ANIMAL FAT IN THE DIET

by A. J. Siedler

One of the problems confronting the meat industry is the implication that saturated fats in the human diet may cause hardening of the arteries or arteriosclerosis.

The symptoms characteristic of arteriosclerosis are described in ancient Egyptian writings. This fact indicates that people have known of this disease for thousands of years. However, Lobstein first used the term "arteriosclerosis" around 1820. In the middle of the 19th century, Rokitansky concluded that arteriosclerosis was a disease of blood clotting. As early as 1856 Virchow thought that the disease was an inflammation followed by deposits of cholesterol in the arteries. Atherosclerosis, which is arteriosclerosis localized in the heart and aorta, is probably the most familiar form.

A number of general factors have been associated with atherosclerosis in man. These include genetic factors, physical activity, hypertension or high blood-pressure, age, mental and physical stresses and diet, including obesity. Recently heavy cigarette smoking also has been associated with the disease.

There are many statistical associations between the incidence of heart disease and certain biochemical changes, primarily in the blood lipids. Scientists have related at least four blood lipid changes to atherosclerosis.

1. A high level of serum cholesterol is associated with a high incidence of atherosclerosis.

2. A high blood triglyceride concentration (hyperlipemia) is associated with a high incidence of atherosclerosis.

3. Differences in the beta-lipoprotein fractions are related to a high incidence of atherosclerosis. The ratio of beta to alpha lipoprotein ("Beta ratio") is often used as a more critical measure.

4. A low level of polyunsaturated fatty acid in the serum is often associated with atherosclerosis.

The blood lipid which has received the most attention in recent years has been serum cholesterol. However, a number of investigators do not believe that the correlation between high-serum cholesterol and the incidence of atherosclerosis indicates that a high serum cholesterol causes atherosclerosis. Nevertheless, there

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has been major interest in serum cholesterol as a possible causative agent or indicator of the presence of atherosclerosis. This interest has been based on a number of statistical studies. (i.e., studies of various population groups in certain countries). However, caution is in order. One of our leading biostatisticians has indicated that statistics can be misused. He warns:

"Perhaps the most serious pitfall in biostatistics is that of leaning on them as a drunkard does on a lamp post: using them for support rather than illumination."

Properly used, statistics is of great value in determining the possible relationship between cause and effect, and other factors.

Diets containing large amounts of saturated fats are associated with high serum cholesterol levels in human beings as well as in experimental animals. Increased serum cholesterol levels have also been associated with physiological stresses, including tuberculosis, syphilis and starvation. It is not known whether there is a true causal relationship between atherosclerosis and increased serum cholesterol. However, high serum cholesterol levels often indicate stresses and are therefore not a good sign.

A number of dietary and chemotherapeutic agents decrease serum cholesterol levels in man and experimental animals. Polyunsaturated fatty acids usually lower serum cholesterol when substituted for saturated fats in experimental diets. Several theories have been advanced as to why they have this effect. Certain polyunsaturated fatty acids have a vitamin-like function. Moreover cholesterol accentuates the need for these polyunsaturated fatty acids or essential fatty acids. Therefore, some scientists postulate that atherosclerosis is a symptom of a deficiency in essential fatty acids. Others posulate that polyunsaturated fatty acids are chemically added to cholesterol and that this form of cholesterol is used by the body at a faster rate than other cholesterol compounds. Research indicates that the degree of solubility of cholesterol in the fat may be related to the serum cholesterol lowering or raising effects. The serum cholesterol raising effects of saturated fatty acids may be due to their ability to dissolve more cholesterol than the polyunsaturated fatty acids. Therefore, cholesterol compounds present in the intestinal tract would be absorbed at a high rate with a saturated fat diet. This high absorption increases serum cholesterol values.

Under certain conditions, exercise decreases serum cholesterol levels in experimental animals. Certain anti-metabolites such as aminopterin (an antifolic acid compound) and MER-29 (an inhibitor of the biosynthesis of cholesterol) decrease serum cholesterol values; however, these compounds may be toxic. The vitamin niacin, in high concentrations, decreases serum cholesterol, whereas nicotinamide does not lower serum cholesterol under the same conditions. Resins which absorb bile salts and prevent reabsorption also lower serum cholesterol levels. Cases are reported of certain metal ions, such as vanadium and magnesium, lowering serum cholesterol. A number of natural hormones have both plus and minus
effects on serum cholesterol levels. Thyroid active compounds markedly lower serum cholesterol, but anti-thyroid compounds such as thiouracil have the opposite effect. Antibiotics have also been shown to have some cholesterol-lowering effects.

The response of animals to differences in protein quality or protein levels in the diet markedly influences serum cholesterol. We recently published a study showing that very high levels of protein do appreciably increase the serum cholesterol in the adult male rat. It has also been shown that diets very low in protein have a cholesterol-raising effect in the rat and chick. Thus, adding more protein or amino acids to these poor diets decreases the serum cholesterol. High-protein diets produced very pronounced effects on the blood lipid picture in mature rats during very short term isocaloric feeding tests conducted recently in our laboratories.

Diets in which bile salts plus thiouracil cause fantastic effects; causing increases up to 10 times the normal serum cholesterol levels. These tremendous increases in serum cholesterol are accompanied by a heavy incidence of infarcts (tissues which are dying because their blood supply has been cut off, for instance by a blood clot). There is, however, no basis for predicting which animal will have an infarct. Those animals which appear to be resistant to infarcts remain immune no matter where the serum cholesterol level is maintained. Therefore, even in highly inbred populations, there appears to be strong individual tendencies designating whether the animal will be responsive to the dietary stress, or not. Whether this carries through to human populations remains to be seen. However, I think there are fairly strong indications that certain individuals do have this type of "metabolic defect" which may show up under certain conditions of stress.

Another experimental index of atherosclerosis in the living animal, is the relative amounts of lipoproteins in the blood. These are proteinacious components found in the human blood, which carry lipids including cholesterol. Some research has indicated that the amounts of the various lipoproteins in serum is an index of atherosclerosis. Many investigators believe this is a much more critical technique for detecting atherosclerosis than other indices.

The study of blood coagulation is a biochemical technique which has been used in attempting to determine the causual agent of atherosclerosis. It has been known for some time that lipemia, or a high incidence of fat in the blood, will lower blood clotting times. Whether this is actually an occurrence that may take place within the animal is not known. There are differences between the clots formed in the test tube and those found in the live animal. At any rate, there appears to be a relationship between blood-clotting time and the amount of fat in the serum, as well as the type of fat. In laboratory studies, the presence of saturated free fatty acids shortens the clotting times, whereas, polyunsaturated free fatty acids generally have little or no effect on clotting time. Triglycerides, lecithin and cholesterol also do not appear to be factors in shortening the clotting time.
Correlations between heart disease and patterns of human behavior have been observed. A very competitive drive, a feeling of time urgency, rapid conversation, and muscle tension are associated with higher serum cholesterol levels and lower clotting times. This type of behavior is further associated with the overproduction or oversecretion of adrenalin. These associations are related to the so-called tension or stress syndrome which has been statistically linked with a higher incidence of heart disease.

Obesity (being overweight) has been closely correlated with the incidence of heart disease, and many investigators believe this to be one of the prime causes of heart disease. English workers have published some rather interesting results indicating that high-fat, high-protein diets are good reducing diets because they tend to decrease caloric intake. These diets have an apparent high satiety value, and the individual does not eat as much as he would with larger amounts of carbohydrate in the diet. Thus the English workers say that these diets should not be called high-fat, high-protein diets, but instead, low carbohydrate diets.

Recently, workers have shown that diets very high in polyunsaturated fats may not be the answer to our ills. A research group in Australia has shown that in the rat, lowering of serum cholesterol by including large amounts of polyunsaturated fatty acids in the diet is followed by increased deposits of cholesterol in the liver, heart, and aorta. Diets high in polyunsaturated fatty acid also will increase the vitamin E requirement in man and experimental animals.

Preliminary data from a study of Irish brothers--one living in Boston, and the other living in Ireland--indicate that the incidence of heart disease is not associated with a high animal fat intake or caloric intake. Rather the difference probably is in the manual labor routinely done by the Irish subjects.

It has been postulated that we are in the state of changeover from active people to sedentary people and our metabolism has not caught up with us yet. Be that as it may, life expectancy statistics show that the meat-eating populations enjoy relatively high longevity.

What does all this mean as far as the human diet and the production of beef is concerned? What fatty acids are contained in a lean piece of beef?

A large percentage of the intracellular fatty acids (primarily the phospholipid fraction) of beef is polyunsaturated--linoleic and arachadonic acid. Therefore, lean beef does not have as high a percentage of saturated fat and, of course, has less total fat. Our problem may lie in consumer and producer education. Good tenderizing procedures may be a solution to the problem of marketing very lean beef.

Another potential method of improving the product would be to increase the polyunsaturated fatty acid content of beef products. This is quite difficult since the rumen (first stomach) is notorious for producing the same amount of metabolite, regardless of feed input. The beef animal takes in a considerable amount of
polyunsaturated fatty acids in its range diet. For example, by eating 100 pounds of grass in a day it will ingest about 450 grams or 1 pound of lipid. The principal portion of this will be polyunsaturated fatty acids, which are rapidly converted in the rumen to saturated fatty acids. How the cow manages to salvage enough of the polyunsaturated fatty acids to satisfy its essential fatty acid requirements is not known, but apparently the cow is able to do this. Future studies on the series of reactions which go on in the rumen as well as the types of microorganisms which carry out these reactions should be extremely valuable. From them researchers may be able to cause the bacteria to form metabolites in the rumen which would lend themselves more to unsaturated fatty acid biosynthesis than saturated fatty acid biosynthesis.

We do have a potential problem in the meat industry because of the fact that saturated and monounsaturated fatty acids are major components of the fat in meat products. However, meat has a host of positive nutritional values which should not be overlooked. These more than off-set the possibility that saturated fats in meat products may impair the nutritional qualities. We should, however, constantly be aware of developments in this area and, at the same time, strive to improve the product by every feasible means.