Roles Of Proteins And Omega-3/Omega-6 Fatty Acids In Cardiovascular Nutrition

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Abstract

Cardiovascular nutrition is an extremely diverse topic in health and medicine. In the United States alone, there are an increasing number of deaths caused by nutrition-related diseases such as atherosclerosis and high blood pressure. The term "cardiovascular" pertains to the heart and the vascular system the heart uses to help transport nutrients within the body. Blood transports many molecules/compounds that are distributed throughout the body. These compounds include proteins and fatty acids along with various different types of macromolecules. These compounds can be beneficial as well as harmful to one's health, depending on whether he or she has good nutritional habits. The heart and its vessels are so vital that when a CVD (coronary vascular disease) occurs, other organs of the body may be affected as well (Haas, 2004). Most of these kinds of CVDs can actually be traced back to the bottom layer of the organismal hierarchy, which includes molecular activity.

INTRODUCTION

The best approach to CVDs is for one to take action before allowing the disease to occur. Namely, it would be prevention. Not everyone concerns themselves more about their cardiovascular health than other aspects of health (mental, social, etc.) (Cooperstein, per. commun., Feb. 2004). Initiating a proper balance of certain proteins and fatty acids in an early stage probably ensures a healthy mental and physical lifestyle. Severe consequences can occur if one does not take heed in this matter. Since the most common cause of death in the United States and the western world are heart attacks (Haas, 2004) taking advantage of healthy nutrition would be a good way to avoid fatal consequences.

This paper intends to demonstrate the role of certain molecules such as proteins, omega-3, and omega-6 fatty acids in cardiovascular (C-V) nutrition. The preliminary aspect of the paper will give a brief description of maintaining a healthy nutrition (including risk factors) as well as a brief overview of the C-V system in which many of the nutrients and macromolecules are transported. (Limiting the number of risk factors may provide many benefits, such as a longer and healthier life.) The second part of the paper will show how proteins relate to CVDs. Proteins are found everywhere in the body, including the heart and blood vessels. Investigating proteins provides a link between human nutrition and CVD. The third component of the paper will reveal the functions (and basic descriptions) of omega-3 and omega-6 fatty acids pertaining to nutrition-related CVDs. Since fat-rich food is so readily available these days, many people overlook the risks of being overweight and overly-consuming fat. Reviewing the contributions of omega-3 and omega-6 fatty acids can be useful in analyzing obesity problems that are subsequently involved in CVDs.

AN IMPRESSION OF RISK FACTORS AND THE CARDIOVASCULAR SYSTEM

A risk factor is basically an aspect of life which is generally associated with an undesirable nutrition/health-related condition. There are many nutrition-related risk factors that are associated with CVD. Age is the most important risk factor for CVD (NIA, 1994). The chance of having a heart attack and/or stroke increases sharply once someone reaches sixty-five years of age. Other primary risk factors include cigarette smoking, high cholesterol, and high blood pressure (Haas, 2004). Eating a proper diet on a regular basis is said to reduce these risk factors, not to mention the other (minor) risk factors involved. Following simple steps can definitely lower risk factors. Many doctors recommend self-monitoring and self-observation of carbohydrates, protein content, and trans-fatty acid consumption to reduce risk factors. The National Institute of Health recommends keeping a record of the food eaten during the three daily meals. After observing the record, one can evaluate whether his or her diet is or will

be leaning toward a risk factors(s). The record is based on the type of food consumed, such as: what type of milk, bread, butter, cooking oil, or salad dressing. (NIH, 1983)

Risk factors are related to socio-economic status, traditional/cultural background, religious beliefs, and overall feeling about health and nutrition (NIH et al., 1983). For example, since some developing countries have low socio-economic status and a scarcity of food, the overall fatty acid-intake per person may also be lower. Thus there may be a lower incidence of people with CVDs, since having too much fat intake does contribute to this disease.

The C-V system is a complicated highway for transporting vital materials, as mentioned earlier. This system includes tissues such as blood and major organs that serve specific functions. The heart impels blood, which happens to contain a number of lipoproteins and other macromolecules. Since CVD is such a complicated disease, it is easy to overlook the direct effects of proteins and triacylglycerides in the heart and blood vessels.

PROTEINS PLAY AN IMPORTANT ROLE IN C-V NUTRITION

One can observe that proteins serve many functions in the C-V system. Consuming foods with high protein content is probably a healthier choice for C-V nutrition "more than [consuming foods highly concentrated with] fat" (Cooperstein, per. commun., Feb. 2004). Subsequently, they are all involved with C-V nutrition in rather important ways. "...The most common form of malnutrition in humans is protein deficiency." (Campbell et al., 1999) Perhaps this is because most countries depend on plants predominantly for their diet and therefore depend mostly on plants for protein; plants regrettably have very low protein content (Campbell et al., 1999). Since proteins are essential to life, they can be found in almost all natural foods. "In order to become protein deficient [one] would need to consume only fruit, only highly processed junk foods, or simply not take enough calories daily." Eating healthy at a normal rate (three meals a day, timely meals, etc.) should be enough to supply all of the protein the body really needs. (Anonymous, 2002)

One of the most recognized protein complexes found in human blood is hemoglobin. Hemoglobin is basically a protein that contains iron and that binds oxygen. "Hemoglobin unloads its cargo in the capillaries of the systemic circuit. There the O2 diffuses into [somatic] cells." (Campbell et al., 1999) Taking vitamin C/iron supplements with food or directly after a meal can enhace the rate of hemoglobin production and iron absorption (Gilbert, 2003). Also, for oxygen to be transported in the blood properly, it must diffuse through the plasma membranes of erythrocytes, and the presence of hemoglobin aids in this process. Blood also contains fibrinogen. Fibrinogen is a protein that leads to fibrin, a protein complex that accumulates to help form blood clots. Fibrin is important for some CVDs requiring anticoagulation for treatment, and it thereby reduces the risk of excessive bleeding.

Calcium is an important nutrient/mineral of the C-V system which sometimes acts as an important partner of protein. For example, there are proteins that are specifically involved in calcium-binding. The most widely known calcium-binding protein is calsequestrin, which works alongside triadin, a basic, transmembrane protein that functions in the calcium release channel. Calsequestrin is normally the protein site of calcium storage, which gathers calcium where it (calcium) was released. (Calcium Binding, 1998) Thus calsequestrin is important for maintaining a desirable heartbeat since it is involved in calcium binding (Anonymous, 2002; Calcium Binding, 1998). Calcium is abundant in many different natural foods, and it is essential in many C-V functions such as intracellular signaling and blood clotting (Kimball, 2003). It is found in rather significant amounts in foods such as green vegetables, almonds, walnuts, and oranges. If protein and phosphorus intake is not high enough, then the calcium from plant-source food may be insufficient (Anonymous, 2002) to maintain high-quality C-V health.

Calreticulin is also a calcium-binding protein. It has been shown to promote many cellular functions, such as supporting the endoplasmic reticulum of blood and bone cells. Calreticulin can be consumed through milk and milk products, which also provide calcium. Unfortunately, the protein in dairy foods can cause calcium loss, which is not exactly most favorable. (Calcium Binding, 1998).

Sarcalumenin is another calcium-binding protein that is important in C-V nutrition. Sarcalumenin is a glycoprotein that is localized in the sarcoplasmic reticulum (hence the name). The relationship of casein kinase (an enzyme that catalyzes transfer of phosphate from ATP) with the cardiac sarcalumenin has been researched using antibodies, and it has been found to have strong links to skeletal muscle proteins as well. (Calcium Binding, 1998; Hadad et al., 1999) Therefore a higher consumption of foods containing sarcalumenin may be advisable.

"Most vitamins are coenzymes, and some have been linked

[to CVDs]" (Cooperstein, per. commun., Feb. 2004). Coenzymes attach themselves inside proteins (enzymatic) and aid them in catalyzing biological reactions. Vitamin C (ascorbic acid) is a coenzyme that functions in the synthesis of collagen, which is the fibrous protein substance of certain connective tissues. Deficiency of vitamin C can result in scurvy, in which proline is unable to hydroxylate in collagen synthesis. Sources of vitamin C include: citrus fruits, green peppers, and tomatoes. Vitamin E (tocopherol) is a coenzyme that acts as a reducing agent in blood cells, and its deficiency can cause anemia. Sources of vitamin E include: egg yolks, salad greens, and vegetable oils. The third coenzyme to be mentioned is vitamin K. This coenzyme is one of the major factors in blood clotting, and so its deficiency can lessen the rate of blood clotting. Sources of vitamin K include spinach and other leafy green vegetables. (Kimball, 2003)

Lipoproteins are important serum proteins that are highly involved in C-V nutrition. Some of them dissolve cholesterol in the blood. The two main types of lipoproteins concerned with cardiovascular nutrition are low-density lipoprotein (LDL) and high density lipoproteins (HDL). "Low density lipoproteins are the primary transporters of cholesterol in the blood" (Cardiovascular, 2002). In addition, LDL has been found to have negative effects on the C-V system. LDLs basically enhance the building of cholesterol deposits in the arteries. Both elevated LDL cholesterol and apo-B (an apolipoprotein) are high risk factors for coronary artery disease. Smaller LDL units are believed to more easily oxidized. Cholesterol needs to be oxidized in order to form plaque that actually results in atherosclerosis. HDLs on the other hand, are not as harmful; they are in fact good for the heart and blood vessels. "High density lipoproteins (HDL) contain more protein than any of the other lipoproteins and are protective against atherosclerosis." (Cardiovascular, 2002)

Soy proteins are also important factors in CVDs. In 1995, Anderson et al. noticed that substituting soy protein for animal protein lowered total cholesterol, LDL cholesterol and triglycerides without affecting HDL cholesterol, and that the components of soy protein implicated in lowering blood cholesterol involve other protein complexes such as: trypsin, phytic acid, saponins, isoflavins, and fiber. The researches found that twenty to fifty grams of soy protein per day improved blood lipid levels in mildly hypercholesterolemic persons. In addition, the Food and Drug Administration stated that approximately twenty grams per day of soy protein, along with a healthy diet of low saturated fat and cholesterol, might reduce the risk of CVDs. (Erdman, 2000)

OMEGA-3 AND OMEGA-6 FATTY ACIDS ARE INVOLVED WITH CVDS

Fatty acids comprise a major portion of fats that are consumed daily. They can be labeled into three major types: saturated, monounsaturated, and polyunsaturated. Saturated fatty acids have been linked to cardiovascular diseases since they have been found to raise LDL "bad" cholesterol levels while reducing HDL "good" cholesterol (which will be discussed shortly.) Trans-fatty acids can be especially unhealthy. These fatty acids have their hydrogen atoms on opposite sides of the double bond, whereas cis-fatty acids have hydrogen atoms on the same side of the double bond. "[Trans-fatty acids] are produced by the partial hydrogenation of liquid vegetable oil, which causes it to solidify" (Willet, 2002). Omega-3 (or n-3) fatty acids have a double bond that is three carbons from the methyl group, whereas the n-6 fatty acids have a double bond six carbons away from the methyl group.

Fatty acids perform an extremely large number of functions. Some fatty acids are considered healthy, while some are unhealthy as mentioned earlier. However, fatty acids are vital to human life regardless of their characteristics. Essential fatty acids (EFAs) are essential for cardiac function. It is important to ingest EFAs because the body cannot manufacture them; they must be imported from other sources into the body. Since EFAs are present in every healthy cell in the body (Dupler, 1995), they are significant for normal growth and functioning of major organs and blood cells. EFAs include alpha-linolenic acid (omega-3) and linolenic acid (omega-6) (Davis, 2002).

Foods and oils that contain omega-3 fatty acids are excellent for the heart and blood vessels. Including omega-3 rich food in one's diet can lower the body's net cholesterol level that accumulates and blocks arteries. "In a clinical study of 38 women, flaxseed flour, which contains high amount of omega-3 fatty acids, decreased total cholesterol level by 6.9 percent and LDL cholesterol by 14.7 percent" (Tran, 1995). Fish oil is very rich in omega-3 fatty acids. "The major unsaturated fatty acids of the erythrocytes from before fish oil feeding, to the time of the last cortical biopsy... [show] the total n-fatty acids increased from 1.3 percent to 3.1 percent of total fatty acids after the fish oil diet" (Mostofsky, 1997). Other sources of omega-3 fatty acids include walnuts, soy, safflower, sunflower, corn, cottonseed, and

olive/vegetable oils, (Cooperstein, per. commun., Feb., 2004; Haas, 2004). The majority of people do not devote much of their attention to (soley for the purpose of lessening their risk of CVD) incorporating the above-mentioned foods into their diet. Nevertheless, "sixty-eight percent of mortalities in [the United States] are related to [fatty acid] consumption and diet, including heart disease... (Dupler, 1995)

Further epidemiological studies (that involve regions other than the United States) also demonstrate the effect of fatty acids on cardiovascular nutrition. For example, the Greenland Inuit had low mortality rates resulting from CVDs despite a diet that is rich in fat. The scientists involved in this investigation suggested that this could be because of the high content of omega-3 fatty acid fish, seal and whale which is part of the Inuit diet. In an Asian population studied by Singh, et al, patients with suspected myocardial infarction taking fish oil capsules experienced a significant reduction in mortality from CVDs after one year, compared with placebo. However, Norwegians who experienced myocardial infarctions did not benefit from taking fish oil capsules compared with placebo after one and ½ years. (Din, 2004)

Cardiac arrhythmia is believed to be one of the major causes of sudden death in patients with coronary heart disease. Researchers have found (after implementation of animal experiments) that omega-3 fatty acids can reduce susceptibility to heart arrhythmia in polyunsaturated form. An experiment was also carried out in Italy showing that patients receiving one gram of omega-3 fatty acids had a reduction in sudden fatal death of forty percent, which was higher then drug-related reductions in mortality. Omega-3 fatty acids can lower risk factors involved with restenosis (reclogging of the arteries), considering this experiment was conducted on patients undergoing angioplasty. Restenosis commonly occurs in thirty to forty-five percent of the dilated lesions about 6 months after surgery. (Newton, 2001) Because of the decreased amounts of omega-6 fatty acids in the Western diet, metabolic products such as prostaglandins, thromboxanes, and leukotrienes are accumulated in vast quantities, compared to those formed from omega-3 fatty acids. These metabolic products contribute to the formation of thrombus and to the proliferation of blood cells. Therefore, a diet rich in omega-6 fatty acid results in increasing blood viscosity, vasospasms and vasoconstriction; it also results in decreased bleeding time. (Mostofsky, 1997)

DISCUSSION

If it were not for biological macromolecules, our heart and blood vessels could not even function properly, and so proteins and fatty acids are vital for maintaining good health. However, having excessive concern of malnutrition leads to unnecessary amounts of protein and fatty acid intake (Anonymous, 2002). Special programs such as the Atkins Diet, that suggest higher protein/fat and lower carbohydrate intake (Cooperstein, per. commun., Feb. 2004) are good examples of such behaviors. Having too much protein/fatty acid in the diet can be harmful for the heart and major organs at times.

Some of the studies mentioned above were rather "vaguely" conclusive, whereas others were very clear. For example, the optimal intake of omega-3 fatty acids for the populations mentioned in Din et al has not been firmly established, nor is their mechanism of action fully understood. Some studies have actually produced conflicting results, such as the case with the prevention trials in the Inuit and Norwegian populations. This may be because of high habitual fish consumptions in the Norwegians studied. (Din, 2004) In addition, M. Tran's project with omega-3 fatty acids involved only women during the tests—it is not known why men were not included in this matter. Nevertheless, one can say that proteins and omega-3/omega-6 fatty acids still play important roles in C-V nutrition in an overall manner.

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