THE HYPOLIPIDEMIC EFFECT
OF PECTIN AND OATS

THESIS

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By

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Pectin and oats as two sources of dietary fiber have been suggested as having a hypolipidemic effect. Ten subjects included either twenty grams of pectin or eighty grams of rolled oats daily in their self-selected diet.

A baseline for each subject was calculated from blood samples taken prior to supplementation. Fasting blood samples were also taken ten, twenty-one, and thirty-one days after beginning supplementation. All blood samples were analyzed for these values: serum cholesterol, serum triglyceride, hematocrit, hemoglobin, serum albumin, and total serum protein.

No significant changes were seen in the cholesterol, hematocrit, hemoglobin, and total protein values. A significant decrease was seen in nine triglyceride values. Albumin levels showed a significant increase in all subjects. No significant differences due to the two treatments were seen.
Preface

I would like to acknowledge and thank the administration and employees of Grapevine Memorial Hospital for their funding of and participation in this research study.
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CHAPTER I

INTRODUCTION

It has been a well-publicized suggestion that the lack of fiber in the United States diet is a major public health problem. This problem is a multi-faceted jewel, each side playing a differing role in the overall reflection of health. Fiber deficiency has been associated with diabetes, diverticular disease of the colon, varicose veins, appendicitis, cancer of the colon, obesity, and hyperlipidemia.

Fiber Defined

Fiber can affect many different diseases because like the term vitamin, "fiber" includes many materials that work in different ways. Dietary fiber includes cellulose, hemicellulose, lignin, gums and pectin.

Fiber substances are complex carbohydrates also called polysaccharides. Figure 1 shows the organization of these polysaccharides into fiber groupings. Crude fiber, water insoluble, is the organic matter left in the residue after extraction of food with acid and alkali. Dietary fiber includes other polysaccharides that are removed from the residue because of their solubility but are not available as sources of carbohydrate.
Polysaccharides

Reserve

dextrins starch Available carbohydrates

Digestable Carbohydrates

gums mucilages

algal polysaccharides

Structural

pectin substances hemicelluloses Unavailable carbohydrates dietary fiber

Crude fiber

*Not a carbohydrate but an aromatic polymer

Fig. 1--Polysaccharide Groups (21, p. 304)

The major contributors of dietary fiber are cereal foods, nuts and vegetables. Minor contributions are from processed foods in which some fibers have been added to increase desirable properties. Some examples include cellulose in ice cream to prevent crystals and in low calorie salad dressings to keep ingredients stable (8). This type of contribution is usually quite low as concentrations used in any one food product are rarely greater than 2 per cent and usually less than 1 per cent. The amount of each of the fiber substances in one food product varies. Wheat bran is rich in insoluble fiber whereas oat bran is rich in soluble fiber. The amount of fiber may vary within a variety depending on growing conditions and maturity of the plant at the time of harvest.
Values for calculating dietary fiber in the diet are currently limited. The complex compounds of dietary fiber do not allow a single procedure for measurement to be applied to all types of food. Measurements to isolate individual components of dietary fiber in a food are very time consuming and can only be used on a limited scale. The fiber value in previously published tables has consisted of crude fiber values. This type of value only accounts for approximately 50 to 90 per cent of the cellulose, 40 per cent of the lignin and 20 per cent of the hemicelluloses making these values limited in predicting intake (12). No specific formula for converting values from crude fiber to dietary fiber can be devised because crude fiber can range from $1/5$ to $1/2$ of the dietary fiber value (8, 18).

Spiller recommended a daily dietary allowance for dietary fiber suggesting that the level should be the quantity which produces a thirty-six hour transit time (12). Before a recommended daily dietary allowance can become useful more foods must be analyzed for types and amounts of dietary fiber. Since not all dietary fiber decreases transit time, that may not be a good guideline for establishing an allowance.
Various Effects of Fiber

Due to the variety of fiber substances and their properties, increasing fiber in the diet has been proposed for the following reasons: increasing fecal bulk, diluting calories available for absorption, lowering serum lipid levels, and decreasing transit time in the colon. These reasons are why so many diseases have been associated with fiber deficiency. Fiber holds water thus stools produced by a high fiber diet tend to be bulkier and softer and pass more quickly and easily through the intestines. This in turn means less strain and pressure on the bowel and blood vessels. This has produced favorable results in alleviating symptoms of diverticular disease. No conclusive evidence for a causal relationship between low intake of fiber and diverticular disease is available (23).

Colonic cancer is another disease in which decreased transit time has been suggested to play a role (23). The theory is that by diluting carcinogenic agents and decreasing the time the feces is present in the colon increased fiber decreases the risk of colonic cancer. Some experts feel that it is not so much the lack of fiber in the Western diet associated with colonic cancer but the increased consumption of animal fat and protein. This is because the evidence does not show that constipated people have more colonic cancer (8).

Cellulose and foods high in cellulose such as wheat bran increase fecal fat excretion, increase fecal bulking and
decrease transit time, but have not shown any significant ability to lower serum lipid levels except in a couple of studies (2, 3, 5, 7, 9, 10, 14, 17, 20, 22, 24). Pectin, a soluble fiber, increases fecal fat excretion also but has been shown to lower serum cholesterol (3, 4, 6, 11, 13, 22). Rolled oats, like oat bran, is rich in soluble fiber and both have been reported as having a lipid lowering effect (1, 15, 16).

Fiber is just one part of a properly balanced diet. Some people encouraged by publicity promoting an increased dietary fiber intake think they can solve their health problems by eating food to which purified cellulose has been added or by taking a "fiber" pill. This fiber, a highly purified cellulose, is not the same as the mixed dietary fiber in bran, grains, fruits and vegetables. The purified cellulose is often from wood pulp. Eating foods to which wood pulp fiber has been added while sharply curtailing foods that provide essential nutrients could have very serious effects on health.

Adding fiber to a poor diet will probably cause more problems than it solves. Large amounts of fiber can impair the body's ability to absorb certain important minerals such as iron, copper and calcium (3, 8, 19). Energy and fat absorption, including fat soluble vitamins, appears to be decreased by increased fiber intake. Decreased absorption
may not be a problem when the intake of these nutrients is sufficiently high, but may be of concern in marginal or deficient diets.

Statement of the Problem

The problem of this study was an analysis of the changes in serum cholesterol, serum triglyceride, hematocrit, hemoglobin, serum albumin and total serum protein when a fiber supplement is given for a period of thirty days. The effects for two different supplements, pectin and oats, will be analyzed.

Statement of the Purpose

The objective of this study was to determine if twenty grams of pectin or eighty grams of rolled oats would be useful in lowering blood lipid levels.

Hypotheses

To carry out the purpose of the study the following null hypotheses were tested:

1. Serum cholesterol levels will not be affected by supplementation.
2. Serum triglyceride levels will not be affected by supplementation.
3. Hemoglobin levels will not be affected by supplementation.
4. Hematocrit levels will not be affected by supplementation.

5. Serum albumin levels will not be affected by supplementation.

6. Total serum protein levels will not be affected by supplementation.

Study Population

The population from which the volunteers were drawn include employees of the Grapevine Memorial Hospital and the connecting Lancaster-Pittard Professional Association Clinic. Grapevine Memorial Hospital employed approximately 130 people and the Lancaster-Pittard Professional Association Clinic employed approximately 30 people at the time of the study.

The area from which the two facilities draw employees is a rural area on the northern edge of the Dallas-Fort Worth metroplex.

The volunteers were required to comply with the following criteria: be at least eighteen years old, not be following a special diet prescribed by a doctor, and presently not taking, or have not taken in at least one month, medication for the purpose of lowering serum cholesterol or serum triglycerides.
Methods of the Study

Twelve subjects, three male and nine female, were divided into two groups. As much as possible choice of supplement was allowed to encourage compliance with the supplementation program. Each participant provided two fasting blood samples (at least one day apart) to be averaged and used as the individual's baseline. One subject from each group had to drop due to illness.

Group one received apple pectin as a supplement. Four of the five subjects preferred to take the pectin in capsule form throughout the day due to the difficulty in blending the pectin in with food items. One subject preferred making "pectin milkshakes" in the blender. Each subject ingested twenty grams of pectin daily.

Group two received Quaker Old Fashioned Oats as a supplement. The oats were offered in several forms allowing each subject some flexibility in order to include eighty grams of oats in their daily diet. The products available were oat bread (ten grams per slice), oat muffins (ten grams per muffin), "Gates" (twenty grams per cookie) or hot cereal (twenty-five or fifty grams per bowl). Eighty grams of rolled oats provides approximately 4.5 grams of dietary fiber.

With the beginning day of supplementation as day one, fasting blood samples during supplementation were taken on day ten, day twenty-one and day thirty-one. All blood
samples were analyzed by registered lab technicians at the Grapevine Memorial Hospital Laboratory. The following lab tests were used: Pierce Cholesterol Rapid Stat Kit for total serum cholesterol; Pierce Triglyceride C-37 Rapid Stat Kit for serum triglyceride levels; Pierce STT Total Protein/Albumin Rapid Stat Kit for total serum protein and serum albumin levels; and the Coulter Model S number 14528 for hematocrit and hemoglobin values. Baseline one, baseline two, day ten and day twenty-one samples were frozen prior to analyzing.

The Pierce procedure for cholesterol utilizes the enzymes cholesterol oxidase and cholesterol esterase in conjunction with the peroxidase/phenol/4-aminoantipyrine system. The color intensity is read in a spectrophotometer at 510 nanometers.

Triglyceride evaluation using the Pierce kit uses an extraction technique in which the serum is mixed with water, sulfuric acid, isopropanol and heptane. The triglycerides are separated into the heptane layer which substances that can interfere in the subsequent color reaction do not enter. Absorbance is determined at 410 nanometers in the spectrophotometer.

The total protein measurement is performed in the Pierce kit by the biuret-type reagent which gives a lavender protein complex which is evaluated at 550 nanometers in the spectrophotometer.
The Pierce procedure for evaluating serum albumin involves dye binding methods. A yellow dyestuff, Spec Tru AB2, forms an orange complex with human serum albumin which is read at 550 nanometers in the spectrophotometer.

Each subject was given a tally sheet to record other sources of dietary fiber daily. Only eight tally sheets were returned. An average daily dietary fiber intake (besides supplement) was calculated for a randomly picked week during supplementation.

The six laboratory values were compared for per cent change between the calculated baseline and day ten, day twenty-one and day thirty-one individually and by groups. A computer run analysis of variance for repeated measures was used to analyze for significant differences between the baseline and day thirty-one for each of the laboratory values.

Significance of the Study

The study is significant in that it provides professionals with further information of the effectiveness of pectin and oats in reducing serum lipids. Information gained from this study may be used in the treatment of hyperlipidemia, with possible preventative indications for coronary heart disease.
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CHAPTER II

RELATED LITERATURE

Lipid Identification

Lipids (fats and oils) are important dietary constituents as a source of energy, fat-soluble vitamins, and essential fatty acids (linolenic, linoleic and arachidonic).

Following consumption of lipids pancreatic lipase and bile salts released in the duodenum work to break up the dietary lipids. Cholesterol, triglyceride, and free fatty acids form micelles with the bile salts which are brought into contact with the microvilli of the intestinal mucosa for absorption. The broken down components undergo a metamorphosis in the mucosal cells and the chylomicron is the final product. In this form they are transported from the mucosal cell by the lymph to the thoracic duct and empty into the subclavian veins of the vascular system. Body cells including the adipose cells and liver cells remove chylomicrons from the blood and use it to form other compounds.

Lipids function as an energy source, structural compound and as hormones.

Plasma lipids, phospholipids, cholesterol, triglycerides, and free fatty acids, are found in the blood at all times. High levels of some of these plasma lipids have been
associated with coronary heart disease.

Phospholipids comprise the largest lipid component of plasma but their clinical significance is not completely understood. One role for the phospholipids is as a detergent to increase the solubility of other lipids. Cholesterol is the second largest component with triglycerides third. The rest, less than five per cent of the total fatty acid present, are long chain free fatty acids.

The free fatty acids are released from adipose tissue and transported in the plasma bound to albumin. To make the larger insoluble lipids available for metabolism and to transport them in the blood the lipids are first complexed with various specific proteins. These combinations are called lipoproteins. There are four major groups of lipoproteins: chylomicrons, very low density lipoproteins (VLDL), low density lipoproteins (LDL), and high density lipoproteins (HDL). The lipoproteins composition is discussed below and represented in Figure 2.
The chylomicrons are synthesized in the intestinal mucosa during absorption. They contain the least amount of protein with about only 2 per cent of the lipoprotein being protein and about 98 per cent lipid. Of the lipid segment the major constituent is triglycerides, about 86 per cent, with phospholipids contributing about 8 per cent and cholesterol about 5 per cent. The chylomicron lipoproteins are rapidly cleared from circulation.
The very low density lipoproteins are predominately synthesized in the liver and are comprised of 8 to 10 per cent protein and 90 to 92 per cent lipids. The lipid portion breaks up into about 55 per cent triglycerides, about 20 per cent phospholipids and about 23 per cent cholesterol.

Low density lipoproteins are derived from the very low density lipoproteins and are approximately 25 per cent protein and 75 per cent lipid. Cholesterol is the main lipid comprising about 60 per cent of the lipid portion. Phospholipids contribute 30 per cent and triglycerides contribute 10 per cent to the lipid fraction of low density lipoproteins.

High density lipoproteins are synthesized mainly in the liver and also in the intestine. High density lipoproteins contain about equal amounts of protein and lipid. The lipid portion is approximately 42 to 51 per cent phospholipid, 32 to 40 per cent cholesterol and about 15 per cent triglyceride.

Risk Factors for Coronary Heart Disease

Arteriosclerosis is the degeneration and hardening of the walls of the arteries, capillaries, and veins due to chronic inflammation which results in fibrous tissue formation. This formation limits the blood supply to the vital organs.
Atherosclerosis is one type of arteriosclerosis, specifically involving an accumulation in the artery of plaque-like lipids which undergo calcification. Atherosclerosis of the arteries supplying the heart muscle is known as coronary heart disease (CHD).

Coronary heart disease has been associated with risk factors due to the fact that people who develop the disease, on the average, exhibit these characteristics more than those who do not develop coronary heart disease. Risk factor associations have been found for smoking, elevated serum cholesterol levels, hypertension and diabetes. Since these characteristics are associated with an increased risk of developing coronary heart disease then all else being equal, a person with this characteristic should be more likely to develop the disease than one who does not. The belief that high levels of plasma cholesterol is a risk factor for atherosclerosis has been amply confirmed. In populations in which plasma cholesterol levels are relatively high, the incidence of atherosclerotic disease is greater than in populations with low cholesterol concentrations (6). Within populations atherosclerosis occurs much more frequently in subjects whose cholesterol levels are high as compared to those with low levels of cholesterol (9).

Blood cholesterol is influenced in several manners. Dietary changes such as decreasing total fat in the diet,
decreasing saturated fats and increasing polyunsaturated fats, decreasing dietary cholesterol, or increasing certain dietary fibers have all been suggested. Hypcholesterolemic drugs can affect the level by blocking the various stages of cholesterol synthesis, by accelerating the catabolism of cholesterol or preventing reabsorption of bile acids.

Drug induced lowering of cholesterol may not be the method of choice for lowering plasma cholesterol. The World Health Organization used clofibrate to induce reduction of cholesterol. Nonfatal myocardial infarctions declined in four years but the overall mortality in the treated groups was 25 per cent greater than in the control groups (26).

One to two grams of cholesterol are synthesized daily by the average adult. The main site of cholesterol synthesis is the liver. The average daily dietary intake contributes only .3 grams of cholesterol (2).

The major route of cholesterol elimination is in excretion of bile salts and neutral sterols in the feces. A minor route is through further metabolism and elimination of inactive hormone products in the urine.

One of the biggest studies to link cholesterol with coronary heart disease was the Framingham study. In this study 5,127 people were followed for 24 years. Some considerations must be made when looking at the incidence of coronary heart disease that develops over twenty-four years in this population. Those persons who had previously
developed cardiovascular disease had little reason to enroll in a research project that was not concerned with therapeutic intervention. Similarly, those with other serious diseases saw no benefit to themselves in participating in a study of cardiovascular disease which they would not live long enough to develop (6).

The serum cholesterol levels almost all lay between 150 milligrams per cent and 400 milligrams per cent. There was no double hump, no suggestion that the distribution curve was composed of two distinctly different curves representing both a normal and a diseased population. In each of the three decades of men, total coronary heart disease increased with higher blood cholesterol levels (6).

In the youngest decade, thirty to thirty-nine years old, the relative risk in men with cholesterol levels of 260 milligrams per cent or more was over four times that of men with levels below 200 milligrams per cent. In men forty to forty-nine years old the rise was not as steep but was consistent (6).

Analysis of the twenty-four year risk in women on the basis of cholesterol level was somewhat complicated by the changing value of this characteristic with age. In both the youngest (thirty to thirty-nine years old) and oldest (fifty to fifty-nine years old) decades, no significant differences in incidence rates of coronary heart disease on the basis of
cholesterol level were observed. In the middle decade there was a relative increase.

Total serum cholesterol levels have been used most extensively in associations with coronary heart disease. Recently cholesterol has been broken up into the lipoprotein fractions contributing the cholesterol. Cholesterol associated with high density lipoprotein has been suggested as having a negative correlation with coronary heart disease (2). It has been observed that at any given level of low density lipoprotein cholesterol, the probability of coronary heart disease increases as high density lipoprotein cholesterol decreases. Low density lipoprotein is considered to be the most atherogenic of all lipoprotein fractions (9).

A proposed mechanism of the protective action of high density lipoprotein may be due to its ability to remove cholesterol from the peripheral tissues and to transport it to the liver for catabolism. It has also been suggested that the high density lipoprotein may interfere with the uptake of low density lipoprotein by the peripheral cells.

Hypertriglyceridemia also shows an association with the risk of coronary heart disease; however it is a much weaker independent risk factor than cholesterol. In studying 1,847 males Scott and his group divided the men into groups by age and risk factors present. There were two age groups in which risk is related primarily to the cholesterol level. Of the
subjects in these groups, the ones in the high risk group also had triglyceride levels contributing to the amount of risk (25).

The correlation of cholesterol levels with coronary heart disease suggests that the control of these levels may be useful in the management or prevention of the disease. Due to this correlation in Western societies it is commonly recommended that consumption of saturated fats and cholesterol be reduced to lessen serum cholesterol levels. This type of advice for the general public assumes that everyone is at equal risk with everyone else and that everyone responds within narrow limits to equal amounts of dietary cholesterol and saturated fat.

The next question to ask is if lowering plasma cholesterol will retard atherogenesis or reverse existing atherosclerotic plaques. This has not been resolved, but there are several lines of evidence which may justify attempts to lower cholesterol levels in particular patients with hypercholesterolemia. Circumstantial evidence based on population studies is great and affords considerable rationale for treatment of hypercholesterolemia. Several field tests strongly suggest that lowering plasma cholesterol will decrease clinical manifestations of atherosclerosis. These studies are criticized severely though due to experimental design. Justification for treatment of hypercholesterolemia can be derived from studies in animals. Reversal of hyper-
cholesterolemia by diet or drugs has been shown to cause regression of atheroma in pigeons, dogs and monkeys. The finding that atherosclerosis can be reversed in mamalian species is of particular interest because their lesions closely resemble those found in man (9). But more studies will be required before the value of treatment of hyper-cholesterolemia has been shown beyond a reasonable doubt.

The recent association of low levels of high density lipoprotein cholesterol and increased risk of coronary heart disease has spurred efforts to find ways of increasing high density lipoprotein levels. Exercise is one treatment receiving major attention. Increased levels of high density lipoprotein cholesterol were seen in two studies with decreased low density lipoprotein cholesterol and total serum cholesterol also reported by one of those studies (33, 22). Another study of exercise also reported a fall in low density cholesterol but did not see a change in high density cholesterol (21). However, no longitudinal follow-up studies have been done to show that the increase in physical exercise decreases the risk of having coronary heart disease concurrent with the increase in high density lipoprotein cholesterol concentration.

High hematocrit values have also been associated with the risk of coronary heart disease. In the Puerto Rico Heart Health Program an elevated hematocrit (>49 per cent) was associated with higher serum cholesterol, higher relative
weight, cigarette smoking and higher blood pressure. Elevated hematocrit was also associated with an increased risk of myocardial infarction, coronary insufficiency or coronary heart disease death. Incidence of those three was more than double in the high hematocrit group compared to the low group. The relationship remained statistically significant after adjustment for the associated risk factors listed above (28).

Review of Fiber Literature

Dietary fiber has been defined in varying ways including plant cell wall, non-nutritive residues, and plant materials that are resistant to the action of the digestive enzymes of the human small intestine. Resistance to digestion by human enzymes is not synonymous with indigestibility. Carbohydrates that escape digestion and reach the lower bowel are subject to microbial fermentation.

In 1887 crude fiber was made the official classification of fiber. This method analyzes for residue left after extraction with solvent, acid and alkali.

Trowell introduced the term "dietary fiber" because he realized that the hypotheses concerning fiber related to all the indigestible components of plant cell wall in the diet and not only those substances left by crude fiber evaluation (29). Dietary fiber is made up of structural polysaccharides
of the plant cell wall, other polysaccharides with related chemical structures and the non-carbohydrate lignin.

A lack of fiber in the diet has been associated with many "Western diseases" including heart disease because of observations between 1930 and 1965. These observations compared the incidence of Western disorders in industrialized populations and populations still unaffected by industrialization. The non-industrialized population had far less occurrences of the "Western diseases" and the most obvious difference between the two groups was the amount of dietary fiber consumed (3, 4).

Coronary heart disease and arteriosclerosis are major causes of close to one million deaths a year (19). This major cause of death is a disease affected by many factors. Some of these factors have been designated as major risk factors because their powerful contribution to the etiology of coronary heart disease has been established scientifically. They are common in the population of industrialized nations, and they are preventable or controllable. These risk factors include hypercholesterolemia, hypertension and cigarette smoking.

Cholesterol is a complex fat produced in the body as well as being derived from dietary sources. The main route for cholesterol is conversion to bile salts, which are released in the intestine to emulsify dietary fat, enabling the fat to pass through the intestinal mucosal cell.
Complexes of lipid and protein carry cholesterol in the plasma. The amount of lipid and protein vary in these complexes with those containing less lipid and more protein being more dense. These are called high density lipoproteins (HDL). Low density lipoproteins (LDL) contain more lipid. Data from nearly 7,000 men and women from five study populations indicate the persons with evidence of coronary heart disease have lower high density lipoprotein levels (19). Since high density lipoprotein contains approximately 20 per cent of serum cholesterol and low density lipoprotein contains approximately 60 per cent, an elevated total serum cholesterol shows a large amount of low density lipoproteins.

Animal studies and human studies have shown that the risk of developing coronary heart disease is related to the serum cholesterol level of the individual. The incidence of coronary heart disease increases sharply with increasing serum cholesterol (9).

Dietary modification can help reduce elevated cholesterol. A decrease in consumption of cholesterol containing foods (animal fats) and food sources high in saturated fats will lower serum lipids. Some forms of dietary fiber have also been suggested to help lower cholesterol values.

Bran, which is a good absorbent of bile acids, increases the fecal loss of bile acids and hence might be expected to lower the serum lipids by influencing the cholesterol turn-
over. However it has been reported to have no effect on serum cholesterol with intakes of up to fifty grams daily (5, 11, 14, 17, 27).

Pectin, a fermentable dietary fiber that is unlikely to retain its structure tends to form a gel. It may be that the gel may reduce the absorption of lipids in the upper intestine due to its physical state but the exact mechanism is unknown. Pectin has been reported to decrease serum cholesterol by 7 per cent to 13 per cent with daily intakes of nine to fifty grams (7, 13, 15, 16, 20, 30, 31).

The information available on oats as a fiber source suggests that it lowers serum cholesterol. In three studies reported by Anderson et al total serum cholesterol was decreased, but, more specifically, the "bad cholesterol" (low density lipoprotein) was decreased in all three, while the "good cholesterol" (high density lipoprotein) was increased, a favorable response, in two of the studies (1).

Kirby et al fed 100 grams oat bran to a group of men and after only ten days reported serum cholesterol reduced by an average of 13 per cent. Low density lipoprotein was decreased by 14 per cent, with high density lipoprotein and triglycerides unchanged (18).

Lee, O'Donnell and Hurt reported at the annual Institute of Food Technologists meeting that compared with a cellulose control diet, three oat containing diets exhibited a hypo-
cholesterolemic effect in the plasma of adult rats. The high density lipoprotein cholesterol was increased while low density lipoprotein cholesterol decreased in the rats fed the oat diet (8).
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CHAPTER III

RESULTS

Serum Cholesterol

After thirty days supplementation, seven subjects cholesterol levels decreased and three increased when compared with their calculated baselines. The changes ranged from an increase of 6.6 per cent to a decrease of 17.2 per cent. The mean change of all subjects was not significant.

There was no significant difference between the mean baselines of the two groups. There was also no significant difference between the mean changes of the groups as shown in Figure three. Neither the oats nor the pectin group had any subjects which showed a progressive change in either direction.

Using the groupings of the Framingham study (1) and calculated baselines, two pectin subjects and one oats subject were in the low cholesterol group (less than 200 milligrams per cent). All the remaining subjects were in the 200 milligrams to 259 milligrams range. No subjects were in the high cholesterol group of values higher than 260 milligrams.
Fig. 3--Mean serum cholesterol

--- Pecin group
--- Oats group
Serum Triglyceride

The serum triglyceride value was one of the two values with a significant change. The decrease between day thirty-one and the calculated baseline was very significant (P<.002). There was no significant difference as a result of the two different treatments.

No subjects showed a progressive decrease or increase. Each subject increased to a peak at either day ten or day twenty-one as shown in Figure four. At day thirty-one, nine of the ten subjects showed a decrease. The decrease ranged from a 20.2 to a 65.7 per cent decline from the calculated baseline.

The one subject who did not show a decrease showed only a 1.3 per cent increase at day ten, a 100 per cent increase at day twenty-one, and a 26.6 per cent increase at day thirty-one when the values were compared with the calculated baseline. The subject reported that during the last two weeks of supplementation was a very stressful time for her. This may be a factor in her non-response to treatment. Stress is one factor leading to higher or fluctuating free fatty acid levels. This in turn involves extra triglyceride output into the circulation. (4).
Fig. 4--Mean serum triglyceride
Hemoglobin and Hematocrit

Hemoglobin and hematocrit values are both used in detecting anemia. In a study of 13,000 children, the data indicated that they are not comparable in detecting anemia. Generally, the hemoglobin tests detect higher rates of anemia than the hematocrits. (3) Using the normal ranges given for the specific laboratory machine used, all subjects were within the normal range for hemoglobin values at their calculated baseline and day thirty-one. In the hematocrit values only one subject was below the normal range at baseline but he fell within the normal range at the other testing days.

There was no significant change for the total subjects by group as shown in Figures five and six, nor were the mean baselines significantly different for the two groups.

None of the subjects had a hematocrit value above 49 per cent. This was the value above which was considered a risk factor for coronary heart disease in the Puerto Rico Heart Health Program. (7)
Fig. 5--Mean hemoglobin
Fig. 6--Mean hematocrit

--- Pectin group

----- Oats group
Serum Albumin

The serum albumin concentration is frequently used to define nutritional status. One study reported that albumin is a valid measurement for epidemiological studies with large populations but due to its sensitivity and specificity it is a poor parameter used alone for evaluating an individual's nutritional state. (2)

Using the normal range given with this test kit, eight of the ten subjects were well within the range at baseline. The other two subjects were above the upper limit of the range. At day twenty-one the same two subjects were above the upper limit with two more subjects right at the upper limit of the range and all others more toward the middle of the range. At day thirty-one, nine of the subjects were well above the range and the other subject was at the upper limit of the normal range. This change between baseline and day thirty-one was significant (P .001). There was no significant difference in the amount of increase as a result of the two treatments as shown in Figure seven.
Fig. 7--Mean serum albumin

--- Pectin group
---- Oats group
Total Serum Protein

Total serum protein measures albumin and globulin. This measurement is more valuable when used in combination with serum albumin as some influences may cause a decrease in albumin while simultaneously increasing globulin.

Four different subjects showed the four values outside the normal range. Subjects two, three, and ten were above the normal range at day twenty-one, day thirty-one, and baseline respectively. Subject six was slightly below the normal range at day ten.

There was no significant change between baseline and day thirty-one for all subjects as shown in Figure eight. There was also no significant difference between the two group means at baseline nor any significant difference as a result of the two treatments.
Fig. 8--Mean total serum protein

---Pectin group

-----Oats group

Day

7.0

8.0

7.9

7.8

7.7

7.6

7.5

7.4

7.3

7.2

0 10 21 31
Tally Sheets

Only eight of the ten tally sheets were returned. Daily dietary fiber intake excluding the supplement was calculated using tables from southgate (8) or Jwuang (5) for a randomly chosen week during supplementation. The average daily intake of dietary fiber ranged from 2.9 grams to 8.98 grams per day. Group means were 3.4 grams for the pectin group and 5.7 grams for the oats group.

This tool is probably not very accurate. While some subjects reported measurements, most subjects wrote in the number of servings eaten with no indication of the size of servings. Other sources of dietary fiber as in processed foods were not considered in these estimates of daily dietary intakes.

Dietary fiber intake of non-vegetarians could be estimated to range from sixteen to sixty grams of total fiber using the findings of Hardinge (6). The highest dietary fiber intake in this study was 8.98, approximately half of the lowest value given above. This group of subjects appeared to ingest a low fiber diet.
CHAPTER BIBLIOGRAPHY


CHAPTER IV

CONCLUSIONS AND RECOMMENDATIONS

The group studied appeared to be representative of a population possessing normal laboratory values at the onset of this study. More effect may have been seen if the subjects were hyperlipidemic, especially hypercholesterolemic.

The results of this study allow retention of the null hypotheses for serum cholesterol, hemoglobin, hematocrit and total serum protein. The lack of response could be due to the low daily intake of dietary fiber calculated for this group. The supplement could have boosted the subjects into the average range and not raised the fiber intake enough to show an effect.

The null hypothesis was rejected for serum triglyceride, which showed a significant decrease of values. Doses of twelve, fifteen, twenty-eight, thirty-six, and forty grams of pectin have also shown this effect. (1, 2, 3, 4, 5)

The null hypothesis was also rejected for serum albumin due to a significant increase. This change in values is unexplained.

Increasing fiber consumption has many beneficial aspects. Coronary heart disease is a major disease in the United States today. Much research is conducted to find ways to decrease the incidence of this disease. One condition seen
in coronary heart disease patients, hyperlipidemia, appears to be affected by some dietary fiber. This study showed that pectin and oats were effective in lowering serum triglyceride levels. Alleviating a factor seen in many patients with coronary heart disease assumably would be effective in lowering the incidence of the disease.

Diabetic patients often have cardiovascular complications. The possibility of decreasing the risk of these complications by increasing dietary fiber and lowering serum lipid levels has beneficial implications. High fiber diets have also shown to have beneficial effects on glucose tolerance in diabetic patients.

Fiber in foods decreases the caloric density. Many carbohydrate sources are refined to remove most dietary fiber. This makes most of the products contain more calories in a smaller portion and in a form that is easier to eat thus making overconsumption of calories easy. A decreased transit time, due to increased dietary fiber, has also been suggested to decrease the opportunity for food to be broken down and absorbed. Continual overconsumption of calories without adequate exercise results in obesity.

Obesity creates health problems in itself but it is also a risk factor for coronary heart disease. Obesity has also been associated with a risk for diabetes. By increasing high fiber foods in the diet, less calories can be consumed to reach satiety and help prevent obesity.
Thus increasing fiber in the diet can help lessen the risk of coronary heart disease in the following three ways: primarily by lowering serum lipid levels, and indirectly by decreasing caloric density, and increasing transit time.

Just as an increased intake of dietary fiber has benefits, there are certain conditions in which an increased intake would not be advisable. High levels of dietary fiber in the diet reduces the absorption of certain minerals (copper, iron, and zinc) and fats (including fat-soluble vitamins). Fiber also lessens caloric intake and absorption. In cases where intake of any of these substances is marginal, increased dietary fiber would create more of a problem.

Future studies of this nature should possibly include the following additional data:

1. A larger sample group would be beneficial for statistical analysis.
2. A longer supplement time might provide more changes in other values along with information as to what the significant changes seen in the triglyceride levels and albumin levels would do.
3. Serum uric acid levels and a determination of free fatty acids included in the blood analysis would provide helpful information.
4. Blood pressure would be very easy to add to the data at each blood sampling and helpful in the examination of an increasing albumin level.
5. If an increase is seen in albumin and blood pressure, a twenty-four hour urinary output analysis would provide information helpful in understanding these changes.

6. Continued monitoring of the values after supplementation is discontinued would provide information about the lasting effects.

7. A comparison of the changes seen in a normolipidemic group and a hyperlipidemic group would be an interesting expansion of this study.
CHAPTER BIBLIOGRAPHY


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**GRAMS OF FIBER PRODUCT EATEN DAILY**

**WEIGHT (do weekly)**

**Fig. 11--Tally sheet for cereals**
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