

## Why do we like alcohol so much?

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*The holiday times are, for some, an occasion to share a glass (or two) with family and friends. The biochemical origin of our relationship with alcohol is complex. The attraction to this toxic substance is due to our unique ability to efficiently digest it, a property inherited from our primate ancestors.*

**All cells** need energy to survive and it is a sugar, glucose, which is the principal source of energy for the living world. During metabolism, this substance is oxidized into carbon dioxide and water while the energy released is converted into a fuel that is essential for cell function (adenosine triphosphate).

Certain organisms like yeast have, however, developed another way of extracting this energy, by a process called aerobic fermentation: instead of being totally oxidized, the glucose is instead converted into ethanol (ethyl alcohol), a substance which the yeast can later use as a fuel if sugar becomes scarce.

Fruits represent the principal source of glucose in nature, and this metabolic adaptation by yeast coincided with the appearance of fruiting plants on earth, about 100 million years ago. Alcohol being a highly toxic substance for most other living species, its production by yeast gave them a survival advantage and thus has been conserved over the course of the past hundred million years.

### DETOXIFYING ALCOHOL

Humans are one of the rare living species which has developed the ability to digest alcohol and thus to reduce its toxic effects. This detoxification is made possible by an enzyme (alcohol dehydrogenase) which is principally found in the liver and which converts alcohol to acetaldehyde. Another form of alcohol dehydrogenase called ADH4 is commonly found in the esophagus, the stomach and the intestines, and this enzyme plays an important role in the tolerance to alcohol because it is the first to come into contact with this substance and to reduce its toxic effects on the organism.

Recent studies have shown that this role for ADH4 is relatively recent, first appearing in the common primate ancestors of gorillas, chimpanzees and humans about 10 million years ago<sup>(1)</sup>. It is likely that this was an adaptation of these ancient primates to their life closer to the soil, where the fruit fallen from trees was an abundant source of nourishment, but which contained alcohol produced by the metabolic activity of fermenting yeast. The appearance of an ADH4 which was more active conferred a strong nutritional advantage which has been conserved with time, even in our species. Other large apes such as orangutans, which essentially pass their lives in trees without contact with fermented fruit, do not possess this more active form of ADH4.



### INCOMPLETE DETOXIFICATION

Certainly, the ability of humans to digest alcohol has long been primarily used to enjoy the euphoric effects of this psychoactive substance. However, it should be kept in mind that even though our metabolism permits us to reduce the acute toxic effects of alcohol, the acetaldehyde produced by alcohol dehydrogenase is a highly reactive molecule which can induce mutations in the genetic material of cells (DNA). For this reason, alcohol is well known to be an important risk factor for several types of cancer, notably those of the oral cavity, larynx, esophagus, colon, liver and breast. It should also be remembered that the harmful effects of alcohol are considerably increased in smokers.

Even though alcohol has an integral role in our lives, particularly during the holiday season, we should not minimize its effects on health and should remain prudent in our drinking habits.

<sup>(1)</sup> Brenner, S et al. Paleogenetics and the history of alcohol in primates. American Association for the Advancement of Science annual meeting, Boston, February 15, 2013.