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This is the accepted manuscript of a conference paper published in Proceedings of the Worldwide Distilled Spirits Conference 2017: local roots; global reach: delivering distilling expertise to the world.

Maskell, P.D. 2018. The science of responsible drinking. In: F. Jack, D. Dabrowska, S. Davies, M. Garden, D. Maskell & D. Murray (eds.) *Proceedings of the Worldwide Distilled Spirits Conference 2017: local roots; global reach: delivering distilling expertise to the world*. Context, Packington, pp. 359-362, 6th Worldwide Distilled Spirits Conference, Glasgow, United Kingdom, 29/05/17-01/06/17.

The Science of Responsible Drinking

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Introduction

Ethyl alcohol (or Ethanol) based beverages, such as beer, wine and spirits, are some of the most consumed beverages in the world with consumption of spirits predicted to surpass 3.2 billion cases by 2020 (IWSR 2015). The alcohol industry has long realised the importance of responsible drinking and in 1989 the UK alcohol industry formed the Portman Group in part to "lead on best practice in alcohol social responsibility through the actions of member companies" (Portman Group 2017). The concept of responsible drinking is one that allows people to "experience the enjoyment that that alcoholic beverages can give but without getting in the way of normal functioning" (Portman Group 2017).

Due to the ubiquitous nature of ethanol around the world it is probably the substance that we know the most about with regard to its action on the human body, in part due to our ability to determine the amount of alcohol in blood from the 1920's (Widmark 1922). There are various "strategies" that can be used in responsible drinking such as eating before and/or during drinking, pacing drinks, and not exceeding a set number of drinks (recommended daily intake) (Carlton University 2017). In this work the the science behind these recommendations and strategies is demonstrated and also look at the science behind

some common drinking “old wives tales” such as “do drinks with bubbles in make you reach a peak blood alcohol concentration faster?”

Ethanol Pharmacokinetics

For ethanol to have an effect on the body it needs to be absorbed. In order to understand the science behind responsible drinking we need to understand the “life cycle” or pharmacokinetics (derived from the ancient Greek words “pharmakon” and “kinetikos”, meaning “drug” and “motion”) of ethanol, or more simply how does ethanol get into the body, and what does the body do to ethanol?

Ethanol is absorbed mainly from the small intestine (~80 %) and to a smaller extent from the stomach (~20 %). Following the consumption of an alcoholic beverage, the time to the peak blood concentration of ethanol is usually around 30 minutes (although this can be up to 2 hours) after the last alcoholic drink has been consumed (Holford 1987). Once the ethanol has been absorbed in the body it is distributed througout the body and can then act to give its pleasurable effects.

In comparison to many other drugs ethanol, in pharmacological terms, is a not particularly potent drug. In order to achieve “mild” euphoria we would need to consume on average 25 g to 50 g of ethanol. Compare this to aspirin (commonly used for headaches) the amount needed to have a pharmacological effect on the average human is much lower at around 0.3 – 0.9 g (Royal Pharmaceutical Society 2017).

The human body has evolved to be able to stop the pharmacological effects of ethanol. Mainly through acquisition of the enzyme alcohol dehydrogenase, enabling the conversion

of ethanol to acetaldehyde (~93-95 % of the ethanol). The presence of alcohol dehydrogenase is thought to have come about through to the exposure of humans to ethanol from fermenting fruit, or from the production of ethanol by bacteria found in the human gut (Antoshechkin 2001). Due to the high concentrations of ethanol that are encountered by humans, the rate of elimination of ethanol is constant, on average 19 mg/100 ml/hour (above blood levels of ~20 mg/100 ml) leading to predictable elimination rates of ethanol in humans (Jones 2010). The metabolites (and a small amount of unchanged alcohol (~2 – 5%) are excreted in the urine (Jones 1990) , but can also be excreted in the breath and sweat (Brown 1985) . An example blood concentration profile of ethanol can be seen in figure 1.

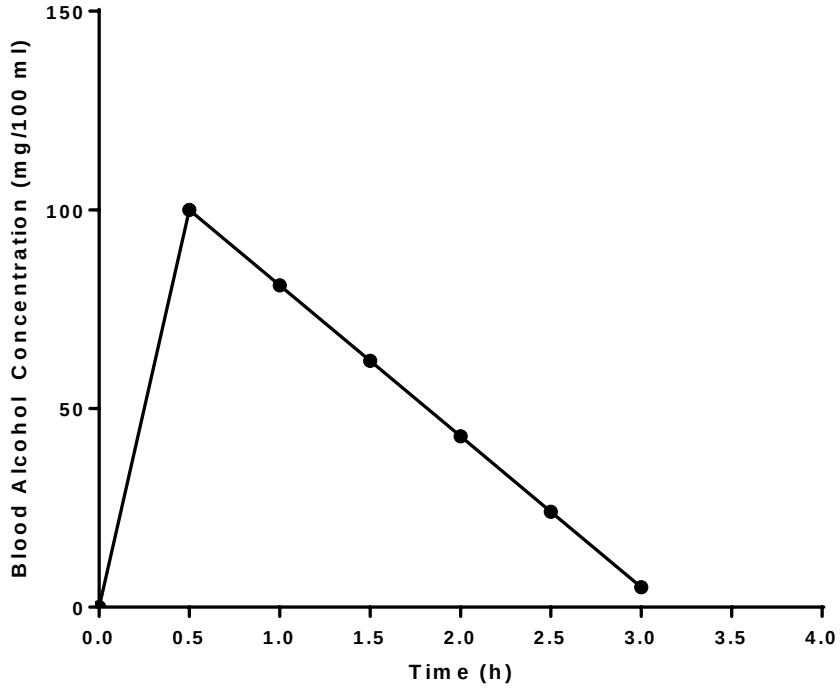

Figure 1: Theoretical blood alcohol concentration time curve

Individual variation in the response to ethanol

Eric Widmark (Professor of Medical and Physiological Chemistry at Lund University.) pioneered the research into the pharmacology and pharmacokinetics of ethanol. He quickly realised that the pharmacokinetics of ethanol is not only dependant on the sex of the person consuming the ethanol but also the individual person (Widmark 1922).

The two main factors that influence the pharmacokinetics of ethanol in an individual are their total body water and the elimination rate. Ethanol can only be distributed in the body in water so the amount of "dilution" of ethanol in the body is dependent on the total amount of water in the body (or the total body water). The bigger the person (in terms of height and lean body weight) the greater the total body water will be. If the person's height and weight are known, then the total body water can be reasonably accurately determined (Watson et al. 1980). Women have on average less body water than men, therefore for a man and a woman of the same height and weight, the woman will on average have a higher blood alcohol concentration when consuming the same amount of alcohol than the man due to having a lower body water content (Watson et al. 1980). The other important factor is the elimination rate of ethanol. On average the human body will eliminate ~8 g of ethanol per hour (1 UK unit). This however varies based on the health of the individual (for example people with liver failure will eliminate ethanol at a slower rate than healthy individuals) (Jones 2010) and also the genetics of the person which can lead to an increase in the amount of alcohol dehydrogenase in the body (such as comparing people who are teetotal

to those who drink ethanol) (Jones 2010). Overall the rate of ethanol elimination can vary from around 4 g to 17 g of ethanol per hour.

Ethanol consumption and peak alcohol concentration

As would be expected the greater the number the alcoholic beverages that are consumed, by an individual, the higher the peak blood alcohol concentration would be. Therefore, the fewer the number of beverages and commensurately a smaller amount of alcohol is consumed, the lower the peak blood alcohol concentration is observed (Wilkinson et al. 1977). The type of alcohol consumed (beer, wine or spirits) also has an influence on the peak alcohol concentration. This was demonstrated in an experiment where the same amount of ethanol (0.5g of ethanol /Kg body weight) was consumed in a 20-minute period on an empty stomach either in the form of beer, wine or a spirit. The mean peak blood alcohol concentration was higher after the consumption of the spirit (77.4 mg/100ml) compared to the wine (61.7 mg/100ml) or the beer (50.3 mg/100ml) (Mitchell et al. 2014). Showing that the type of drink consumed can influence the level of intoxication.

The peak alcohol concentration can also be influenced by the mixers that are used with spirits. In a study where the same amount of vodka was mixed with either a diet or full sugar version of a carbonated beverage, and consumed by people that had not eaten, the mean breath alcohol concentration was higher with the diet mixer (0.091g/210L = ~100mg/100ml blood alcohol concentration), than the full sugar mixer (0.077g/210L = ~84mg/100ml blood alcohol concentration). It is thought this is due to a reduction in the gastric emptying time with the diet mixer compared to the full sugar mixer (Marczinski & Stamates 2013). As

alcohol is mainly absorbed in the small intestine a reduction in gastric emptying results in reduced absorption. This was illustrated when the peak alcohol concentration was measured after a 0.8 g/Kg dose of ethanol had been given to a series of subjects, either on an empty stomach or immediately after breakfast. The mean peak blood alcohol concentration of ethanol after the meal was 67 mg/100ml compared to 104 mg/100ml after an overnight fast an approximately 33% reduction in the mean peak alcohol concentration due to the meal (Jones & Jönsson 1994). The presence of the food does not "absorb" the ethanol but as with the sweetener leads to a reduction in the gastric emptying time (Doran et al. 1998) and thus a reduction in the alcohol absorption. Therefore any prescription medicines that alter gastric emptying such as cisapride, (commonly prescribed for reflux) that increases gastric emptying will lead on average to an ~ 32% increase in the peak alcohol concentration of ethanol compared to control alcohol administration studies (Kechagias et al. 1999). The presence of carbonation of drinks has shown to lead to a faster rate of absorption of ethanol with the mean blood alcohol concentrations of carbonated beverages being significantly higher than the same concentration of ethanol diluted with water for the first 20 minutes after the consumption of the carbonated beverage. However, both types of beverage have the same mean peak alcohol concentration after 25 minutes (Ridout et al. 2003). The reason for the increased rate of absorption of alcohol in carbonated beverages is unclear.

Overall for responsible drinking it is important to limit the number of drinks consumed, to eat before or during drinking, to use full sugar mixers and to understand the changes that different types of drinks can have on the peak alcohol concentration and most importantly to drink an alcoholic beverage than you enjoy.

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