Fructose and its effect on alcohol elimination from blood following alcoholic beverage consumption

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ABSTRACT: Fructose is a naturally occurring simple carbohydrate that successfully found its way into a myriad range of food and beverage applications. This paper will describe a possible different use of fructose as a detoxification agent, by examining the ability of fructose to accelerate the elimination of alcohol in blood following alcoholic beverage consumption. The recommended dosage ranges between 0.25 g/kg body weight to 2 g/kg body weight.

Fructose, also known as “fruit Sugar”, is a naturally-occurring, simple bulk sweetener used in the food industry, and is characterized by “clean” non-lingering sweet taste. Fructose is highly soluble, and is characterized by a Relative Sweetening Value (RSV) of 1.1-1.7 (where sucrose = 1.0), depending on temperature and pH (1).

Fructose’s advantages are prominent in products consumed at refrigeration temperatures and acid pH (~ 2.5-4.5). Fructose is GRAS and non-allergenic sweetener, and its use is not restricted by official regulatory bodies (2). Additional beneficial trait of fructose includes its ability to reduce the glycemic loads of food (2). Fructose is characterized by a GI ~20 (sucrose GI ~ 60). Fructose also works as a “masking agent” for undesirable aftertastes of some artificial sweeteners. Combinations of fructose with aspartame, Ace K, cyclamate, saccharin allow a reduction in the caloric content up to 60 percent. Moreover, fructose also exhibits sweetening synergy effects with several bulk sugars. In this article, a unique feature of fructose, namely its ability to accelerate the elimination of alcohol in blood, following alcoholic beverage consumption, will be discussed, suggesting a potential application.

Following its ingestion, about 20 percent of alcohol consumed is absorbed in the stomach with rest (~80 percent) more rapidly and at a constant rate through the intestine. Ninety percent of the alcohol consumed is metabolized in the liver (small quantity that is not metabolized can be measured in breath and urine). About 90 to 98 percent of ingested alcohol is eliminated from the body through oxidative metabolism, and the basic pathways involve the progressive oxidation of ethanol to ethanoic acid via ethanol (3). The major site of this oxidation is the liver parenchyma cells, but other potential sites include the stomach (4), vascular tissues, and the brain (5). Thus the metabolic rate of alcohol is a two-step process: -1 the enzyme alcohol dehydrogenase (ADH) metabolizes alcohol to acetaldehyde, -2 acetaldehyde is converted by acetaldehyde dehydrogenase to either acetate or into water + acetic acid.

The liver can metabolize only a certain amount of alcohol per hour, regardless of the amount that has been consumed. The rate of alcohol metabolism depends, in part, on the amount of metabolizing enzymes in the liver, which varies among individuals and appears to have genetic determinants (7, 8).

In general, after the consumption of one standard drink, the amount of alcohol in the drinker’s blood (blood alcohol concentration; BAC) peaks within 30 to 45 minutes. [A standard drink is defined as 12 ounces of beer, 5 ounces of wine, or 1.5 ounces of 80-proof distilled spirits, all of which contain the same amount of alcohol.] The BAC curve, shown below provides an estimate of the time needed to absorb and metabolize different amounts of alcohol (9). Since the metabolism of alcohol is slow, consumption needs to be controlled to prevent accumulation in the body and intoxication.

TIME NEEDED TO ABSORB AND METABOLIZE DIFFERENT AMOUNTS OF ALCOHOL*

Factors such as food intake and its constituent profile, gender and age have been reported to influence the kinetics of alcohol absorption and metabolism. It is widely accepted that the rate of alcohol absorption can be decreased by consuming food along with the alcoholic drink (10-12). The rate at which alcohol is absorbed depends on how quickly the stomach empties its contents into the intestine. The higher the dietary fat content, the more time this emptying will require and the longer the process of absorption will take. One study found that subjects who drank alcohol after a meal that included fat, protein, and carbohydrates, absorbed the alcohol about three times more slowly than when they consumed alcohol on an empty stomach (13). In another work (14) Rogers et al. showed that carbohydrates significantly increased the rate of alcohol metabolism in fasting humans while protein and fat failed to show the same effect.

Among foods, the special effect of fructose on alcohol metabolism has been reported as early as from 1937 (15).
In this context it is interesting to mention that for a long time [prior to controlled scientific interventions] a common non-scientific experience existed claiming that consumption of honey may shorten the period of alcohol intoxication (honey is an excellent rich source of nutritional fructose). Nowadays the above observation is also supported up by well-controlled documented studies such as that of Onyesom [16]. Onyesom demonstrated that honey significantly increased blood alcohol disappearance and elimination rates by 32.4 and 28.6 percent, respectively, and reduced the intoxication time (that is, the time taken to attain zero blood alcohol level) and its degree (the peak blood alcohol level) by 30 and 4.4 percent.

With regards to the possible mechanism by which fructose accelerates ethanol metabolism, a literature review indicates a possible shift in the metabolism of fructose in the presence of alcohol. This shift has been linked to the production in the liver of NAd+ which facilitates alcohol oxidation [17, 18, 20]. Therefore, in the presence of alcohol, the metabolism of fructose in the liver is diverted from NAd+ to NADH requiring pathways, which in turn generates the NAd+ needed for alcohol oxidation.

Several clinical intervention studies on humans have been reported demonstrating the ability of either intravenous or oral fructose treatment to enhance alcohol metabolism following its ingestion i.e. namely increasing the speed of its clearance from blood. While intravenous treatment with fructose has been reported a possible practice in health care institutions, oral consumption of fructose may be more adequate for accelerating the rate of alcohol disappearance from blood in the case of occasional or light drinkers (< 20 g alcohol/day).

Various clinical interventions studies were conducted to check the oral ability of fructose to speed up the elimination of alcohol from blood. For example, Onyesom & Anosike [19] checked the effect of fructose on blood ethanol peak levels and elimination rates within a group of 10 healthy adults (3 males and 7 females, average age 23.3 years). Four hours after breakfast the volunteers were orally given a moderate dose 0.55g (20 percent) ethanol/kg body weight, on two different occasions separated by 2 weeks. They were instructed to consume the alcohol single dose within 10 minutes after diluting to 20 percent with orange squash. On both occasions, the experiments were conducted in a similar manner, with the exception of fructose use. During the first occasion, alcohol was consumed alone, but during the second, 0.25g fructose/kg body weight was administered orally after about 40 minutes of ingesting the alcohol. Blood alcohol level (BAL) was determined every 30 minutes for 90 minutes using whole blood obtained from the vein.

Oral administration of fructose however, changed the kinetics of alcohol absorption and elimination in both male and female subjects. Total intoxication time, i.e. the time needed to gain zero BAL was reduced by 41.7 percent (from 5.4 to 3.15 hours) in the men and by 40 percent (from 4.75 to 2.85 hours) in the women. Blood ethanol clearance rate, an index of blood ethanol metabolic rate, in both the male and female subjects was increased by 66.7 percent and 92.3 percent, respectively, in the presence of fructose. The increases in both genders were demonstrated to be statistically significant (p<0.05).

A review, reporting the effect of oral fructose treatment on alcohol metabolism, was internally conducted (20-28). In those reviewed studies, fructose was provided to participants (N= 5-109) who were non-alcoholics as well as alcoholics characterized by different degrees of consumptions habits. Protocols included participants groups of females, males or mix. Fructose was provided either as a single dose or as a multiple dose, along with the alcohol or after its consumption. A review of the studies shows that reported administered levels of fructose ranged from 0.25-2.0 g /kg body weight or 62-135 g / participant (total provided to participants, not on a basis of g/kg body weight). The reported increase in values of “Blood Ethanol Elimination Rate” (BEER), as a percentage above the basic rate (range: 100-110 mg/kg/hr) for all treatments, was between 6-100 percent. Shortening longitudes of intoxication was decreased also by up to 40 percent [19, 20].

In conclusion, the accumulated data originating from the above clinical studies shows that fructose while being formulated into beverage products may provide a simple way aiming to help dealing with alcohol intoxication. The mechanism supporting the above is based upon the ability of fructose to accelerate the rate of ethanol elimination from blood following consumption of alcoholic beverages.

**REFERENCES AND NOTES**

- If the same number of drinks is consumed over a longer period of time, BAC’s will be lower.