Converting Carbohydrates to Triglycerides

Consumers are inundated with diet solutions on a daily basis. High protein, low fat, non-impact carbohydrates, and other marketing "adjectives" are abundant within food manufacturing advertising. Of all the food descriptors, the most common ones individuals look for are "fat free" or "low fat". Food and snack companies have found the low fat food market to be financially lucrative. The tie between fat intake, weight gain, and health risks has been well documented. The dietary guidelines suggest to keep fat intake to no more than 30% of the total diet and to consume foods low in saturated and trans fatty acids. But, this does not mean that we can consume as much fat free food as we want: "Fat free does not mean calorie free." In many cases the foods that are low in fat have a large amount of carbohydrates. Carbohydrate intake, like any nutrient, can lead to adverse affects when over consumed. Carbohydrates are a necessary macronutrient, vital for maintenance of the nervous system and energy for physical activity. However, if consumed in amounts greater than 55% to 65% of total caloric intake as recommended by the American Heart Association can cause an increase in health risks. According to the World Health Organization the Upper Limit for carbohydrates for average people is 60% of the total dietary intake.

Carbohydrates are formed in plants where carbons are bonded with oxygen and hydrogen to form chains of varying complexity. The complexity of the chains ultimately determines the carbohydrate classification and how they will digest and be absorbed in the body. Mono-and disaccharides are classified as simple carbohydrates, whereas polysaccharides (starch and fiber) are classified as complex. All carbohydrates are broken down into monosaccharides before being converted to glucose. As glucose enters the blood the concentration of sugar in the blood rises. In response, the pancreas releases insulin to cause the body to remove the surplus of blood sugar. Muscle and liver cells use the glucose to form glycogen for later energy needs. Glycogen stored in the body usually represents about 1200-1600 kcal of potential energy. This fuel is exclusive for brain function, the maintenance of the central nervous system and high intensity physical activity. When carbohydrates are needed by the body the energy is created by the breakdown of plasma glucose and/or glycogen stored in the liver or muscles.

Moderate to vigorous activities are fueled predominately by the breakdown of glucose. Increasing the volume of exercise requires greater amounts of carbohydrate consumption to increase readily available energy. However, if an excessive amount of carbohydrates are consumed they will be converted to fat and stored in adipose tissue in a process called lipogenesis. This occurrence is what fueled the low carbohydrate craze. Accumulation of fat can lead to an increased risk for various diseases.

Simple or refined carbohydrates are considered to be a negative contributor when they are over consumed in the diet. The two most prominent simple carbohydrates in the

American diet are sucrose and high fructose corn syrup (refined sugars). They are commonly found in foods that have added sugar for flavor. These types of carbohydrates do not contain the beneficial properties found in complex carbohydrates. Refined carbohydrates displace nutrient dense foods and do not provide good sources of other nutrients such as vitamins, minerals, proteins, or fiber; making them empty calories.

Refined carbohydrates also have an adverse affect on blood glucose and insulin levels. These types of carbohydrates go through a manufacturing process that breaks down the complexity of their natural chains. This allows them to be digested quickly, rapidly increasing serum blood glucose levels. When a notable increase in blood glucose occurs either due to a high glycemic index or large glycemic load the acute hyperglycemia is commonly referred to as a glucose spike. The body, in response, releases insulin to try to return it back to a state of homeostasis. After meeting the body cells' immediate energy needs and reaching glycogen storage capacity, the body has a third path to accommodate excess sugar. Increased insulin levels that occur after eating promote a higher rate of fat storage due to the lipogenic activity of the anabolic hormone. The insulin allows the entry of glucose into fat cells by converting it into triglycerides in the liver.

Unlike simple and refined carbohydrates, complex carbohydrates are found in grains, cereals, dark green leafy vegetables, yellow fruits and other vegetables. Consumption of complex carbohydrates tends to lead to a diet high in fiber, vitamins, and minerals (particularly those identified as antioxidants).

A diet too low in complex carbohydrates will have the opposite effect and can actually be hazardous on a number of levels. Due to the fact that glucose is the predominant energy source to fuel the nervous system, limiting its consumption is ill-advised. Diets low in complex carbohydrates, but high in refined carbohydrates are lipogenic, provide poor nutritional value, and increase risk for metabolic disease. When the diet is low in total carbohydrates additional problems occur. The body gives up its protein sparing mechanism when glucosides in the hypothalamus become too low for any extended period of time. This causes the body to breakdown protein (catabolism) and converts the carbon chains into glucose through gluconeogenesis in the liver. This increases the risk for dehydration due to excess nitrogen and in extreme cases can lead to acidosis due to metabolic shifts toward protein metabolism.

A diet high in total carbohydrates (>60% of the diet) can be problematic as well. It has already been stated that excess circulating glucose is converted to triglycerides and stored in adipose tissue. This makes sense because adipose tissue represents an efficient, non-metabolic storage instrument for the body. The body preferentially oxidizes carbohydrates rather than fat oxidation because it provides more energy (6% more). However, lipids are more energy dense (9kcal/g) than carbohydrates (4kcal/g) and allow for more stored energy than can occur in muscle and liver cells. Carbohydrates are the preferred source of energy due to their accessibility while dietary fat (triglycerides) is ideal for energy storage and resting metabolism. Glucose is broke in half which releases energy. The two halves can either be further broken down into carbon dioxide and water or can come together to form fat. This is how glucose can be converted to fat. These fats

are then released into the blood stream (triglycerides) to be stored in the fatty tissues of the body. If carbohydrates are not used they will be oxidized, transformed to fat, and stored. The body wants to store excess energy for times of famine because physiologically the human body still has environmental defense mechanisms to prevent starvation even though the threat is unlikely.

Triglycerides are the most common form of fat found in a normal diet. They account for the majority of fat in the body representing 50,000-100,000 kcal in stored adipose tissue and 2000-3000 kcal in intramuscular fat. Triglycerides are made up of three units of fatty acids and one unit of glycerol. Glycerol is a component of fatty acids in fats that is released when stored fat is metabolized for energy. It then enters into the bloodstream and transferred to the liver where it can be converted to glucose.

When triglycerides build up in the blood they increase the risk of heart disease. Diets high in carbohydrate consumption and low in physical activity increase this risk. Further fueling the increase in triglyceride/carbohydrate relationship is the consumption of refined carbohydrates. Refined carbohydrates are more likely to adversely affect blood triglycerides than carbohydrates from complex sources. Indivduals looking to positively affect their blood lipid profile should reduce refined carbohydrates and increase complex sources while engaging in regular exercise.

Level mg/dL	**Level** mmol/L	**Interpretation**
<150	<1.69	Normal range, lowest risk
150-199	1.70-2.25	Borderline high
200-499	2.25-5.63	High
>500	>5.65	Very high, increased risk

Recommended by the American Heart Association

Excessive triglycerides increase risk for a coronary incident. Individuals engaging in exercise should be aware of their blood lipid profiles before beginning an exercise program and monitor higher risk profiles. It is important to monitor blood lipids because a high level of triglycerides (and LDL-C) is a factor associated with Cardiovascular Disease (CVD) due to atherosclerosis or plaque build up. Plaque build-up within the blood vessels, increased platelet adhesion, and vessel damage are the results from high levels of triglycerides in the blood stream. Cardiovascular exercise and appropriate carbohydrate consumption are the keys to reducing triglyceride levels.