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How to Fatten a Mammal?

Analysis by Dr. Joseph Mercola April 27, 2024

STORY AT-A-GLANCE

- Brad Marshall, a molecular biologist, farmer and chef, believes trees evolved to use mammals to move their seeds around for them
- Black oak acorns, which squirrels prefer, contain about 46% of calories from fat, 48% of calories from carbohydrates and 6.6% of calories from protein
- The acorns are very low in saturated fat with very high amounts of monounsaturated fat, moderate amounts of polyunsaturated fat (PUFA) along with starch
- This "recipe" effectively fattens up squirrels for the winter and does the same in those who consume modern-day diets with a similar makeup, including high amounts of PUFA like linoleic acid (LA)
- Marshall dives into the complex biochemistry behind a squirrel digesting an acorn, and what it can teach us about human fat digestion and its effects on the body, including obesity

Could we learn something from the dietary habits of squirrels, particularly their penchant for acorns, which they depend on to fatten up for the winter? According to Brad Marshall, a molecular biologist, farmer and chef, the secret to staying slim may lie in the ancient relationship between squirrels and the oak trees that give them their favorite food source.

> *"All mammals evolved from a common ancestor. We have the same enzyme systems that control energy balance in and out and even though we live in*

different environments and we have different preferred foods, our metabolisms all essentially work the same way," Marshall says.[1]

Oak Trees Make Acorns to Fatten Up Squirrels

You may assume that squirrels evolved to eat acorns in order to gain weight before winter sets in. But Marshall points out that mammals have been around for at least 200 million years, while flowering plants like oak trees and hickory trees are comparatively much younger, evolving around 130 million years ago.

"I believe that the trees evolved to use mammals to move their seeds around for them," Marshall says.[2] He cites a study of wild red squirrels,[3] which found their body weight increased from about 310 grams to 330 grams in the fall when they eat the most acorns.

> *"They're essentially adding about 10% of their weight in body fat during the part of the year when they're eating these acorns and, of course, from the perspective of the tree, the tree needs those squirrels to fatten up. The tree needs a healthy squirrel population so that it can spread its seeds and so this is what squirrels eat."*[4]

In the fall, acorns and hickory nuts make up 90% of squirrels' diets. This falls to about 50% to 63% in the summer, when squirrels are their leanest. Marshall poses the question:

> *"So … if you are an oak tree and it's your imperative to fatten up your squirrels so that they can survive winter so that you can spread your seeds, what do you make your acorns out of?"*[5]

Black oak acorns, which squirrels prefer, contain about 46% of calories from fat, 48% of calories from carbohydrates and 6.6% of calories from protein. "That is the equation that the oak trees decided to use."[6]

The acorns, along with hickories and chestnuts, are very low in saturated fat with very high amounts of monounsaturated fat and "quite a bit of polyunsaturated fat along with starch in the acorns. That seems to be the recipe that is preferred," Marshall points out.[7] In the video, he then reveals data showing people in France, who eat more butter and dairy fat, are leaner than those in Italy and Spain, where olive oil is favored.[8]

Why Acorns Make Squirrels Fat

A squirrel digesting an acorn can teach us a lot about fat digestion and its effects on the body. When a squirrel eats an acorn, its body breaks down the fats it contains. During this process, the squirrel's intestines release a substance called oleoylethanolamide (OEA). OEA acts as a signal telling the body that fats are being digested.

Once OEA enters the bloodstream, it triggers a reaction in the liver by activating a receptor known as PPAR-alpha. This activation starts the process of fat accumulation in the body. Researchers study this process by using special mice models called "knockout models," where specific genes are removed to see the effects.

In studies focused on diet-induced obesity, these mice are fed a diet similar to the composition of acorns, which is high in fat, primarily from lard and some soybean oil.

This diet mirrors the fatty content of acorns and is designed to induce obesity and insulin resistance in mice. An important point is that lard is mainly composed of monounsaturated fats (MUFAs); modern lard contains more polyunsaturated fats (PUFAs) than it used to. The diet for the mice includes about 5% soybean oil to ensure there's enough PUFA.

This diet effectively causes weight gain and insulin resistance in mice. The studies show that having the PPAR-alpha receptor is crucial for the mice to develop insulin resistance, offering insights into how fats affect the body's metabolic processes.

A similar process occurs in humans when they're given a drug called fenofibrate, which also activates PPAR-alpha. In a study conducted on men, researchers used fenofibrate to intentionally activate PPAR-alpha to study its effects on the liver.[9]

Interestingly, Marshall explains, while fenofibrate is effective at lowering cholesterol, this was the first time researchers directly observed its impact on the liver in humans. The results showed that fenofibrate increased liver fat content by about 23%, which suggests that activating PPAR-alpha can have unintended effects on the body's fat storage processes.

Additionally, the study examined the activity of two enzymes: delta-6 desaturase and delta-9 desaturase, also known as SCD-1. These enzymes play roles in fat metabolism, and their activity levels increased significantly — by about 58% and 36%, respectively — in participants whose PPAR-alpha was activated by fenofibrate. This increase in enzyme activity further indicates changes in how the body processes and stores fats.[10]

The significance of these findings lies in the connection to MUFA, like those found in acorns. The presence of MUFA can initiate the activation of PPAR-alpha, showcasing its role as a key regulator in fat metabolism.

What This Means for Human Metabolism

When glucose from foods like acorns enters a cell, it undergoes a process called glycolysis in the cell's cytoplasm, converting into pyruvate. This pyruvate then moves into the mitochondria, the cell's powerhouse, where it has two main pathways. One pathway involves conversion into acetyl coenzyme A (acetyl-CoA) by an enzyme called pyruvate dehydrogenase, leading to the tricarboxylic acid (TCA) cycle, a critical step in energy production from food.[11]

During this cycle, acetyl-CoA is broken down, producing molecules called nicotinamide adenine dinucleotide, or NADH. The availability of another molecule, NAD+, is crucial here because a shortage can slow down metabolism. Your body has mechanisms to convert NADH back to NAD+ to maintain metabolic balance.

One primary method is through the electron transport chain in the mitochondria, which not only regenerates NAD+ but also produces ATP, the energy currency of the cell used for everything from moving muscles to brain functions.

However, not all energy production goes smoothly. When there's an excess of NADH and not enough demand for ATP, an enzyme called pyruvate dehydrogenase can become less active, leading to the production of reactive oxygen species (ROS), like hydrogen peroxide. Another enzyme, NNT, helps convert this potentially harmful byproduct back into water, simultaneously converting NADH back to NAD+.

But, when PPAR-alpha, activated by the MUFAs from acorns, comes into play, it inhibits pyruvate dehydrogenase by activating a different enzyme, pyruvate dehydrogenase kinase. This action prevents the normal breakdown of pyruvate via the TCA cycle. Instead, pyruvate takes an alternate route through an enzyme called pyruvate carboxylase, favoring the production of a compound called oxaloacetate.

This shift redirects the cell's energy processes, combining pyruvate from carbohydrates and acetyl-CoA from fats to create new fats through a process called de novo lipogenesis. Essentially, Marshall explains, the presence of PPAR-alpha, stimulated by fats in the diet, influences your body's decision to convert carbohydrates into fat.

Why Diets High in Linoleic Acid Are Fattening

Acorns from red or black oaks are a mix of fats and carbohydrates, with their fat content being mostly monounsaturated and a good portion of it being linoleic acid (LA), a PUFA.

LA accounts for about 80% of the fat composition of vegetable/seed oils. Examples of seed oils high in omega-6 LA include soybean, cottonseed, sunflower, rapeseed (canola), corn and safflower.[12]

Marshall explains that the presence of oleic acid, another component of the fat in acorns, is also important because it triggers a reaction in the liver that activates PPAR-alpha. Once activated, PPAR-alpha influences how the cell uses energy, leading to a preference for creating new fats rather than just burning carbohydrates for energy.[13]

This process involves several steps within the cell. High levels of NADH, which occur when PPAR-alpha is active, favor the conversion of substances in the cell in a way that leads to fat production. Specifically, delta-6 desaturase converts LA to arachidonic acid, which plays a role in creating molecules that can trigger reactions leading to the production of substances associated with obesity.

The activation of PPAR-alpha and another component called cytochrome P450 1B1 also leads to increased activity of an enzyme called SCD1. This enzyme, along with others involved in fat creation, ramps up your body's ability to make fat.

As a result, certain fatty acid levels change, promoting the storage of fat over burning it for energy. This mechanism slows down the metabolic rate, causing your body to store more calories as fat.

From the perspective of an oak tree, this process is ideal, Marshall says. By producing acorns that lead to the storage of fat, oak trees help squirrels gain the weight necessary to survive the winter. This ensures the squirrels are ready to disperse the oak's seeds, helping in the tree's reproduction.

This intricate connection between the composition of acorns and the metabolic processes in animals that eat them illustrates a fascinating aspect of natural symbiosis that also gives clues to human obesity.

In short, Marshall notes, “Black and red oak acorns have evolved to be perfectly fattening,”[14] and so, too, have the modern-day diets that mimic them, which are very low in saturated fat with very high amounts of MUFA, and PUFA like LA.[15] Ideally, your intake of LA should be below 5 grams a day.

The easiest way to do this is to use an online nutritional calculator such as Cronometer to calculate your daily intake. Cronometer will tell you how much omega-6 you’re getting from your food down to the 10th of a gram, and you can assume 90% of that is LA. Anything over 10 grams is likely to cause problems but, as mentioned, I recommend keeping your intake below 5 grams a day.

Sources and References

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