IJFANS
International Journal of Food And Nutritional Sciences

Volume 3, Issue 4, Jul-Sep 2014, www.ijfans.com e-ISSN: 2320-7876

# INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

## IMPACT FACTOR ~ 1.021

Official Journal of IIFANS

INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES

*e-ISSN* 2320 –7876 *www.ijfans.com*
Vol.3, Iss.4, Jul-Sep 2014


*Research Paper* *Open Access*

# CHOLESTEROL – LOWERING EFFECT OF OAT FLOUR SUPPLEMENTATIONON LIPID PROFILE OF MILD HYPERLIPIDEMIC MALE SUBJECTS

**Vani Bansal, HarjotKaur Mann*, RajbirSachdeva and Anita Kochhar**
Department of Food and Nutrition, College of Home Science,Punjab AgriculturalUniversity, Ludhiana

*Corresponding author: harjotkaurmann@gmail.com

**Received on: 28th July 2014** **Accepted on: 27th September 2014**

## ABSTRACT

Sixty at risk of coronary heart disease male subjects in the age group of 40-50yrs were selected. The subjects were equally divided into three groups i.e. E1, E2 and C group, respectively. Subjects of the E1 and E2 groups were provided oat flour to supplement the wheat flour in the ratio of 1:4 and 1:3, respectively, for a period of 2 months, while C group was not given any form of supplementation. A significant ($p \leq 0.05$) decrease in energy intake and protein intake increased significantly ($p \leq 0.05$) in E2 group. Total fat intake decreased significantly in E1 ($p \leq 0.05$) and E2 ($p \leq 0.01$) groups. Blood pressure and blood lipid profile of all the subjects were recorded before and after the supplementation period. A significant ($p \leq 0.01$) reduction in systolic and diastolic BP was reported in the E1 and E2 groups. A significant ($p \leq 0.01$) reduction in TC and TG was reported in E1 and E2 groups and a significant ($p \leq 0.01$) increase in HDL-C was reported in E2 group. Further, a significant decrease in LDL-C and VLDL-C levels was reported in E1 ($p \leq 0.05$) and E2 groups. It is concluded that better results in blood pressure and blood lipid profile were obtained in E2 group, followed by E1 group. It could be due to the presence of soluble fibre i.e. β-glucan, gamma linolenic acid and antioxidants present in oats, which is responsible for reduction in LDL-C and lowers total cholesterol, thus exhibiting a cardio-protective mechanism. It is thus suggested that oat flour supplementation in the ratio of 1:3 can be a panacea in counteracting the problems of heart patients.

**Keywords:** Blood lipid profile,Blood pressure,Coronary heart disease, Oat flour, supplementation.

## INTRODUCTION

Coronary Heart Disease is one of the major causes of mortality and morbidity in population of both developed as well as developing countries and is the number one killer in the world. It has been estimated that by the year 2010, India will carry 60 percent of the world's heart disease burden, nearly four times, more than its share of the global population (Powel 2009). With 100 million people affected by heart related diseases, India is set to be the heart disease capital of the world by 2010 (Kapoor 2008). In India heart attack ranks second in the ten selected diseases which are responsible for deaths and it is reported that in every minute, five people die of heart attack in India(Khosla 2007).It is predicted that by the year 2015, almost 20 million people will die from CVD, mainly from heart diseases and stroke. These are projected to remain the single leading causes of death globally(WHO 2008).Many scientific studies have proved that soluble fibre present in the whole grain like oats have the ability to lower total cholesterol, LDL-C and improvement in the LDL:HDL ratio and thus exert a preventive role against heart diseases.(Michael *et al.*,2005).

The modern Oat (*Avena Sativa*) have been cultivated for two thousand years in various regions throughout the world. Oats contain an active compound,β-glucanis a soluble fiber, responsible for reduction in LDL and lowers total cholesterol(Duss and Nyberg 2004). Antioxidant compounds unique to oats, called Avenanthramides help to prevent free radicals from damaging LDL cholesterol, thus reducing the risk of CHD(Chen *et al.*, 2004).Oats also contain many powerful phytochemicals, Phenolics and Lignans, which is converted into enterolactone in our intestines and protects against heart disease(Slavin*et al.*, 2008).Oats is the only food that naturally contains GLA (Gamma linolenic acid), which is an essential fatty acid that fills the metabolic pipelines and allow the body to make other essential fatty acids(Sears 1995).Oat is the only cereal containing a globulin or legume-like protein, avenalins, as the major (80%) storage protein(Anonymous 2007). Oats are also one of the best sources of compounds called tocotrienols which inhibits cholesterol synthesis and thus lowers blood cholesterol (Peterson 2001).Therefore, it is suggested that oat flour supplementation could be an

excellent way to lower the risk of heart disease. Hence the present study has been undertaken to investigate the effect of oat flour supplementation on blood lipid profile of at risk coronary heart patients**.**

## MATERIALS AND METHODS

### SELECTION OF SUBJECTS

A sample of 60 male subjects free from serious complications, aged 40 – 60 yrs at risk of CHD i.e. total cholesterol levels ≥ 200 mg/dl and triglyceride levels ≥ 160 mg/dl were selected from the OPD of Punjab Agricultural University Hospital, MediCity and Sigma Hospital, Ludhiana. These subjects were equally divided into three groups i.e. E1, E2 and C respectively. The reference year for the study was 2009.

### SUPPLEMENTATION OF OAT FLOUR

Oats were procured from Department of Plant Breeding, College of Agriculture, PAU, Ludhiana. These were first processed by steaming in autoclave at 121°C for 1 hour and 30 minutes and were then dried using cabinet dryer at 35-40°C overnight to retain a moisture level of 8-10%. Dehusking was done and finally oats were milled to form oat flour. The oat flour was provided to the experimental group in zip lock bags on weekly basis, which further helped to monitor their consumption. Oat flour was given to subjects of group E1 and E2, to supplement the wheat flour in the ratio of 1:4 and 1:3 respectively, in their daily diets for making *chapattis*, for a period of 60 days, while C group was not given any supplementation. All the subjects were on medication as per their physician.

### NUTRIENT INTAKE

Dietary intake of the subjects was recorded by "24 hour recall method" for three consecutive days using standardized containers before and after the supplementation. The average nutrient intake of diets was calculated using MSU Nutriguide Computer Programme (Song *et al.*, 1992). The average raw amounts (g) of each and every item of food consumed for each subject was fed in the hardware and nutritive value of diets were recorded.

### BLOOD PRESSURE MEASUREMENT AND BIOCHEMICAL ANALYSIS

Blood pressure of all the subjects was recorded by using sphygmomanometer with the help of physician. Blood analysis of all the subjects was done for lipid profile i.e. serum total cholesterol (TC), triglycerides (TG), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C) and very low density lipoprotein cholesterol (VLDL-C) by standardized methods before and after the study period.

### STATISTICAL ANALYSIS

The data was analyzed with the help of various statistical tools such as mean, standard error of the mean (SE) and percentage. To test the significant student's 't' test was applied using Microsoft Excel Computer Programme Package on all the parameters.

## RESULTS AND DISCUSSION

### DEMOGRAPHIC INFORMATION OF THE SUBJECTS

In the present study subjects above 40 yrs were chosen as they were more prone to CHD. Table 1 depicts the average age of the subjects in E1, E2 and C groups was 47±1.15, 48±1.32 and 47±1.21 years, respectively. Further, the monthly per capita income calculated among the three groups was Rs 9101±741, Rs 12300±701 and Rs 13511±764 respectively and hence belonged to higher socio economic status. It was observed that majority of the subjects i.e. 55, 55 and 70 percent in E1, E2 and C group were involved in desk work and used to work for > 6 hours. It was further seen that 60 and 50 percent subjects of E1 and E2 group used to sometimes bring their office work at home. Thus, it was concluded that the subjects were leading a stressful life and stress is an important risk factor in causation of heart attack. Further the data revealed that majority of the subjects had a family history of hypercholesterolemia and hypertension followed by diabetes. Majority of the subjects of the three groups were not in a habit of eating out frequently.

**Table 1- Demographic Information of the subjects**

| Particulars | Group | | |
|---|---|---|---|
| | E1 (n=20) | E2 (n=20) | C (n=20) |
| **Mean Age (Mean±SE) (yrs)** | 47±1.15 | 48±1.32 | 47±1.21 |
| **Mean Monthly per capita income (Rs)** | 9101±741 | 12300±701 | 13511±764 |
| **Nature of work** | | | |
| Desk | 11(55) | 11(55) | 14(70) |
| **Carry office work sometimes at home** | - | 12(60) | 10(50) |
| **Working hours** | | | |
| >6 hrs | 7(35) | 8(40) | 9(45) |
| **Family history** | | | |
| Yes | 7(35) | 6(30) | 8(40) |
| No | 13(65) | 14(70) | 12(60) |

| | | | |
|---|---|---|---|
| **Consume alcohol** | | | |
| Yes | 11(55) | 10(50) | 8(40) |
| **Smoking** | | | |
| Smokers | 3(15) | 4(20) | 2(10) |
| ***Type of family history** | | | |
| Hypercholesterolemia | 2(10) | 3(15) | 4(20) |
| Hypertension | 3(15) | 4(20) | - |
| Diabetes | 2(10) | - | 2(10) |
| **Consumption of** | | | |
| Fried | 15(75) | 14(70) | 15(75) |
| Steamed | 17(85) | 18(90) | 17(85) |
| Baked | 4(20) | 5(25) | 3(15) |
| **Frequency of eating out** | | | |
| Once a week | 3(15) | 4(20) | 2(10) |
| Once a month | 6(30) | 4(20) | 5(25) |
| Occasionally | 7(35) | 8(40 | 9(45) |
| **Likings** | | | |
| Sweets (*ladoo, rasgulla, barfi)* | 6(30) | 7(35) | 8(40) |
| Salty (Namkeen, chips, samosa ,etc) | 11(55) | 10(50) | 10(50) |

Figures in parentheses indicate percentages
* Multiple Responses

**NUTRIENT INTAKE**

The data revealed that the initial mean daily energy intake of the subjects in E1 E2 and C group was 1880±40, 1891±34.97 and 1885±39.15 Kcal respectively (Table 2). The final mean intake was 1850±32, 1842±26.39 and 1906±30.14 Kcal in all the groups, respectively. The mean intake was slightly less than the suggested intake range of 1800-2400 Kcal(Ghafoorunissa and Krishnaswamy, 2000). There was a non significant decrease in energy intake in E1 group but a significant ($p\leq 0.05$) decrease was reported in E2 group. A highly significant ($p\leq 0.01$) increase in the energy intake was observed in C group. The decrease in energy intake in E1 and E2 group subjects was due to the presence of soluble fibre in oats that forms a gel which in turn causes the viscosity of the contents of the stomach to be increased. This gel delays stomach emptying making one feel full longer which further led to decreased consumption of other energy rich foods (IANS, 2009).Lefevre (2009) reported that a calorie restricted diet favorably reduces the risk for CVD by 29% even in healthy non obese individuals. The initial and final mean daily protein intake was 62.75± 4.2, 60.18 ± 3.57, 62.13 ± 3.51g and 65.15± 4.0, 63.6±3.35, 63.42± 3.33g respectively, in all the three groups. The intake of protein was little higher than the suggested intake of 50-60g(Ghafoorunissa and Krishnaswamy, 2000).A significant ($p\leq 0.05$) increase was reported in the mean daily intake of protein in E2 group and a non significant increase was reported in E1 and C group. The increase was reported as the subjects had increased their consumption of milk & milk products and pulses. A six week study on 164 adults showed that replacing carbohydrate rich diet with protein rich diet decreases cardiovascular risk by 21% (Patton 2005). The initial and final mean intake of carbohydrates was 265.39±4.20, 263.85± 4.86, 257.85± 5.13g and 259.39±6.20, 249.60±3.96, 255.85±5.05g respectively. The intake of carbohydrates was found to be inadequate when compared with the suggested intake range of 300-340g (Ghafoorunissa and Krishnaswamy, 2000). A significant ($p\leq 0.05$) decrease in intake of carbohydrates was reported in experimental groups and non significant decrease was reported in C group. A study by Liu (2000) suggested that a high dietary glycemic load from refined carbohydrates increases the risk of CHD. The initial and final mean daily fat intake was 64.70±4.00, 65.05±4.50, 63±4.20g and 62±3.80, 62.50± 4.65, 65.60±4.03g in all the three groups. The intake was higher than the suggested range of 40-60g (Ghafoorunissa and Krishnaswamy, 2000). Total fat intake decreased significantly in E1 ($p\leq 0.05$) and E2 ($p\leq 0.01$) groups. This was due to the changed consumption pattern from *paranthas* to *chapattis* and decrease in consumption of non- vegetarian food. A significant ($p\leq 0.05$) increase in fat intake was seen in the subjects of C group as they started consuming fried foods. The initial and final mean P:S ratio was 0.44, 0.36, 0.37 and 0.42, 0.40 and 0.35 in the three groups, respectively. The intake was less than the suggested ratio of 0.8-1 (Ghafoorunissa and Krishnaswamy, 2000).Further, a significant ($p\leq 0.05$) increase in P: S ratio was observed in E2 group and a non significant increase was observed in group C. A non significant decrease in P: S ratio was observed in group E1. Bender *et al* (2005) suggested that increasing the P: S ratio to near 1.0 would reduce the risk of coronary heart disease.

**PERCENT CONTRIBUTION OF CARBOHYDRATES, PROTEIN AND FAT TO THE TOTAL ENERGY INTAKE**

It was observed that initially carbohydrates contributed to 56.45, 55.81 and 54.70 percent of total energy intake in E1, E2 and C group, which decreased to

56.08, 54.19 and 53.69 percent after the supplementation. This was because the subjects changed their dietary habits from *parantha* to *chapatti* and also a decrease in the intake of sweet meats like *pinni* and *gur* in their regular meal.

**Table 2- Mean daily nutrient intake of the subjects (n=20 each)**

| Nutrients | Initial | Final | Difference | t- value | Recommended intake## |
|---|---|---|---|---|---|
| **Energy (Kcal)** | | | | | |
| E1 | 1880±40 | 1850±32 | -30 | 1.785NS | 1800–2400 |
| E2 | 1891±34.97 | 1842±26.39 | -48.65 | 2.23 * | |
| C | 1885±39.15 | 1906±30.14 | 20.84 | 2.96 ** | |
| **Protein** | | | | | 50 – 60 |
| E1 | 62.75±4.2 | 65.15±4.0 | 2.4 | 0.69 NS | |
| E2 | 60.18±3.57 | 63.6±3.35 | 3.42 | 2.49* | |
| C | 62.13±3.51 | 63.42±3.33 | 1.29 | 1.67 NS | |
| **Carbohydrates** | | | | | 300 – 340 |
| E1 | 265.39±4.2 | 259.39±6.2 | -6 | 2.33 * | |
| E2 | 263.85±4.86 | 249.6±3.96 | -14.25 | 2.69 * | |
| C | 257.85±5.13 | 255.85±5.05 | -2 | 1.78 NS | |
| **Fat** | | | | | 40 – 60 |
| E1 | 64.7±4.0 | 62±3.8 | -2.7 | 2.12 * | |
| E2 | 65.05±4.5 | 62.5±4.65 | -2.55 | 2.89 ** | |
| C | 63±4.2 | 65.60±4.03 | 2.6 | 2.11 * | |
| **Saturated fat** | | | | | <20 |
| E1 | 34.95±0.8 | 31.25±0.6 | -3.7 | 3.25 ** | |
| E2 | 37.95±0.65 | 32±0.52 | -5.95 | 2.96 ** | |
| C | 36±0.65 | 38±0.76 | 2 | 2.06 NS | |
| **Polyunsaturated fat** | | | | | <18.56 |
| E1 | 15±0.6 | 13±0.7 | -2 | 2.16 * | |
| E2 | 14±0.55 | 12±0.47 | -2 | 2.32 ** | |
| C | 13±0.47 | 13±0.49 | 0 | -- | |
| **P:S Ratio** | | | | | 0.8 – 1 |
| E1 | 0.44±0.0 | 0.42±0.0 | -0.02 | 1.92 NS | |
| E2 | 0.36±0.013 | 0.4±0.014 | 0.04 | 2.12 * | |
| C | 0.37±0.02 | 0.35±0.015 | 0.02 | 1.77 NS | |
| | | | | | |

# #Ghafoorunissaand Krishnaswamy (2000) ** Significant at 1% level
* Significant at 5% level NS Non Significant

Similar percentage of energy i.e. 50-60 percent from carbohydrates has been suggested by Sharma. In the present study, dietary protein contribution to the total energy intake increased from 13.35, 12.73 and 13.18 percent to 14.09, 13.81 and 13.31 percent. This increase was due to higher intake of milk & milk products and pulses among the subjects of all the three groups. Due to less intake of cereals (*parantha, pinni*etc) and non-vegetarian food, a decrease was reported in the percentage of the total fat contribution to the total energy intake. A slight decrease from 30.97 and 30.96 to 30.16 and 30.53 percent contribution by fat was reported in the E1 and E2 groups, respectively. The percentage of energy contributed by fat before and after supplementation was higher than the suggestedintake (15-20g) among all the subjects (Sharma 2004).

**BLOOD PRESSURE (BP) LEVEL**

Table 3 depicts blood pressure levels of the subjects before and after the study. The mean initial values

for Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) were 133±2.30, 134±3.25, 135±2.35 and 85±1.47, 86±1.52 and 84±1.79 respectively. After the study period, the values were 130±2.2, 129±2.99, 134±2.46 and 82±0.98, 82±0.79 and 83±0.99mmHg. The mean values of SBP and DBP were higher than the normal values given by Raghuram*et al* (1993). A significant (p≤0.0l) reduction in BP was reported in the experimental groups after oat flour supplementation. This decrease could be due to the presence of soluble fibre and Magnesium in oats. Observational studies conducted on more then 500 patients suggested that dietary and tissue gamma linolenic acid with lowered blood pressure and for each one percent increase in tissue gamma LA, mean arterial blood pressure decreased by 5mm Hg. Further magnesium present in oat flour helps in functioning of heart beat and maintenance of blood pressure (Bemelmans *et al* 2000). Keenan et al (2002) reported that 5.52 g/day β-glucan from oat cereal led to 7.5 mm Hg reduction in SBP and a 5.5 mm Hg reduction in DBP over a 6 week period.

**Table 3.Mean blood pressure of the subjects before and after the study (Mean ±SE)**

| Blood pressure (mmHg) | Before | After | Difference | t – value | Normal values++ |
|---|---|---|---|---|---|
| **Systolic** | | | | | <120 |
| E1 | 133 ± 2.30 | 130 ± 2.2 | -3 | 3.21 ** | |
| E2 | 134 ± 3.25 | 129 ± 2.99 | -5 | 3.76 ** | |
| C | 135 ± 2.35 | 134 ± 2.46 | -1 | 1.87 NS | |
| **Diastolic** | | | | | <80 |
| E1 | 85 ± 1.47 | 82 ± 0.98 | -3 | 2.97 ** | |
| E2 | 86 ± 1.52 | 82 ± 0.79 | -4 | 3.52 ** | |
| C | 84 ± 1.79 | 83 ± 0.99 | -1 | 1.86 NS | |

Figures with different superscripts in a column differ significantly

++ Raghuram *et.al* (1993) **Significant at 1%* Significant at 5% NS Non Significant

**BLOOD LIPID PROFILE**

Table 4 depicts the mean values before and after supplementation period in all the three groups were 210±7.55, 215.15±4.54, 217.45±6.64 and 192.8±7.34, 191.1±4.39, 219.9±4.39 mg/dl respectively. A highly significant (p≤0.0l) decrease was reported in E1 and E2 groups, whereas a non significant increase was reported in C group. Cholesterol lowering effects of oat flour may be due to presence of gamma linolenic acid and soluble fibre i.e. β-glucan. Viscous fibre i.e. oat β-glucan interferes with the absorption of dietary fat and cholesterol as well as enterohepatic circulation of cholesterol and bile acid which inturn exhibits a cholesterol lowering effect. The non significant decrease in control group reported could be due to the fact that the patients were on medicines. Van Horn et al (1991) found that people who consumed three grams of oat fiber a day reduced their cholesterol levels by 5-6mg/dl.

As depicted in the Table 4, the initial and final mean values of TG recorded in the three groups were 203±10.15, 202.95±9.5, 207.35±8.18 and 186.97±8.22, 184.15±7.46, 212.35±7.2mg/dl. A highly significant (p≤0.0l) decrease in the mean values of TG was reported in E1and E2 groups. On the contrary a non significant increase was reported in C group. Oat flour has gamma linolenic acid (GLA), which dissolves these fat deposits, thus preventing heart problems as it facilitated reduction in triglycerides and total cholesterol. A highly significant and positive association between triglyceridelevels and coronary heart disease risk was reported in a study (Sarwar 2006).

The initial and final mean values of HDL-C reported in the three groups were 47.8 ± 1.88, 48.05±1.35, 45.5±1.59 and 50.2±1.24, 51.55±0.87, 43.6±1.16 mg/dl respectively. A significant (p≤0.0l) and a non significant increase were reported in E1 and E2 groups. In C group, there was a non significant lowering. Increased level of HDL-C is associated with decreased risk of CVD. The increase in HDL-C in the experimental groups was probably due to presence of an essential fatty acid i.e. gamma linolenic acid in oat flour which aids in increasing HDL-C levels. It was observed that an increment of 1-mg/dl (0.026 mM) HDLC levels was associated with a significant coronary heart disease risk decrement of 2% in men and 3% in women. (Gordon *et al.,* 1989).The initial and final values of LDL-C in the three groups were 121.6±7.76, 125.06±5.23, 130.48±7.19 mg/dl and 105.22±7.20, 102.72±4.33, 133.83±4.98 mg/dl respectively. However, a non significant increase was reported in C group. The decrease was highly significant (p≤0.0l) in E1and E2 groups. This decrease in the supplemental groups was due to the intake of oat flour containing soluble fiber and antioxidants which prevents formation of LDL-C. Kendall *et al* (2004) reported that viscous fibers like oat beta-glucan, helps in lowering of mean LDL cholesterol by approximately 30%.The initial mean values of VLDL-C were 40.6±2.03, 42.64±3.79, 41.47±1.64 mg/dl and after the supplementation period, the values were 37.39±1.64, 36.83±1.49 and 42.47±1.44 mg/dl. A statistically significant decrease was observed in E1 (p≤0.05) and E2 (p≤0.0l) groups. On the contrary the levels increased in C group, though it was non significant.The initial and final TC: HDL-C ratio in all the three groups were 4.49±0.24, 4.56±0.17, 4.95±0.28 and 3.86±0.14, 3.73±0.11, 5.13±0.19, respectively. The decrease was significant in E1 (p≤0.05) and E2 (p≤0.01) groups. An increase in ratio was reported in C group but it was non significant. Further, the mean value of LDL: HDL-C before and after supplementation were 2.67± 0.23, 2.71±0.14, 3.01±0.25 and 2.12±0.15, 2 ±0.09, 3.14±0.17 in the three groups respectively. A significant decrease was reported in E1 (p≤0.05) and E2 (p≤0.01) groups, whereas a significant (p≤0.05) increase was reported in C group subjects.

The results of the present study indicated that there was a significant improvement in blood pressure and various blood lipid levels i.e. TC, TG, LDL-C and VLDL-C in both the experimental groups when compared with the control group which could be due hypolipidemic effects of oat flour supplementation due to presence of soluble fibre – β glucan, gamma linolenic acid, various antioxidants and phytochemicals which dissolves fat deposits, thus exhibiting a cardio-protective mechanism. Nazni et.al., (2012) suggested that incorporation of roasted flaxseed powder chapattis were significantly reduced serum total cholesterol, serum LDL-cholesterol, serum HDL-cholesterol and triglyceride level.

**Table 4.Lipid profile of the subjects before and after the study**

| Variable | Group | Initial | Final | Difference | t -value | Reference Standard |
|---|---|---|---|---|---|---|
| **TC (mg/dl)** | E1 | 210 ± 7.55 | 192.8±7.34 | -17.2 | 3.25 ** | <200 ++ |
| | E2 | 215.15±4.54 | 191.1±4.39 | -24.05 | 4.29 ** | |
| | C | 217.45±6.64 | 219.9±4.39 | 2.45 | 1.05 NS | |
| **TG (mg/dl)** | E1 | 203 ±10.15 | 186.97±8.22 | -16.03 | 3.11 ** | <150 ++ |
| | E2 | 202.95±9.5 | 184.15±7.46 | -18.8 | 4.27 ** | |
| | C | 207.35±8.18 | 212.35±7.2 | 5 | 2.08 NS | |
| **LDL-C (mg/dl)** | E1 | 121.6±7.76 | 105.22±7.20 | -16.38 | 2.68 * | 80-160 ++ |
| | E2 | 125.06±5.23 | 102.72±4.33 | -22.34 | 4.01 ** | |
| | C | 130.48±7.19 | 133.83±4.98 | 3.35 | 0.76 NS | |
| **HDL-C (mg/dl)** | E1 | 47.8±1.88 | 50.2±1.24 | 2.4 | 1.94 NS | 40-70 ++ |
| | E2 | 48.05±1.35 | 51.55±0.87 | 3.5 | 3.76 ** | |
| | C | 45.5±1.59 | 43.6±1.16 | -1.9 | 1.59 NS | |
| **VLDL-C (mg/dl)** | E1 | 40.6±2.03 | 37.39±1.64 | -3.21 | 2.76 * | <40 ++ |
| | E2 | 42.64±3.79 | 36.83±1.49 | -5.81 | 3.98 ** | |
| | C | 41.47±1.64 | 42.47±1.44 | 1 | 0.97 NS | |
| **TC:HDL-C (mg/dl)** | E1 | 4.49±0.24 | 3.86±0.14 | -0.63 | 2.25 * | <4.5 $ |
| | E2 | 4.56±0.17 | 3.73±0.11 | -0.83 | 4.38 ** | |
| | C | 4.95±0.28 | 5.13±0.19 | 0.18 | 0.78 NS | |
| **LDL:HDL-C** | E1 | 2.67±0.23 | 2.12±0.15 | -0.55 | 2.64 * | <3 [1] |
| | E2 | 2.71±0.14 | 2.00±0.09 | -0.71 | 4.3 ** | |
| | C | 3.01±0.25 | 3.14±0.17 | 0.13 | 2.16 * | |

Figures with different superscripts in a column differ significantly
++ Raghuram*et al* (1993) [1]Castelli*et al* (1997)
** Significant at 1% $ Anonymous (2007a)
* Significant at 5%NS Non Significant

## CONCLUSION

The perusal of the data clearly indicated that oat flour supplementation had significant effects in the improvement of blood pressure and lipid profile of the subjects which was mainly due to the presence of soluble fibre. The scrutiny of data indicated that maximum change was observed in the values of subjects in E2 group followed by E1 group. Hence, from the foregoing results, it can be inferred that oat flour supplementation in the ratio of 1:3 for two months is an effective measure to bring favorable and significant improvements in coronary heart disease patients as compared to oat flour supplementation in the ratio of 1:4 and thus helps in the retardation of secondary complications. Thus oat flour is surely a panacea for patients who are at risk of CHD.

## REFERENCES


- Anonymous 2007.www.andysmarket.com/healthfacts/oats. Php-25k-Andys Market.com - Home of Bulk Foods Direct.
- Anonymous2007a.Cholesterol. http://www.medicinenet.com/cholesterol/glossary.htm
- Bemelmans, W J, Muskiet F A and Feskens E J 2000. Association of alpha linolenic acid with risk factors for coronary heart disease.*Eur.J.Clin.Nutr*.**54**:865-871
- Bender D A 2005."P/S ratio" A Dictionary of Food and Nutrition. www.encylopedia.com/doc/1039-PSratio.html?jse=0-
- Castelli W P, Doyle J P, Gorden J, Hames C G, Hjortland M C, Kagan A and Zubel W J1997.HDL-C and other lipids in coronary heart disease.The Cooperative lipoprotein phenotyping study.*Circulation* **55**: 762-72.

- Chen C Y, Mulbury P E, Kwak H K, Collins F W, Samuel P, Blumberg J B 2004.Avenanthramides and phenolic acid from oats are bioavailable and act synergistically with vitamin C to enhance hamster and human LDL resistance to oxidation. *J Nutr* **134:** 1459-66.
- Duss R and Nyberg L 2004. Oat Soluble Fibers (β-Glucans) as a source for healthy snack and Breakfast Food. *Cereal Food World* **49:** 320-24.
- Ghafoornissa and Krishnaswami K 2000.*Diet and Heart Disease*. National Institute of Nutrition, Hyderabad
- Gordon D J, Probstfield J L, Garrison R J, Neaton J D, Castelli W P, Knoke J D, Jacobs D R, Bangdiwala S and Tyroler H A1989.High-density lipoprotein cholesterol and cardiovascular disease. Four prospective American studies. *Circulation* **79**: 8-15
- IANS2009. Moderate weight loss helps obese avoid heart disease risk blog.taragana.com/.../moderate-weight-loss-helps-obese-avoid-heart-disease-risk-3026/-
- Kapoor K 2008. Punjabi diet prone to cardiology problems.www.thaindian.com/.../ punjabi-diet-prone-to-cardiology-problems_10079696.html
- Keenan J M, Pins JJ, Frazel C, Moran A andTurnquist L 2002. Oat ingestion reduces systolic and diastolic blood pressure in patients with mild or borderline hypertension: a pilot trial *J Fam Pract* 51: 369.
- KendallC W C and JenkinsD J A 2004. A Dietary portfolio: Maximal reduction of low-density lipoprotein cholesterol with diet. *Current Atherosclerosis Reports* **6 (6)**: 492-498.
- Khosla I 2007.Heart of the problem.In body+mind, The Indian Express October 21.
- Lefevre M, Redman L, Heilbronn L, Smith J, Martin C, Rood J, Greenway F, Williamson D, Smith S and Ravussin E2009. Caloric restriction alone and with exercise improves CVD risk in healthy non-obese individuals. *Atherosclerosis*, **203**(1): 206-213
- Liu S, Willett WC, Stampfer MJ, Hu FB, Franz M, Sampson L, Hennekens CH, Manson JE 2000.A prospective study of dietary glycemic load, carbohydrate intake, and risk of coronary heart disease in US women.*Am J ClinNutr* 2000 Jun;71(6):1455-61
- Michael T, Murray N D2005.Lowering Cholesterol with Highly Viscous Dietary Fibre.www.alive.com/3045a6a2.php-33k-
- Nazni.P and Parameswari.S 2012, Fatty acid composition and hypolipidemic effect of roasted flaxseed powder, International Journal of Pharma Medicine and Biological Sciences, Vol. 1, No. 2, pp-151-158.
- Patton D 2005. More proteins, less carbs may cut heart risk – www.nutraingredients.com/.../More-proteins-less-carbs-may-cut-heart-risk
- Peterson D M 2001.*J Cereal Sci***33**(2): 115-129, Academic Press
- Powel D 2009.News: The heart disease mutation carried by 60 million. www.genengnews.com/news/bnitem.aspx?name=48319934
- Raghuram T C, Parischa S and Sharma R D 1993.*Diet and Diabetes*.National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India.
- Sarwar N, Danesh J, Eiriksdottir G, Sigurdsson G, Wareham N, Bingham S, Boekholdt S M, Khaw K T and Gudnason V 2006.Triglycerides and the Risk of Coronary Heart Disease. 10 158 Incident Cases Among 262 525 Participants in 29 Western Prospective Studies. www.circ.ahajournals.org/cgi/.../CIRCULATIONAHA.106.637793v1
- Sears B 1995.*Enter the Zone*.Reagan Books, Harper Collins pp. 119-134
- Sharma 2004.*Diet Management* pp 88.All India Institute of Medical Sciences.New Delhi
- Slavin J L 2008.Plausible mechanisms for the protectiveness of whole grains.*Am J ClinNutr***70**:459-63.
- Song, W. O., Mann, S. K., Sehgal, S., Hoerr,S., Bond, J., Singh, I., Devi, P. R., Gadaru, S. and Kakarala, M1992.*Nutriguide, Asian Indian Foods, Nutritional Analysis Computer Programme*, Michigan State University, USA.
- Van Horn L, Moag Stahlberg A, Lin K, Ballew C, Ruth K and Hughes R1991.Effects on serum lipids of adding instant oats to usual American diets.*Am J Public Health***81**: 183-188
- WHO 2008.http://www.who.int/cardiovascular_diseases/en/