family history of this disorder from their mother, 16 per cent of subjects had their family history from their father, 7 per cent of male had their family history from their grandfatherand one per cent of male had their family history of the condition from their grandmother. Remaining 51 per cent of male and 46.5 of female subjects do not have their family history of the disease.

- Among the one hundred selected hyperlipidemics, it was recorded that 58 per cent of male and 79.1 per cent of female had their height below the standard height of ICMR.
- From the one hundred subjects surveyed, 12.3 per cent of the male and 21 per cent of female had their body weight above the normal body weight. More than 80 per cent of male and more than 65 per cent of the female had their weight above the desirable body weight.
- With regard to the BMI of the selected one hundred hyperlipidemic subjects, around 12.3 per cent male and 11.6 per cent of female subjects had the BMI ranged from 18.5 – 22.9 that is normal grade, 15.8 per cent of male and 11.6 per cent of female had the BMI 23-24.9 which belongs to overweight and14 per cent of selected hyperlipidemics are overweight and 72 per cent of subjects are obese. This is concluded that obesity is the fundamental risk factor for the progression of hyperlipidemia.
- It is noted that, majority of the male (43.9 per cent) and female (93 per cent) were in the above normal level.
- With regard to the mean food intake, the consumption of cereals, pulses, green leafy vegetables, roots and tubers, other vegetables, fruits, milk and milk products fats and oils and sugar were deficient and meat was more than the recommended intake in both experimental and control group.
- Regarding the nutrient intake, both control and experimental group showed a deficit in energy, protein, carbohydrate, fiber, iron and beta-carotene.
- The mean lipid profile of selected one hundred hyperlipidemics was more than the normal values. The mean total cholesterol, LDL cholesterol, HDL cholesterol, triglycerides and VLDL cholesterol of the hyperlipidemics were 202.8mg/dl, 122mg/dl, 43.7mg/dl, 168.7mg/dl and 34.6mg/dl respectively.
- Results recorded for the BMI grade clearly depicted that, due to the supplementation in the experimental group subjects from overweight category, 10 per cent of subjects shifted to normal grade, this may be due to the effect of supplementation of flaxseed and garlic.

- Results depicted that, 20 per cent of subjects in the experimental group were in the range of 0.91-0.95 were shifted to 0.80-0.90 level that is normal category it may be due to the effect of supplementation of flaxseed and garlic.
- The mean total cholesterol level of experimental group before the supplementation was 218.6 mg/dl and had reduced to 191.9 mg/dl after the supplementation period of 45 days. The difference showing statistical significance at p (<0.01) level. The mean LDL cholesterol level of experimental group before the supplementation was 142.9 mg/dl and had reduced to 114.3 mg/dl after the supplementation period. The difference showing statistically significant at P (<0.01) level.
- From the results obtained for the lipid profile, it was noted that, supplementation of flaxseed and garlic as a mix is highly helpful to control the blood lipid levels particularly Total Cholesterol and LDL Cholesterol among the hyperlipidemics.

Conclusion

From the results obtained for the lipid profile, it was concluded that supplementation of flaxseed and garlic as a combination is highly helpful to control and manage cholesterol level among hypercholesterolemic population.

Results of the present study it was revealed that flaxseed and garlic are having Hypolipidemic effect especially in lowering the Total Cholesterol and LDL Cholesterol levels. So the supplement given is reasonable cost and locally available in the market which was highly effective for the proper management of hyperlipidemia.

RECOMMENDATIONS

1. Flaxseed and garlic can be supplemented for hyperlipidemics in the form of recipes.
2. Other types of under exploited foods which are hypolipidemic in nature can be studied.
3. Combinations of different supplements can be recommended for treating conditions leading to non-communicable diseases will reduce the family burden especially for the low income group.

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APPENDIX I

ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS

S.No	BMI	WHR	TC	LDL	HDL	TG	VLDL	S.No	BMI	WHR	TC	LDL	HDL	TG	VLDL
1	31.0	0.96	183	115.6	22	227	45.4	26	18.6	2.40	264	141.8	64	291	58.2
2	29.1	1.0	217	147	43	133	27	27	29.3	1.56	257	175	47	175	35
3	25.4	1.25	234	99	38	207	41.4	28	30.6	1.56	221	155.5	41.5	229.2	45
4	25.4	1.25	146	87	42.4	85.8	17.6	29	28.5	1.71	222	145	46	203	40
5	26.6	1.23	209	134.4	40	173	34.6	30	26.2	1.86	220	149	35	180	34
6	31.2	1.05	172	90	38.5	145	40.4	31	29.4	1.6	185	109	40	209	35
7	29.5	1.1	205	116.4	51	188	37.6	32	21.8	2.28	239	167	43	144	28.8
8	29.8	1.13	194	125	41	140	28	33	29.6	1.6	215	146	44	125	25
9	28.0	1.24	197	132	40	123	25	34	30.1	1.65	181	96.7	41	162	32.4
10	29.2	1.19	190	99	40	120	29	35	25.0	1.99	240	150.2	41	244	48.8
11	32.8	1.06	227	161.4	43	113	22.6	36	33.4	1.49	204.2	38.2	36.3	169	37.3
12	29.4	1.2	222	126	36	222	44.4	37	22.8	2.27	190	72.6	39	392	78.4
13	24.6	1.4	214	132	38	221	44	38	24.5	2.16	207	126	36	222	44.4
14	29.3	1.25	199	114	53	158	32	39	30.6	1.73	280	126	36	222	44.4
15	21.9	1.73	242	172.8	48	106	21.2	40	26.8	1.97	175	101	39	158	40
16	25.1	1.58	216	143	30	214	42.8	41	26.8	2.01	131	76	34	107	21
17	23.5	1.69	229	171	37	105	21	42	25.9	2.08	186	88	33	173	34
18	23.1	1.73	245	147	44	271	54	43	26.2	2.05	215	90	37	190	47
19	30.8	1.29	225	99.2	39.8	198	45.3	44	28.5	1.9	195	121	43	155	31
20	23.1	1.7	256	161	47	240	48	45	25.3	2.25	182	131	39	143	29
21	24.6	1.6	196	117.4	39	198	39.6	46	25.9	2.1	190	110.2	40.5	205	35
22	27.7	1.55	260	180	52	136	27.2	47	26.6	2.17	184	93.7	47.8	166	33.2
23	26.2	1.63	188	125	41	140	28	48	24.2	2.39	202.3	127.5	36.4	192	38.4
24	25.9	1.65	165	98.2	35	200	40.6	49	18.6	3.22	231	135.7	37.9	286	57
25	16.6	2.63	159	64	60	175	35	50	18.5	3.2	220	129	66	125	25
S.No	BMI	WHR	TC	LDL	HDL	TG	VLDL	S.No	BMI	WHR	TC	LDL	HDL	TG	VLDL
51	36.0	1.66	149	88	38	115	23	76	32.1	0.87	218	143	43	160	32
52	21.0	2.84	195	95	40	178	56	77	28.2	0.97	210	118	36	240	48
53	30.4	1.96	210	120	35	130	36	78	25.3	0.8	202	135	37.2	148	29
54	23.0	2.60	189	110	43	182	36	79	24.7	0.79	185	109	54	111	22
55	20.5	2.9	141	87	35	115	39	80	23.6	0.86	208	141	47	102	20
56	24.8	0.90	199	131	39	143	29	81	25.7	0.94	160	110	39	128	25
57	29.8	0.9	221	129	45	235	47	82	31.2	0.87	235	172	37	129	25.8
58	31.5	1.05	182	172	37	129	25.8	83	39.1	1.0	220	154	43	115	23
59	34.6	0.95	190	140	36	115	23	84	23.7	0.86	214	128	52	172	34
60	27.7	0.95	186	143	43	160	32	85	23.0	0.86	222	131	54	186	37
61	43.5	0.91	164	73	43	238	48	86	26.3	0.87	201	121	49	153	31
62	31.6	0.71	180	99	31	134	26.8	87	22.3	0.87	217	145	40	159	32
63	29.0	0.71	255	197.6	44	67	13.4	88	30.9	0.92	194	117	33	220	44
64	34.6	0.95	188	92	54	210	42	89	19.1	0.93	235	140	70	122	22
65	32.1	0.87	197	48.7	113	145	41.4	90	22.3	0.87	231	148	42	208	41
66	38.7	0.87	185	109	54	111	22	91	31.5	1.05	180	110	40	150	30
67	21.5	0.88	191	121	49	153	31	92	27.4	0.94	204	130	47	136	27
68	24.4	0.94	207	123	49	175	35	93	38.1	0.89	220	150	35	175	35
69	27.4	0.94	185	128	52	172	34	94	27.7	0.95	255	44	167	186	37
70	31.6	0.7	160	110	39	128	25	95	21.5	0.88	250	130	40	239	80
71	34.2	0.92	200	134	37	103	20	96	38.7	0.87	171	108	32	150	30
72	34.2	0.92	184	93	40	135	31	97	27.8	0.8	158	108	35	112	22
73	38.1	0.89	183	73	43	238	48	98	25.0	0.9	273	209	36	140	23
74	26.7	0.90	184	112	44	142	28	99	31.5	0.93	188	121	35	158	31
75	26.9	0.91	205	128	41	176	36	100	29.5	0.93	175	102	41	164	32

ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS

OF

EXPERIMENTALANDCONTROLGROUP

S.No.	BMI		WHR		TC		LDL		HDL		TG		VLDL	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS OF EXPERIMENTAL GROUP														
1	31.01	31.82	0.98	0.98	183	181	115.6	97.6	22	26	227	287	45.4	57.4
2	26.68	25.68	0.92	0.82	209	192	134.4	115.2	40	39	173	189	34.6	37.8
3	29.02	28.8	1.05	1.05	255	198	197.6	134.4	44	43	67	103	13.4	20.6
4	29.59	29.13	0.91	0.89	205	210	116.4	110.6	51	68	188	157	37.6	31.4
5	21.93	21.08	0.92	0.9	242	194	172.8	117.2	48	49	106	139	21.2	27.8
6	25.19	25.05	0.85	0.8	216	197	143	124.4	30	32	214	203	42.8	40.6
7	23.15	24.6	0.92	0.9	256	157	161	92.6	47	47	240	87	48	17.4
8	24.67	22.7	0.97	1.0	196	221	117.4	119.4	39	54	198	238	39.6	47.6
9	24.51	23.9	0.73	0.75	207	195	126	122.2	36	45	222	139	44.4	27.8
10	22.34	24.5	0.87	0.90	217	174	145	109.2	40	37	159	139	32	27.8
ANTHROPOMETRIC AND BIOCHEMICAL PARAMETERS OF CONTROL GROUP														
1	**28**	**25.68**	**0.78**	**0.92**	**197**	**199.2**	**122.4**	**130.2**	**40**	**34.6**	**173**	**189**	**34.62**	**34.4**
2	24.04	23.56	0.94	0.90	201	205	172.8	142.2	18	29	106	139	10.2	33.8
3	28.9	27.9	0.9	0.97	230	214	141	144.5	49	44	240	238	40	25.5
4	31.03	32.5	0.84	0.97	212.2	182	145	124.2	35.2	37	159	139	32	20.8
5	31.01	31.82	1.02	1	211	226	115.6	112.6	22	26	227	287	73.4	87.4
6	24.67	24.67	0.94	0.97	212	237	117.4	107.6	39	67	198	87	55.6	62.4
7	25.19	25.05	0.92	0.81	247	261	153	149.2	40	32	214	203	54	79.8
8	29.59	29.13	0.98	0.97	240	245.6	116.4	163.2	51	68	188	157	72.6	14.4
9	29.9	27.4	0.98	0.92	205	207.5	116	127.2	46	45	222	139	43	35.3
10	29.02	28.88	1.10	0.94	260	265	197.6	196.2	48.2	43	67	103	14.2	25.8

APPENDIX II

QUESTIONNAIRE

HYPOLIPEDEMIC EFFECT OF FLAX SEEDS AND GARLIC

Socio-Economic background

1. Name :
2. Date of Birth : Age:
3. Sex : Male / Female
4. Name of the Institute / factory / Hospital:
5. Qualification : Primary/High School / Higher Secondary/ Degree / Post Graduate / Professional/ Others
6. Occupation : Doctor/ Engineer / Government/ Private/ Business / Farmer / Housewife / Retired / Others
7. Activity : Sedentary / Moderate / Heavy
8. Family : Nuclear / Joint
9. No. of people in the household : ☐ 1-3 Small family ☐ 4-6 Medium family ☐ Above 6 Big family

10. Total Monthly income of the family (Technical Report of 11^{th} Five Year Plan)

Grades	Income / Month in Rs.
Low income grade	3301 – 7300
Middle income grade	7301 – 14500
High income grade	14501 and above

11. Diet Pattern

1. Dietary habit :Veg ☐ Non veg ☐ Ova veg ☐
2. How many meals do you take per day? < 2 ☐ 2-3☐ > 3 ☐
3. Do you drink any hot beverages? : Yes / No
4. If Yes, mention the item and no. of cups consumed per day?

Items	No. of Cups per day			
Milk	1	2	3	4
Coffee	1	2	3	4
Tea	1	2	3	4
Other hot drinks	1	2	3	4

5. Do you take food from home? Yes ☐ No ☐
6. If No, where else you eat ☐ Mess ☐ Canteen ☐ Hotel R☐ad side vehicle ☐Other
7. Daily meal pattern(24 hours)

Meals / day	Menu	Ingredients	Quantity consumed
Break Fast			
Mid-morning			
Lunch			
Tea time			
Dinner			
Bed time			

8. Food consumption pattern

Food item	serving / day	Daily	Twice a week	Weekly once	Fort-night	Monthly	Rarely	Never
Cereals Rice Wheat Ragi Jowar Bajra Others								
Pulses Red gram dhal Green gram dhal Black gram dhal Bengal gram dhal Bengal gram Green gram Others								
Vegetables Brinjal Ridge guard Ladies Finger Bitter gourd Snake gourd Raw Banana Tomato Cauliflower Others								
Roots and Tubers Potato Carrot Beetroot Yam Tapioca Others								
Green Leafy vegetables Amaranth Spinach Coriander Cabbage Mint Others								
Fruits Banana Apple Grapes Guava Citrus								

Seethapal Others								
Milk and Milk Products Milk Ghee Butter Curd Buttermilk Cheese Paneer Others								
Meat and meat products Chicken Mutton Fish Egg Others								

9. Fats and Oils used for cooking

Types of Fats & Oils	Quantity (ml/lt)
Hydrogenated oil	
Gingelly oil	
Groundnut oil	
Palmolein oil	
Sunflower oil	
Refined Groundnut oil	
Rice bran oil	
Red palm oil	
Olive oil	
Others	

10. Do you consume snacks? ☐ Yes ☐ No
11. If Yes, mention the Frequency and consumption

Type of snacks	Frequency of consumption			
	Daily	Weekly twice	Weekly once	Occasionally
Vada				
Bajji / Bonda				
Pakoda				
Chips				
Samosa / Puffs				
Murukku / Mixture				
Chaat items				
Cakes				

<u>lifestyle Pattern</u>

1. Do you do any exercise? ☐ Yes ☐ No
2. If Yes, What type of exercise?

Type		Duration			Frequency
		30 min	45 min	1 hr	
Moderate intensity	Walking				
	Gardening				
	House work				
	Meditation				
	Others				
Vigorous intensity	Jogging				
	Cycling				
	Swimming				
	Shuttle / Tennis				
	Volley Ball				
	Others				

3. Do you consume alcohol? ☐ Yes ☐ No
4. If Yes, How often do you take? ☐ Daily ☐ Weekly twice ☐ Weekly once ☐ Occasionally
5. Mention the type and quantity of alcohol consumed?
   A. ____________ml. B.______________ml.
   C.____________ml.
6. How long do you have the habit of drinking? Years___________
   Months___________
7. Do you smoke? Yes ☐ No ☐
8. If Yes, No. of cigarettes / beedi / cigar per day
   No. smoked : ☐ 0-5 ☐ 5-10 ☐ 10-15
   Frequency : ☐ Daily ☐ Weekly twice ☐ Weekly once ☐ Occasionally
9. How long do you have the habit of smoking?
   Years___________ Months____________

Personal and family history

1. Are you having hyperlipidemia / hypercholesterolemia?
   ☐ Yes ☐ No
2. Do you have any family history of hyperlipidemia / hypercholesterolemia?
   ☐ Yes ☐ No
3. If Yes,

Relationship	Age	No. of years
Both parents		
One of the parents		
Grand parents		
Other relatives		
None		

4. When do you diagnosed? _______________
5. What are the symptoms you have?

Symptoms	
Hypertension	
High Blood Pressure	
High cholesterol	
Nausea, Fatigue	
Shortness of breath	
Diabetes	
Anxiety	
Depression	

6. Do you know the cause of the disease? Yes ☐ No ☐
7. Do you think your lifestyle can alter your serum cholesterol level?
   ☐ Yes ☐ No
8. Do you think that your eating habits can affect your serum cholesterol levels?
   ☐ Yes ☐ No
9. Have you changed your food habits after the diagnosis? Yes ☐ No ☐
10. If Yes, what changes did you make?

	Foods included(Qty)	Foods avoided	Exercise included	Exercise avoided
Before	1. 2. 3. 4.			
After	1. 2. 3. 4.			

Omega 3 fatty acid and Fibre rich foods

1. Do you know what is omega 3 fatty acids? ☐ Yes ☐ No
2. Do you know what are omega 3 foods? ☐ Yes ☐ No
3. Do you know what is dietary fibre? ☐ Yes ☐ No
4. If Yes, indicate the foods:
   1.____2______
5. Do you consume them? Yes ☐ No ☐
6. If Yes, mention the quantity you are consuming?

S.No	Foods	Intake / day	Frequency
1.			
2.			
3.			
4.			

7. In what way they are helpful?
   1. To reduce LDL cholesterol
   2. To reduce total cholesterol
   3. To reduce blood sugar
   4. To reduce body weight
   5.Anything else
   6. Don't know

Anthropometric data

a) Weight (Kg) :
b) Height (cms) :
c) BMI :
d) Waist circumference (cm) :
e) Hip circumference (cm) :
f) Waist to Hip Ratio :

Biochemical parameters

a) Total cholesterol (mg/dl) :
b) LDL cholesterol (mg/dl) :
c) HDL cholesterol (mg/dl) :
d) Triglycerides (mg/dl) :
e) VLDL (mg/dl) :

Address:

Phone/mobile:

All information on this form is correct to the best of my knowledge and I have saw and followed any necessary medical advice.

Client's Signature