INFLUENCE OF SUNFLOWER OIL ON BLOOD CHOLESTEROL LEVEL IN HYPERCHOLESTEROLAEMIA

by

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I INTRODUCTION

Coronary heart disease is the major public health problem in many of the countries. It is particularly disturbing that many relatively young people in their most protective years are killed or incapacitated by this disease.

Coronary heart disease arises on the basis of coronary artery atheroma, a fibre fatty deposition in the inner lining which may constrict the lumen arteries supplying the heart muscles. The manner of development of athromatus plague is a fat deposition on the surface of the vessel known as atherosclerosis (Stewart, 1965).

Atherosclerosis and its complications are the chief causes of death. This results from the interaction of multiple factors such as hereditary, individual environment that is diet, activity, smoking and life style.

There is concern about the relationship between a high fat intake and coronary heart diseases. It has been shown that people with a high cholesterol level in their blood are more likely to built up fatty deposition in their blood vessels. Thus reducing intake of animal fats and increasing intake of unsaturated oils will reduce the likelyhood of the person developing coronary heart disease (Keys et al. 1964).

Sabir et al (1964) and Truswell (1966) stated that diet is one of the more valid arms of prevention of atherosclerosis and this can be achieved through proper alteration in quality and quantity of fat.

Nutritionally, fat supplies energy and also serves as vehicle of fat soluble vitamins, apart from being a source of essential fatty acids. However, it goes without saying that though fats in general are the suppliers of energy, the vegetable fats are good for health as they are rich in poly unsaturated fatty acids (Nabayan, 1974).

The unsaturated fatty acids possess double bonds in their chain which make them more active chemically and oxidise readily (Cheng et al, 1972).

Fats like groundnut oil, sesame oil, safflower oil and sunflower oil contains a high proportion of poly unsaturated fatty acids and do not increase blood cholesterol level very much even when consumed in large quantities. As this fat induces lowering of serum cholesterol and phospholipid levels than others like butter and coconut oil it is useful in reducing the incidence of atherosclerosis (Gopalan et al, 1972; Banajee, 1973 and Vergroesseen, 1970).

Standard diet for hypercholesterolaemia are foods including ordinary bread, cereal, fruits, vegetables, fat free beverages and unsaturated vegetable oil(Krause, 1966).

Fat controlled diets are more and more widely recommended in the treatment of coronary heart disease. The linoleic and oleic acids which are poly unsaturated fatty acids present in sunflower oil minimises the serum cholesterol. (Abrens et al, 1964; Brown, 1961 and Sinclair, 1964).

Sunflower has come to be considered as a substitute for groundnut not only because of its high oil content, but also because of its adaptability in Indian Agro-climatic condition (Bhatia, 1975).

The study by John Yudkin (1969) and Trulson (1971) revealed that the number of poly unsaturated fatty acids are more in sunflower oil when compared to other oils. So, the sunflower oil when compared to other oils. So, the sunflower oil is best in the reduction of serum cholesterol.

Tamilnadu Agro Industries Corporation and Ramachandram (1983) reported as sunflower oil is the wonderful edible oil which plays an important role in synthesis of prosto-glatins the substance which influences various body functions.

Because of this and its quality in controlling blood cholesterol content sunflower oil is considered good for patients affected with coronary heart disease.

It is undoubtedly clear that there has been tremendous rise in the incidence and mortality due to coronary heart disease. It is not only the duty of the government but also every research worker to accept the challenge and guide the public. So that one can reduce the mortality due to this disease in the country. So the investigator has taken this topic to reduce the serum cholesterol in blood by substituting sunflower oil in place of other edible oils in their diet.

II REVIEW OF LITERATURE

The literature pertaining to this study is reviewed under the following heads:

A. Incidence and risk factors of coronary heart disease.

B. Nutritional consideration in coronary heart disease.

C. Role of dietory fat on serum cholesterol.

D. Hypocholesterolaemic effect of sunflower oil

A. Incidence and Risk Factors of Coronary Heart Disease:

In India coronary heart disease is main etiological type of cardio vascular disorder and constituted 39 per cent of hospital admissions in a period of three years. Among these 30.5 per cent is due to hypercholesterol (Agarwal and Muralilal, 1970).

Statistical difference were observed between the patients in India shows, many variables have been incriminated in the search for causes of coronary heart disease rengingfrom hypertension and electrocardiography abnormalities to behaviour pattern and cholesterol level. It has concluded that a high cholesterol is risk factor of coronary heart disease (Barrington, 1960).

Padmavathi (1961) states that incidence of coronary heart disease in India, in general, is low when compared to other countries. The incidence is highest in those

parts of India where consumption of coconut oil is high, because of its saturation.

The "risk factors" in atherosclerosis are age, diet smoking, obesity, blood pressure, mental stress exercise, alcohol, drinking water, sex and sedentary occupation. A high degree of physical activity present in most communities in the under developed parts of the world are usually assumed to be free from coronary heart disease. (Ramadas Moorthy, 1972). In brief, the risk factors accelerate the development of atherosclerosis in communities (Krause, 1966).

Age has the strongest and most consistent association with lesions of all known risk factors. The average involvement with raised atherosclerotic lesions increases with age (Strong, 1977).

Atherosclerotic lesions seem to be related to levels of serum cholesterol and dietary fat. Attempts have been made notably by Keys (1973) to correlate the death rates from coronary heart disease with the total fat in the diet. There is good correlation between these death rates and the intake of animal protein and carbohydrate. Increase in consumption of fat, carbohydrate and protein leads to rise in serum cholesterol (Yerushalmy and Hilleboe, 1977; and Yudkin, 1964).

Statistical data shows that peripheral vascular disease and ischemic heart disease occur much more frequently in heavy smokers than in those who donot smoke (Doll and Hill, 1964 and Dawber et al. 1957). It was found that there was a rising gradient of mortality from heavy cigarette smokers at all ages under 65 years. There is clear relationship between ischemic heart disease and the amount of smoking and this is particularly the cause for the younger age groups. The nicotine in tobacco causes adverse effect (Passmore, 1979).

Ischemic heart disease and other clinical evidence of atherosclerosis arises more commonly in patients who are obese. At present it is possible to state that an accelerating action on the development of the atherosclerotic lesions or to an increasing liability to thrombosis and other complication are due to obesity (Dawber et al. 1957).

Coronary heart disease arises more commonly in patients who have high blood pressure. This view has been supported by the results of the Framingham study out of 1335 men aged 40-61 years, 96 developed atherosclerotic heart disease during a six year period. The overall incidence rate was 72/1000. In those who had a normal blood

pressure, a low plasma cholesterol and a normal electrocardiogram, the incidence rate was only 36/1000. These figures show in a striking manner how a high blood pressure and a raised plasma cholesterol predispose to ischemic heart disease (Kember et al, 1967 and Kannel et al, 1965).

Ischemic heart disease is reported to be common among business executives lawyers and doctors who are subject to constant mental strain. The higher incidence in recent times has been due to mental stress of modern living.

Coronary heart disease is more likely in sedentary workers than those taking moderate physical exercise, which tends to open up coronary collateral vessels. Thus physical exercise may prevent the first and subsequent attacks of coronary heart disease and is beneficial after recovery from infaretion (Antia, 1975).

Alcohol has rapid short-term effects upon heart functioning, blood pressure and triglycerides. Excessive consumption may have a direct toxic effect on the myocardium, resulting in alcohol cardiomyopathy (Leports et al, 1980).

There is no doubt that in many countries there is a significant negative association between the hardness of

drinking water contains the lower death rate from cardio vascular disease (Crawford et al. 1968).

Ischemic heart disease is about ten time as common in men as in women up to the age of 45. After the menopause there is greatly increased incidence in women, by the age of 70, there is no difference between six. In both ovaries are removed before the age of 35 this is often followed by a rise in plasma cholesterol and the incidence is greatly increased (Davidson and Passmore, 1979).

Three rayon factories showed that mortality from coronary heart disease was 42 per cent among the process workers, as compared to 24 per cent in non process workers in the same factory and 17 per cent among men living in the locality. During the manufacture of viscose rayon, cellulose produced from wood pulb is mixed with carbondisulphide. This is the evidence of an occupational toxic factor in the etiology of coronary heart disease(Thomas, 1968).

B. Nutritional Considerations in Coronary Heart Disease:

Serum cholesterol lowering can be achieved most practicall by replacement of dietary sources. John (1973) recommended to reduce total fat, restrict saturated fat,

restrict dietary cholesterol, adjust calories, carbohydrate and protein for coronary heart disease.

The American heart association recommends total fat content in diet to no more than 35 per cent of total recommendation includes avoidance of excessive post-prandial hyperlipidaemia and the desirability of limiting unnecessary calories. Many foods high in fat are also high in cholesterol and the amount of fat affect cholesterol absorption (John, 1973).

Casein prevents atherosclerosis in monkeys. However casein deficiency is unlikely to be a cause of atherosclerosis, particularly in western countries where milk is consumed freely (Antia, 1975).

The ingestion of carbohydrates play a major role in lipid synthesis. The body can synthesise lipids from carbohydrates. When 35-40 per cent calories were supplied as carbohydrate more than 90 per cent of patients with coronary heart disease showed increased serum cholesterol and frequent hypercholesterolaemia (Bornemisaac, 1970).

C. Role of Dietary Fat on Serum Cholesterol:

Dietary cholesterol appears to be linearly related to the serum cholesterol. An increase of 50g. of dietary cholesterol of approximately 5mg/100ml. In view of these

results, the diet for lower the serum cholesterol is inclusion of high proportion of polyunsaturated fatty acids and a small amount of dietary cholesterol (Finland, 1958; Green et al. 1964 and Tan et al. 1961).

Increased dietary cholesterol do infact bring about increased plasma cholesterol. Egg yolk influences the serum cholesterol. Working with various hospital patients who were fed with various vegetable fats, concluded that vegetable fat that containing saturated fat increases the serum cholesterol (Messinger et al. 1978 and Kinsell et al. 1974).

Generally serum cholesterol lowering can be achieved most practically by replacement of dietary sources of unsaturated fat especially rich in polyunsaturated fatty acids and by the reduction in the consumption of food rich in cholesterol (Cook et al. 1972 and Blackburn, 1978).

Fat intake, calorie need, polyunsaturated fatty acid intake, cholesterol metablism and coronary risk factors were considered in setting dietary allowances. Polyunsaturated fatty acids decrease the chance of coronary risk factors (Dalfin, 1974).

According to the formula of Keys et al (1973) saturated fats are twice as effective in increasing serum cholesterol where as polyunsaturated are in reducing them. The limitation of dietary cholesterol is a very important in the aspect of planning diets to lower cholesterol.

The metabolic studies have been undertaken in the department of clinical science Australian University pointed out that fats of both polyunsaturated and saturated fat were fed to 14 healthy male for a period of three to seven e weeks. Results indicate that polyunsaturated fatty acids are effective in reducing serum cholesterol and saturated are in the opposite direction (Nestal scott and Cook, 1974; Lees and Wilson, 1960; Bonnemisaac, 1970; Utian, 1971 and the Council of Food and Nutrition of the American Association, 1973).

In human subjects the effects of feeding a highly saturated fat and unsaturated fat were studied on serum cholesterol. The serum cholesterol levels were determined initially and the subjects then received 100g. of one of the fat daily. Serum cholesterol levels were determined at an intervals of a week over a nine week period. On viewing the results, the saturated fat level remined

above the basal with minor fluctuations while in unsaturated fat level had fallen below the basal by the fourth week (Gopalan and Ramanathan, 1967).

The daily diet should supply only 30-35 per cent calories from fat, less than 150 mg. cholesterol and rich in polyunsaturated fatty acid to reduce the serum cholesterol in blood (Mathatie, Hawenstein, 1974).

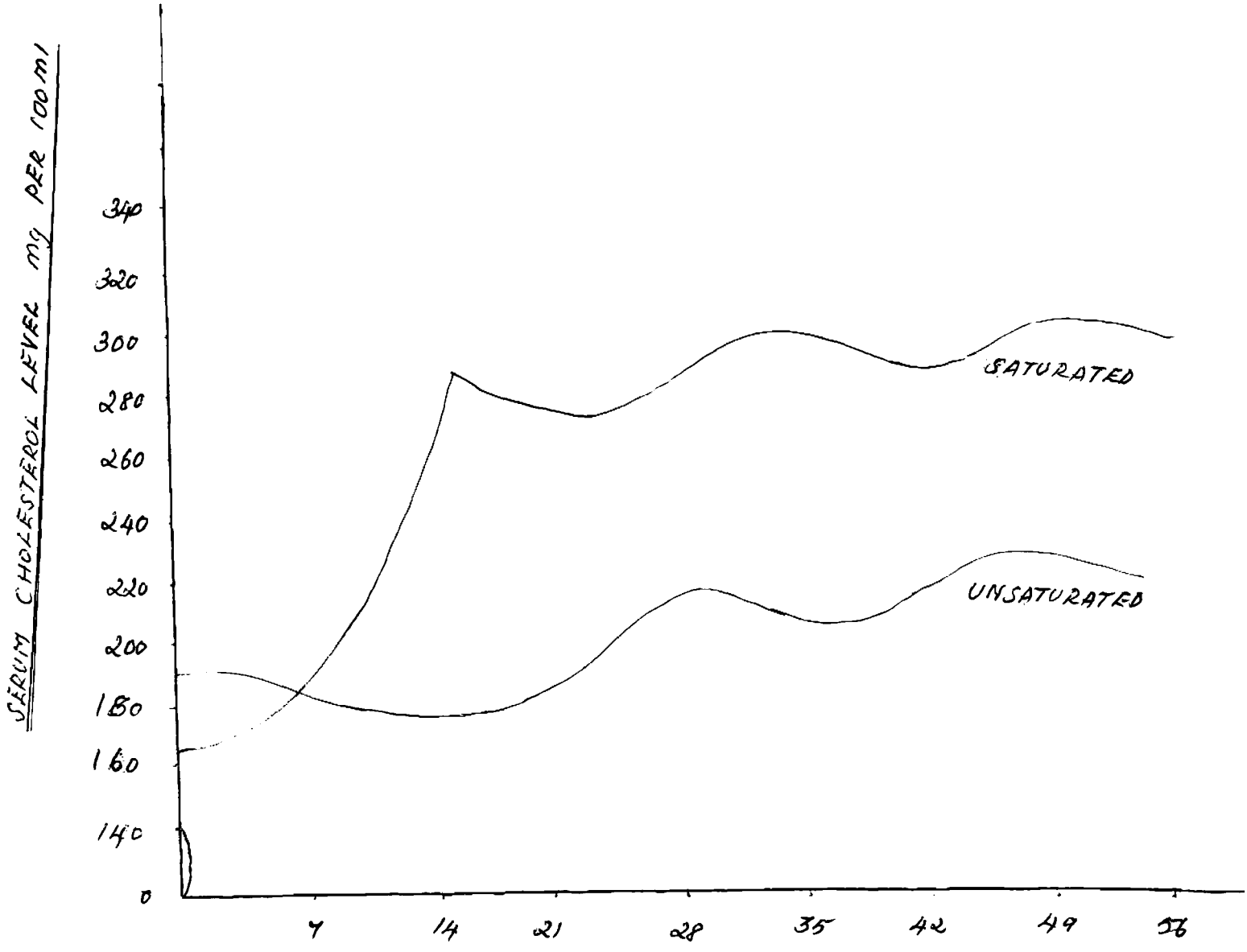
Serum cholesterol levels can be lowered as a result of either depressed endogenous synthesis of cholesterol or as a result of enhanced degradation of cholesterol or both. A study was therefore done in human subjects to determine whether the hypocholesterolaemic effect on fats rich in polyunsaturated fatty acids was mediate through a greater degradation of cholesterol. The result of these studies show that the type of fat and amount of fat consumed are very important factors in determining the serum cholesterol and is in shown in Figure . (Gopalan et al, 1962).

D. Hypocholesterolaemic Effect of Sunflower Oil:

The unsaturated fatty acids cannot be synthesised by the population group. Therefore it must be supplied in the diet. These essential fatty acids occur in high concentration in various edible oil such as corn oil,

EFFECT OF FEEDING VARIOUS FATS ON

SERUM CHOLESTEROL IN HUMAN SUBJECTS.



sunflower oil and soyabean oil. These fatty acids are important because they seem to play a role in the regulation of several aspects of cholesterol metabolism such as transport, transformation, in the metabolic products and to ultimate excretion of some of these products. This reduces hyper cholesterolaemia in experimental animals and in man although the excess fat is removed from the circulation. It also regulates the blood pressure (Ramanathan, 1968).

Covey et al (1978) and Kritchevsky et al (1976) reported that observation on American green monkeys maintained on sunflower oil diets. The results show that serum cholesterol reduction is about 80mg/100ml after few months.

Ross (1978) Olson and his Associates (1978) state dietary sunflower oil reduces serum cholesterol more than other dietary fats.

Adding plant sterol in the diet prevents the hypercholesterol (Pollack, 1953 and Ketametal, 1970). It is generally held that phytosterol, interfere with the absorption of cholesterol, as a result of competition among these sterols in the absorption process either in the intestinal lumen or at intracellularate of esterifi-

eation (Treadwell et al. 1965). The supplementation of diet in human subjects with plant sterols is a significant decrease in plasma cholesterol had resulted in a proposal to use sterol as a therapeutic agent (Hofmann et al. 1962).

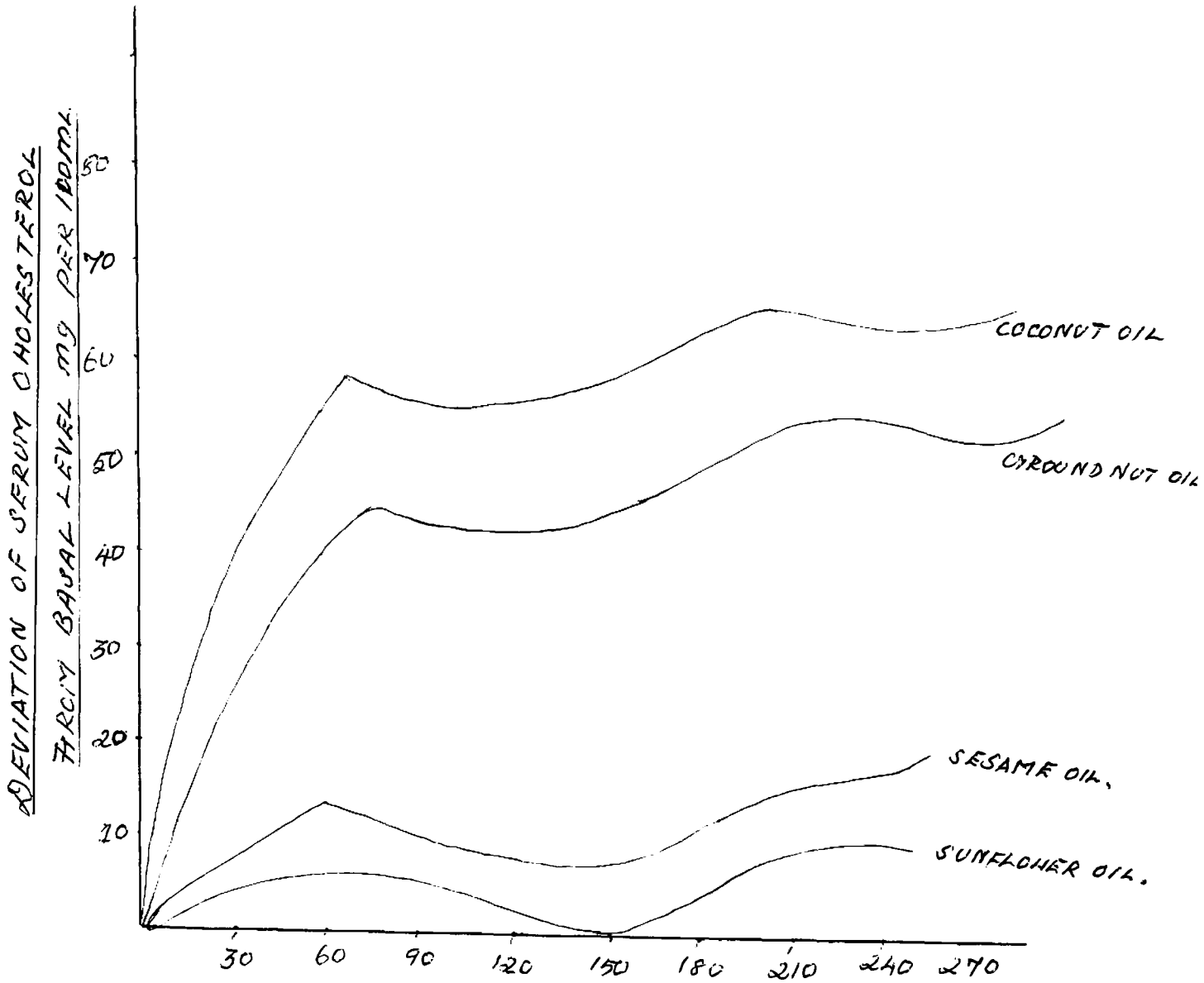
Thirty grams of sunflower oil was fed to normal healthy adult women for a period of six months. The serum cholesterol was gradually decreased from the second week as 4.9 mgm./100ml per week (Premakumari, et al.1976).

A long term study was carried out by using various vegetable fats. Four commonly used fats were used, two of them were saturated as cocconut oil and groundnut oil and two were unsaturated as sesame oil and sunflower oil. Serum cholesterol levels were followed over a period of one year and the results were, saturated fat produced a sharp and marked increased in serum cholesterol, unsaturated fats depressed serum cholesterol and keep it low (Gopalan, Srikantia and Ramanathan, 1960), and is shown in Figure .

According to Gopalan et al (1962) the mode of taking meals whether as frequent small feeds or two or three meals a day can substancially alter the serum cholesterol responsed to high fat intake. The result of two groups of monkeys

EFFECT OF VARIOUS TYPES OF DIFFERENT FATS ON SERUM CHOLESTEROL IN MONKEYS.

[40 PER CENT CALORIES SUPPLIED BY OILS].



were studied. One group was fed with saturated with coconut oil another with a highly unsaturated fat sunflower oil. Half of the animals received fat in their entire days food as a single feed (by stomach tube) while the other half received the day diet by two divided doses. The rise in cholesterol was much higher when fat was fed in one meal. While the reduction in cholesterol was more when unsaturated fat fed in one meal.

Studies were under-taken to determine the minimum level of polyunsaturated fat needed to counteract the hypercholesterolaemic effect of saturated fats. A saturated fat was fortified to different extends with different levels of linoleic acid insunflower oil. The results of these diets show that the increase in linoleic acid content reduces the cholesterol more. So type of fat and the amount of fat consumed are important factors in determining serum cholesterol level (Jagannathan, 1962).

Chemical changes occurring in sunflower oil and gingelly oil were compared. The results indicate that sunflower oil is a very good edible oil does not undergo undesirable physical and chemical changes on cooking and storing. Further it is cheaper compared to other oils. In view of these observations the Indian Council of

Agricultural Research is justified in promoting sunflower oil seeds (Giri and Dorothy, 1976).

TAMILNADU AGRO INDUSTRIES (1983) COMPARED SUNFLOWER OIL TO OTHER OILS

It is Tabulated Below:-

Oil/Fat	Saturated acid	Unsaturated Fatty Acid	Poly Unsaturated Fatty Acid Cholesterol Preventive Matter
Sunflower oil	7.80	34.00	58.50
Cotton Seed Oil	21.70	35.80	42.50
Gingelly Oil	13.60	47.40	39.00
Groundnut oil	17.40	61.20	21.40
Palmolein Oil	47.50	43.00	8.50
Ghee	61.50	34.20	4.30
Vanaspathi	61.30	28.35	5.05
Coconut Oil	91.70	5.67	2.70

III METHODOLOGY

The methodology followed for the present study consists of the following headings:

A. Selection of the subjects

B. Conducting the survey

C. Conducting the feeding trial

D. Diet counselling and follow up

E. Analysis of the blood samples

A. Selection of the Subjects:

Four hospitals in Coimbatore city namely K.S.I. Hospital, Kuppuswamy Naidu Hospital, General Hospital and Ellen Hospital were selected for conducting the study. The subjects selected were all hypercholesterolaemic individuals. Hypercholesterol is a condition where serum cholesterol is above 180mg/100ml (Srinivasan, 1962). Increased levels of cholesterol is more prone to atherosclerosis. Depending on the availability, 18 subjects were selected, in the age group of 35-60 years both male and female for the study. All the selected patients were out patients. The subjects were divided into two comparable groups as experimental and control group. Thirteen subjects were in experimental group and 5 were in control group.

B. Conducting the Survey:

For this particular study the investigator selected the direct personal interview method. Although there are many methods available for collecting information the direct personal interview method was selected because response is more encouraging as most of the people are willing to supply information when approached personally. A questionnaire was prepared to elicit information regarding the age, occupation, education, income level, cholesterol level and dietary pattern and is given in the Appendix I.

C. Conducting the Feeding Trial:

The 15 subjects of experimental group were advised to take foods prepared using sunflower oil for a period of two months. Each subject was asked to take 50g. of sunflower oil per day. Care was taken to see that the total calories of the subject did not exceed the Recommended Daily Allowances of ICMR 1977. They were strictly advised not to take cholesterol rich foods like egg yolk, meat and dairy fats. The control group consumed foods cooked in other cooking oils like groundnut oil, gingelly oil, and coconut oil except sunflower oil. Along with the normal diet they took the medicines such as perritrate, adalphene and clofibrate prescribed by the physician.

D. Diet Counselling and Follow-up:

Nutrition education was imparted to the subjects according to their convenience. Diet counselling was given once in a week. The investigator has also visited the patients to know whether the selected patients were following the diet.

E. Analysis of the Blood Samples:

The initial blood cholesterol of all subjects were determined. As the feeding proceeded, blood samples were collected from all the subjects for two time at an interval of one month in the two months study period. 5ml of venous blood was collected by trained technician and the serum was analysed for serum cholesterol content by Zak's method and is given in the Appendix II. The results of experimental and control group are discussed under Results and Discussion chapter.

IV RESULTS AND DISCUSSION

The data obtained in this research study are discussed under the following headings:

A. Background information of the selected patients.

B. Dietary pattern of selected patients

C. Initial and Final cholesterol level of experimental group and control group

D. Comparison of cholesterol level of experimental and control group

E. Diet counselling.

A. Background information of the selected patients:

The information collected from the questionnaire were the age, sex, weight, educational status, occupation, income, food habits and cholesterol level of the selected patients.

The study included both the sex with a range of age between 40-60 years. The age and sex of the selected patients were given in the following Table I.

TABLE I

DISTRIBUTION OF PATIENTS ACCORDING TO AGE AND SEX

Age in years	Number of Patients		Total Number of patients
	Male	Female	
40-45	5	1	6
45-50	2	2	4
50-55	1	2	3
55-60	3	2	5
Total	11	7	18

The above table shows that six of the patients fall in the age group of 40-45 years includes five men and one women. Among the selected patients peak evidence of disease remains in the age of 5 40-45 years. Next affected is 55-60 followed by 45-55 years.

The weight measurements of the patients were taken and given in Table II.

TABLE II

NUMBER OF PATIENTS ACCORDING TO THEIR WEIGHT

Weight in Kg.	Number of patients
40-50	1
50-60	5
60-70	6
70-80	6
Total :	18

Table II shows the link between weight of the patients and coronary heart disease. Obesity contribute a risk through promoting hyperlipidaemia and hypertension. Mean cholesterol rise with increasing body weight.

Among selected patients, 12 of the patients fall in the weight range of 60-80 kg. and 6 were in the weight range of 40-60 kg. body weight.

Regarding the education level of the selected patients only three patients had college education, five had higher secondary education, four had elementary school education and rest of the six patients were illiterate.

An important risk factors for cardiovascular disorder is sedentary living. Out of 18 selected patients seven male and four female were sedentary workers and five male and two female were moderate workers. It is listed in the following Table III.

TABLE III

DISTRIBUTION OF PATIENTS ACCORDING TO WORK PATTERN

Sedentary		Moderate		Total
Male	Female	Male	Female	
3	-	1	1	5
1	1	3	-	5
-	1	1	1	3
3	2	-	-	5
7	4	5	2	18

Among the selected male patients 9 were mill workers and four were businessmen. Out of five women patients four were house-wives and only one woman was mill worker. It is clear that the incidence of coronary

heart disease in sedentary patients are more than moderate because of lack of exercise, intake of more calories and mental stress.

Out of 18 patients, seven of them were high income group earning Rs.1000-2000 and rest 11 were from middle income group. The socio-economic status is an important factor that influence the chances of developing cardio-vascular disease.

Another finding was that 10 of the patients were smokers. Out of that six were heavy smokers and four were medium smokers. Nine patients were non smokers. Cigarette smoking increases the risk of serious adverse effects in elevated serum cholesterol.

As regard to alcoholism it was evident that nine of the patients addicted to alcohol. Out of them four were occational drinkers and five were regular drinker. Alcoholism is counted as a risk factor for heart disease.

The range of serum cholesterol was found to be 225-325mg. and shown in Table IV.

TABLE IV

INITIAL SERUM CHOLESTEROL LEVEL OF SELECTED PATIENTS

Cholesterol level mg/100ml	Number of Patients		Total
	Male	Female	
225-250	2	5	7
250-275	4	1	5
275-300	3	2	5
300-325	1	-	1
Total	10	8	18

From the Table IV it is clear that seven of the selected patients were fall in the range of 225-250mg. serum cholesterol level includes two male and five female. 10 patients fall in the range of 250-300mg serum cholesterol only one patient in the range 300-325mg. It can be shown in Figure I.

B. Dietary pattern of selected patients:

To find out the past history of the patients a three day recall method was used. The average daily calorie intake of the selected patients were given in Table V.

FIGURE - I

INITIAL SERUM CHOLESTEROL LEVELS OF THE SELECTED SUBJECTS.

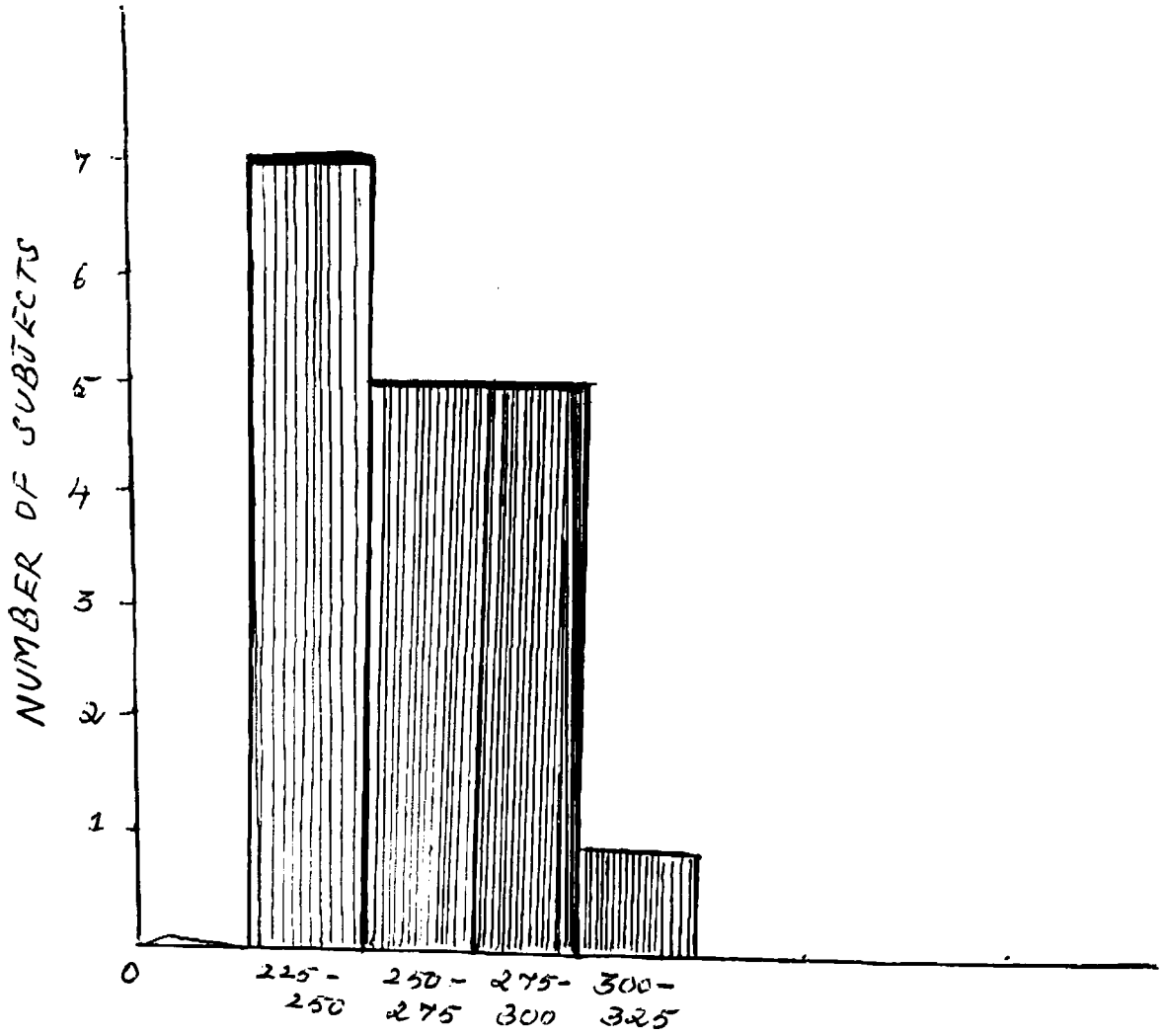


TABLE V

MEAN CALORIC INTAKE PER DAY BY THE SELECTED PATIENTS

Number of Patients	Calorie intake per day Kcal	Recommended Daily Allowances Kcal
1	2653	2800
2	2564	2400
3	2655	2800
4	2623	2400
5	2356	2200
6	2638	2400
7	2436	2200
8	1752	1900
9	2395	2200
10	2644	2800
11	3123	2800
12	2061	2400
13	2815	2200

Out of 13 patients seven of the patients calorie intake was above 2600-3000 calories and the remaining five patients had 2400-2600 calories and one patient was taking 1800 calories. About 200-300 excess calories was

taken by the nine patients out of 13 patients. The calorie intake of four patients were adequate and meet the Recommended Daily Allowances.

Nutrition is one of the most important factor in any disease condition. When the nutritional aspects of the patients taken in to consideration out of 18 patients 13 were non vegetarian which include eight male and five female and five were vegetarian includes four male and one female.

The quality and quantity of fat taken is another important factor. It was found from the selected patients that seven were using groundnut oil six were using sunflower oil which is rich in polyunsaturated fatty acid three were using coconut oil and two were using sesame oil.

C. Initial and final cholesterol level of experimental control groups:

After administering sunflower oil for two months the initial and final serum cholesterol were recorded and tabulated in Table VI.

TABLE VI

INITIAL AND FINAL SERUM CHOLESTEROL LEVEL OF THE EXPERIMENTAL GROUP mg/100ml.

Subjects	Initial Cholesterol Level	Final Cholesterol Level		Difference in Cholesterol		Total Cholesterol level reduction mg/100ml
		After One Month	After Two Month	After One Month	After Two Month	
1	320	302	287	18	15	33
2	247	241	239	8	12	20
3	297	288	281	9	7	16
4	263	248	230	15	18	33
5	282	275	269	7	6	13
6	249	241	235	8	6	14
7	257	246	236	11	9	20
8	257	243	230	14	13	27
9	242	235	228	7	8	15
10	297	280	260	17	20	37
11	242	237	227	8	7	15
12	285	270	252	15	18	33
13	249	240	231	9	9	18

From the above table VI it is clear that all final values were lowered when compared with the initial levels. The maximum difference between initial and final level of cholesterol was 37mg/100ml. In five patients there was a reduction between 32-36mg. which shows that the patients have followed the diet strictly, and in six patients reduction was 16-20mg. In three patients the reduction was only 12-14mg. of cholesterol. The reason may be that the diet had not been followed carefully or it may be due to unavailability of sunflower oil or may be due to lack of financial availability to purchase that. But what ever the case may be the efforts had been taken to consume the prescribed oil and to bring down the cholesterol level. Initial and final serum cholesterol levels after one month and after two months were analysed statistically reduction in serum cholesterol after the administration of sunflower oil was found to be statistically significant at 5 per cent level. It is shown in Appendix III(a) and III(b) and also in Figure II.

The five patients in the selected control group were following the normal diet and prescribed drugs. Except sunflower oil they were using oils such as groundnut oil, gingelly oil, coconut oil and G.K. oil. The changes in cholesterol level in control group is indicated in Table VI.

COMPARITION OF INITIAL AND FINAL SERUM CHOLESTEROL LEVELS

IN EXPERIMENTAL GROUP AFTER ONE MONTH AND TWO MONTHS.

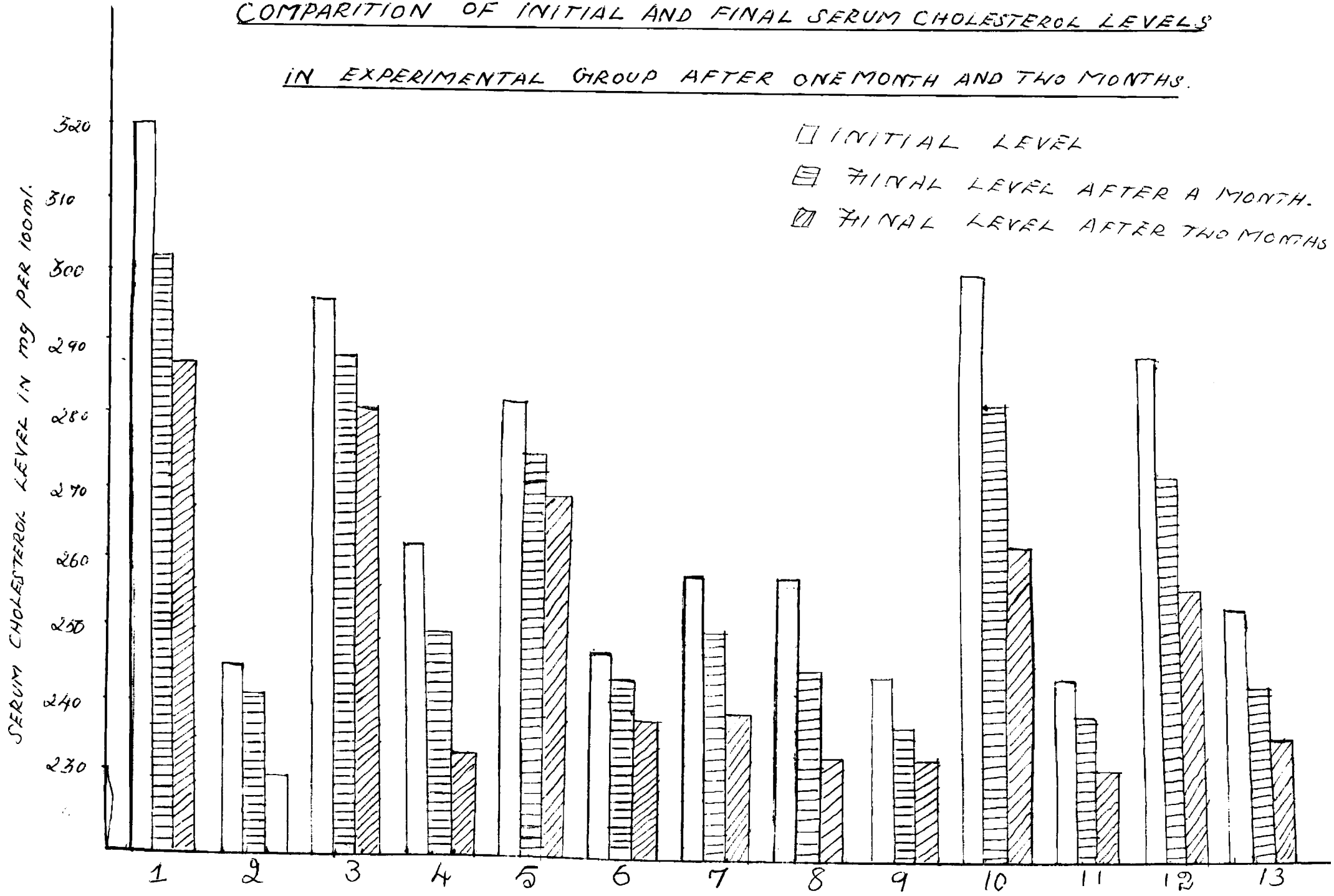


TABLE VII

INITIAL SERUM CHOLESTEROL LEVEL OF THE CONTROL GROUP (mg./100ml)

Subjects	Serum Cholesterol Level		Difference in Serum Cholesterol Level
	Initial	Final	
1	292	291	1
2	254	257	3
3	237	233	4
4	242	238	4
5	252	241	5

The above table shows that the initial serum cholesterol level in the control group ranges from 237-292mg/100ml. and the final level ranges from 233-291mg./100ml. So it is clear from the result that there is no significant difference between the initial and final cholesterol level after the two months period.

The results of the control group were analysed statistically and the calculated value of 't' test is significant at 5 per cent level It is given in Appendix III(e)

D. Comparison of Cholesterol Level of Experimental and Control Groups:

When compared with the experiment group the reduction was much lesser in the control group ranging from 1 to 5mg.

The maximum reduction of cholesterol level in the experiment group after two months was found to be 32-37 mg/100ml. All the patients in the experimental group showed a minimum reduction of 9mg./100ml which is higher than the control group.

The difference between experimental and control group was due to polyunsaturated fatty acids which are present in sunflower oil reduces the cholesterol. Saturated oils present in other oils act in the opposite direction.

The investigator has justified that sunflower oil reduces the cholesterol level and it is good for coronary heart disease patients with hypercholesterol.

E. Diet Counselling:

During the course of the experiment the investigator gave dietary counselling to the subjects. They were advised to restrict the intake of calories and dietary cholesterol by eliminating cholesterol rich food such as egg yolk, dairy fats and organ meat.

The investigator also visited the homes during the experimental period and found that the patients followed the prescribed diet.

Out of 13 patients in the experimental group five of them consumed sunflower oil before the study. But they were ignorant about the effectiveness of sunflower oil. After diet counselling, all were aware of the role and important of the sunflower oil. This is clear from the reduction of cholesterol level in the experimental group.

V SUMMARY AND CONCLUSION

The study was carried out to evaluate the effect of sunflower oil on the serum cholesterol in hypercholesterolaemia patients.

Eighteen patients were selected for the study with hypercholesterol from four different hospitals in Coimbatore city. Questionniare was prepared to elicit information regarding the age, occupation, education, income level, cholesterol level and dietary pattern. The patients were divided into two comparable groups as experimental group and control group. Thirteen patients were in the experimental group and five were in the control group. The 13 patients of experimentalgroup were advised to take foods prepared using sunflower oilfor a period of two months. Each subject was advised to take 50g. of sunflower oil per day. Care was taken to see that the total calories of the subject did not exceed the Recommended Daily Allowance of the ICMR 1979. The control group consumed foods cooked in other cooking oils like groundnut oil, gingelly oil, and cocconut oil except sunflower oil. Along with the normal diet they took the medicines such as perritrate, adalphane and clofibrate prescribed by the physician.

The initial blood cholesterol of all subjects were determined. As the feeding proceeded, blood samples were collected from all the subjects for two times at an interval of one month in the two months study period.

In the experimental group all the final values were lower when compared with the control group. The maximum difference between initial and final level of cholesterol was 37mg/100ml. In five patients there was a reduction between 32-36mg/100ml. which shows that the patients have followed the diet strictly, and in six patients reduction was 16-20mg. In three patients the reduction was only 12-14mg. of cholesterol.

When compared with the experimental group the reduction was much lesser in the control group ranging from 1 to 5mg. The maximum reduction of cholesterol level in the experimental group after two months was found to be 32-37mg./100ml. All the patients in the experimental group showed a minimum reduction of 9mg./100ml. which is higher than the control group.

The results of the study are analysed statistically and calculated value of 't' is significantly found to be greater at 5 per cent level.

Thus, saturated fats should be avoided and only unsaturated fats should be included for cooking as these fats have a hypocholesterolaemic effect.

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APPENDICES

APPENDIX I

INTERVIEW SCHEDULE TO ELICIT INFOMATION REGARDING THE DIETARY PATTERN OF HYPERCHOLESTEROLAEMIC PATIENTS

Name of the Investigator: Date:

1. a. Name:

   b. Age: c. Height: d. Weight:

   e. Address:

   f. Occupation & Income:

   g. Education Status:

2. Vegetarian or Non-Vegetarian

3. Initial Chol. Level

4. Physician Name and Address

5. Are you using oral drugs?

   Yes / No

   If yes, name of the drug.

6. What is your dietary pattern:

Day	B. Fast	Lunch	Tea	Dinner
First				
Second				
Third				

7. Who prepares your meals?

   For how many persons meals are prepared?

8. Do you use any of the following:-

   Ground nut oil ☐ Sun Flower Oil ☐

   Coconut oil ☐ Gingely oil ☐

9. Do you drink alcoholic beverages (Wine, beer, whiskey)

   Never ☐

   Occationally(describe) ☐

   Regularly (describe) ☐

10. Do you have the hapit of smoking?

   Heavy ☐

   Medium ☐

11. a. What kind of work do you do?

   b. What are working hours?

   Hrs/Day ☐ Hours/week ☐

12. What are usual leisure time activities?

   Week ends ☐ Holidays ☐ Vocation ☐

13. Name any food that you cannot eat (dislike, make you ill, religious rules, doctor told you not to eat etc.,)

14. Do you know the importance of unsaturated oils?

Yes ☐ No ☐

15. Has the doctor ever told you to follow a diet?

Yes ☐ No ☐

If yes, describe.

16. Are you still on this diet?

Yes ☐ No ☐

17. Any other persons in your family is suffering from this disease?

Yes ☐ No ☐

Signature of the Investigator

APPENDIX II

ESTIMATION OF CHOLESTEROL BY ZAK'S METHOD

Aim:

To estimate the amount of cholesterol present in the Serum.

Principle:

Cholesterol reacts with ferric chloride in the presence of concentrated sulphuric acid to give a pink colour. The intensity of colour developed is directly proportional to the amount of cholesterol present and read it at 540 millimicrons.

Reagents:

1. **Stock Ferric Chloride reagent:**

   40mg. of pure dry ferric chloride was weighed and dissolved in glacial acetic acid and made up to 100ml. in a standard flask.

2. **Ferric chloride precipitating reagent:**

   10 ml of the stock ferric chloride reagent is placed in a 100ml standard flask and made up to 100ml.

3. **Ferric chloride reagent:**

   8.5 ml of the stock ferric chloride is diluted to 100ml with pure glacial acetic acid in a 100ml standard flask.

4. **Standard cholesterol solution:**

   100g. of pure substance was placed in a clean dry 10ml. standard flask and dissolved in glacial acetic acid.

Then made up to the mark with pure glacial acetic acid.

5. Working standard:

100ml of the stock standard was placed in 100ml standard flask containing 0.25ml. of ferric chloride reagent and made upto the mark containing 100mg. of cholesterol.

Procedure:

0.5ml to 2.5ml. of the working standard cholesterol solution was pipetted out in to a clean dry test tube. The total volume at each tube was made up to 5ml. with ferric chloride diluting reagent.

The 0.1ml. of serum added 4.9ml of ferric chloride precipitating reagent, mixed well. Allowed to stand for a while and centrifuged. Transferred 2.5ml of a clear supernatent into a dry test tube and added 2.5ml of ferric chloride diluting reagent, mixed well. The test tubes were kept in cold water and to each tubes were added 4ml. of concentrated sulphuric acid drop by drop. The solution was mixed well. The tubes were allowed to cool to room temperature. A control was also simultaneously prepared by taking 5ml. of the diluting reagent and 4ml. of concentrated sulphuric acid after 30 minutes the intensity of the colour developed was read at 540 millimicrons using control blank.

APPENDIX III(a)

NULL HYPOTHESIS: PROVISION OF SUNFLOWER OIL HAS NO EFFECT ON SERUM CHOLESTEROL AFTER ONE MONTH

Subjects	Initial Cholesterol Level mg/100ml.	Final Cholesterol Level after one month mg/100ml.	Reduction in cholesterol level mg/100ml. d	d^2
1	320	302	18	324
2	247	241	6	64
3	297	288	9	81
4	263	248	15	225
5	282	275	7	49
6	249	241	8	64
7	257	246	11	121
8	257	243	14	196
9	242	235	7	49
10	297	280	17	289
11	242	237	8	64
12	285	270	15	225
13	249	240	9	81

$\Sigma d = 146 \quad \Sigma d^2 = 1832$

$$\bar{d} = \frac{\Sigma d}{n}$$

$$= \frac{146}{13}$$

$$= 11.23$$

$$S = \sqrt{\frac{\Sigma d^2 - (\bar{d})^2 \times n}{n-1}}$$

$$= \sqrt{\frac{1832 - (11.23)^2 \times 13}{12}}$$

$$= \sqrt{\frac{1832 - 123 \times 13}{12}}$$

$$= \sqrt{\frac{1832 - 1638}{12}}$$

$$= \sqrt{\frac{194}{12}}$$

$$= \sqrt{16.16}$$

$$= 4$$

$$\text{'t'} = \frac{\bar{d}\sqrt{n}}{S}$$

$$= \frac{11.23 \times \sqrt{13}}{4}$$

$$= \frac{11.23 \times 3.6}{4}$$

$$= \frac{40.4}{4}$$

$$= 10.1$$

Since the value of 't' at 5 per cent is 10.1 which exceeds the table value 't' at 5 per cent level is 2.179. So we reject Null Hypothesis and accept the Hypothesis that sunflower oil has significant effect on reducing serum cholesterol.

APPENDIX III(b)

NULL HYPOTHESIS: PROVISION OF SUNFLOWER OIL HAS NO EFFECT ON SERUM CHOLESTEROL AFTER TWO MONTHS

Subject	Cholesterol level after one month mg/100ml.	Cholesterol level after two months mg/100ml	Reduction in cholesterol level d	d^2
1	302	287	15	225
2	241	229	12	144
3	288	281	7	49
4	248	230	18	324
5	275	269	6	36
6	241	235	6	36
7	246	235	9	81
8	243	230	13	169
9	235	223	8	64
10	280	260	20	400
11	237	227	7	49
12	270	252	18	324
13	240	231	9	81

$\Sigma d = 148$ $\Sigma d^2 = 1882$

$$\bar{d} = \frac{\Sigma d}{n}$$

$$\bar{d} = \frac{148}{13}$$

$$= 11.38$$

$$S = \sqrt{\frac{\Sigma d^2 - (\bar{d})^2 \times n}{n - 1}}$$

$$= \sqrt{\frac{1882 - (11.38)^2 \times 13}{12}}$$

$$= \sqrt{\frac{1882 - 129.5 \times 13}{12}}$$

$$= \sqrt{\frac{199}{12}}$$

$$= \sqrt{16.58}$$

$$= 4.07$$

$$t = \frac{\bar{d}\sqrt{n}}{S}$$

$$= \frac{11.38 \times \sqrt{13}}{4.07}$$

$$= \frac{11.38 \times 3.6}{4.07}$$

$$= \frac{40.96}{4.07}$$

$$= 10.06$$

Since the table value 't' at 5 per cent is 10.06 which exceeds the table value 't' at 5 per cent level is 2.179. So we reject null hypothesis that sunflower oil has significant effect on reducing serum cholesterol.

APPENDIX III(e)

NULL HYPOTHESIS: PROVISION OF OTHER VEGETABLE OILS HAVE NO EFFECT ON SERUM CHOLESTEROL

Subject	Cholesterol Level mg/100ml		Reduction in Cholesterol level d	d^2
	Initial	Final		
1	292	291	1	1
2	254	257	3	9
3	237	233	4	16
4	242	238	4	16
5	252	247	5	25

$\Sigma d = 17 \quad \Sigma d^2 = 67$

$$\bar{d} = \frac{\Sigma d}{n}$$

$$= \frac{17}{5}$$

$$= 3.4$$

$$s = \sqrt{\frac{\Sigma d^2 - (\bar{d})^2 \times n}{n-1}}$$

$$= \sqrt{\frac{67 - (3.4)^2 \times 5}{4}}$$

$$= \sqrt{\frac{97 - 11.56 \times 5}{4}}$$

$$= \sqrt{\frac{97 - 57.8}{4}}$$

$$= \sqrt{\frac{9.2}{4}}$$

$$= \sqrt{2.3}$$

$$= 1.5$$

$$\text{'t'} = \frac{\bar{d}\sqrt{n}}{S}$$

$$= \frac{3.4 \times \sqrt{5}}{1.5}$$

$$= \frac{3.4 \times 2.23}{1.5}$$

$$= \frac{7.58}{1.5}$$

$$= 5.05$$

Since the value of 't' at 5 per cent is 5.05 which exceeds the table value at 5 per cent level is 4.604 So we reject null hypothesis and accept the hypothesis that other vegetable oils have effect on serum cholesterol.