Alcohol is a Metabolic Bully

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ABSTRACT

The metabolic fate of ingested alcohol is poorly understood, even by those who are highly educated and otherwise fit, healthy, or athletic. Those who drink heavily, even if 'just on the weekends,' can derive a large portion of their total caloric intake from alcoholic beverages. Indeed, alcohol is a form of energy, but as a 'bully' it sabotages normal energy conversion pathways in the body. Instead of directly fueling muscle contraction or other desirable biochemical processes, the energy in alcohol is first converted to triglycerides and stored as body fat. In that process, a metabolic traffic jam is created as the break down of alcohol takes priority, and chemical entities such as NAD+ are snatched away from the productive pathways of glycolysis and the Kreb's cycle. Thus, muscle function is limited while the person is fattened - two effects which most college students would not want to promote! The purpose of this project was to review the literature on the metabolic effects of alcohol and synthesize the information into a message that is applicable to college students.

INTRODUCTION

The relative caloric contribution of carbohydrates, fats, and proteins in the diet has attracted much attention and study, especially in attempts to limit total caloric intake. There are popular arguments for low fat, low carbohydrate, and low protein (at least less than in typical American diet) programs in attempt to maintain a neutral or even negative caloric balance – and often therefore a favorable body composition. Much less attention has been paid to the energy in alcohol and the metabolic pathways by which this energy is converted in the human body. This is unfortunate, especially for athletes, because of the high caloric content (~7 Kcal/g) and the large amounts that are sometimes ingested at a single occasion. This review will examine the metabolism of alcohol – how does it break down and where the energy typically ends up. We will present evidence that alcohol is not an efficient fuel for muscle metabolism, that it too easily ends up as stored body fat. We will also discuss the role of alcohol as a 'metabolic bully.' Once ingested, its breakdown takes precedence over other metabolic processes and it creates a back up of more desirable processes such as glycolysis and the Kreb's cycle. Thus, the production of ATP for muscle contraction is slowed down, and the energy from the alcohol is converted to triglycerides and stored as body fat.

RESULTS

Alcohol as Energy

Alcohol can be seen as energy through its amount in calories. Calories give us the energy needed to do work (both internal body functions and muscular contractions) and this energy comes from the chemical bonds between atoms of the items we ingest. In alcohol there are 7 kcals of energy per gram compared to the 4 kcal/gm found in carbohydrates or proteins and near the 9 kcals/gm found in dietary fat. Although there are many calories in alcohol, these are seen as "empty" calories because they have little nutritional value, thus not being a healthy energy source.

Metabolic Breakdown

Once alcohol is absorbed into the bloodstream, it can then start its process of being broken down. This happens by first being oxidized in the liver starting with the enzyme alcohol dehydrogenase, secondly be broken down by the microsomal ethanol-oxidizing system, and lastly be passed out of the body in the breathe and urine. Alcohol is oxidized at a rate of 100 mg per kg of body mass per hour. This gives a 220 lb. person the ability to metabolize one drink per hour while in a 110 lb. person it would take two hours. There is no way to speed up this process, as the rate of breakdown is determined by the amount of the enzyme alcohol dehydrogenase available in the liver.

Blood Alcohol Concentration	*Effect on One's Body*
	
.01	The lowest amount typically measured by breath analysis, breaking absolute sobriety.
.05	One will have impaired judgment, a change in mood, relaxed inhibitions, and an increased heart rate.
.08	The recent legal cutoff for DWI
.10	One will have impaired coordination, and delayed reaction time which will give them the inability to drive a vehicle.
.15	One will show signs of serious impaired coordination and judgment which includes but is not limited to slurred speech, exaggerated emotions, blurred vision, and staggered walking.
.20	One will suffer from double vision and have the inability to walk without falling.
.30+	One will be unconscious, in shock, in a coma, or possibly dead from cardiac or respiratory failure.

Alcohol's Effect on the Body

Alcohol acts as a depressant by sedating both inhibitory and excitatory nerves and the severity of the side effects depends on the amount of alcohol ingested and the resultant blood alcohol concentration (BAC). When BAC levels go above 0.10, some effects may include reduced motor control and reduced physical performance. Higher levels have effects on one's metabolic, cardiovascular, and thermoregulatory functioning, as well as one's reaction time, fine motor control, levels of arousal, and judgment. Other side effects of increased BAC include one's loss of social inhibition, erratic behavior, increased aggression, and loss of control of voluntary actions. When BAC. levels climb over 0.30, one may become unconscious and possibly die due to cardiac or respiratory failure from the overdose.

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Alcohol can be seen as a metabolic bully by the way its breakdown takes precedence over, and actually disrupts other metabolic processes within the body. In the process of breaking down alcohol's carbon chains, important chemical intermediates (e.g. NAD+) are hijacked from the normal energy producing reactions in the body (glycolysis and the citric acid cycle). The carbon chains from the ethanol are converted to acetyl CoA, but unlike the acetyl CoA from the breakdown of your regular food intake, these are prevented from easily entering the citric acid cycle by the high levels of NADH. Thus production of ATP, the body's currency of energy exchange, is hindered while the alcohol is being metabolized. Furthermore, the acetyl CoA from alcohol is then repackaged as fatty acids or ketone bodies and primarily stored as body fat.

SUMMARY AND CONCLUSIONS

Alcohol has many effects, some potentially desirable, some not. It may provide the 'social lubricant' many people are looking for at a party. It may even help raise HDL cholesterol a little bit, or make blood platelets less likely to aggregate. It has been suggested that dark beer, in particular, has compounds that, like those in dark chocolate, may hold a variety of beneficial health effects. It has been suggested, however, that to maximize such health benefits, the proper rate of alcohol ingestion would be so slow that the blood alcohol level would not even rise. (think slow *intravenous* drip!) What alcohol won't do is promote a lean body or provide ready energy for muscular work. Especially when ingested in quantities greater than one or two drinks, the energy contained in alcohol is readily converted to triglycerides and stored as adipose tissue. Meanwhile,the chemical steps that are involved in muscle contraction are hindered as the processing of the alcohol takes precedence.

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