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Alcohol or Caffeine; What Would Kill You First? A Study into Common Alcoholic Beverages Consumed by University Students.

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Abstract
Jägerbombs and VKs contain very high levels of alcohol and caffeine. By using the manufacturer's figures for the levels of these two substances, the volume that would need to be drunk to reach a lethal dose was modelled. This was calculated by using LD_{50} figures for alcohol and caffeine. In both Jägerbombs and VKs it was calculated that the alcohol would be at a lethal level prior to the caffeine. 67 Jägerbombs or 53 bottles of VK are required to reach the lethal dose of alcohol in a median human of 65 kg.

Introduction
Binge drinking has become a common issue in university culture but what really is the limit to which an average sized human can push themselves to? Mainstream media frequently report the dangers regarding the consumption of alcohol mixed with caffeine [1]. Caffeine is a widely consumed stimulant producing the desired effect of increased alertness [2]. By increasing the heart rate and constricting the blood vessels the desired effect is achieved; however at high dosage this can lead to myocardial infarction [2]. Although a lethal dose is known, the drug has been known to kill in much lower doses in persons with heart problems. Alcohol on the contrary is a commonly devoured depressant which gives users a feeling of euphoria at low doses. At higher doses its effects include lethargy, confusion, stupor and coma. Ultimately alcohol can cause death from respiratory depression however other side effects can cause death prior to its primary effect [3]. This is without mentioning the potential long term damages that alcohol can do to the body, in particular, the liver.

This paper has been written to deduce the quantities of caffeine and/or alcohol that would be required to potentially kill someone. This does not mean that drinking this quantity of alcohol or caffeine is safe. The authors of this paper are in no way responsible for any injuries or deaths caused by alcohol or caffeine and do not condone the use of these drugs beyond a person's safe limits.

'Jägerbombs' consisting of Jägermeister and an energy drink, such as Red Bull, are frequently consumed by socialites. Other beverages such as VKs aim to encapsulate the mixture, whilst providing an enticing flavour.

Assumptions
For the purpose of this calculation it is presumed that a Jägerbomb contains 100 mL of Red Bull with caffeine content of 32 mg/100 mL [4] and 25 mL of Jägermeister (35% ABV) [5] with an ethanol content of 27.62 g/100 mL. Whereas VK contains 14 mg/100 mL of caffeine and 3.156 g/100 mL of ethanol (4% ABV) [6].

The alcohol component of each drink is assumed to be entirely ethanol, having a density of 0.789 g/cm^3 [7]. All the alcohol is presumed to be absorbed by the body and ingested without factoring time. The LD_{50}—median lethal dose—is the dosage required of a given substance to eradicate half the sample population. In this paper the figures for laboratory rats have been quoted and are accepted to be of the same value as a human. The bioavailability is assumed to be 1 for alcohol and caffeine as their experimental values are very close to this figure [2, 3].

Calculations

In a Jägerbomb it is calculated that there is 25.6 mg/100 mL of caffeine and 5.52 g/100 mL of ethanol. This was done by the simple calculation:

$$\frac{100\ mL}{125\ mL\ (vol.drink)} \times mass\ of\ drug\ per\ 100\ mL$$

It is found that the LD_{50} of alcohol is 7.06 g/kg of body weight [8] and the LD_{50} of caffeine is 175 mg/kg of body weight [9]. This would mean that 128 mL/kg of alcohol would need to be consumed to reach the median lethal dose. This opposes to 684 mL/kg of caffeine. The inference from this is that alcohol would be in lethal doses prior to caffeine in Jägerbombs of this concentration. It can also be deduced that in an average human, with a weight of 65 kg, 67 Jägerbombs would need to be ingested to kill them.

Conversely in a VK, with the values previously stated, 1250 mL/kg of the beverage would be required to reach the lethal dose of caffeine. 224 mL/kg of the drink would be needed to reach the LD_{50} for alcohol. This produces the same conclusion that alcohol would reach a lethal level before caffeine. This equates to 53 bottles of 275 mL in volume.

Conclusion

To conclude, the original aim of this paper was to determine what substance would kill first out of caffeine and alcohol, in commonly consumed beverages. It was found that in Jägerbombs, the alcohol would be in a lethal dose before the caffeine and the same conclusion was determined for a VK. Jägerbombs and VKs required 67 servings and 53 bottles respectively to reach the median lethal dose of alcohol. This figure is obviously extremely high and under real life conditions drinking this much alcohol would be very dangerous. As previously discussed, the secondary effects of alcohol are often lethal prior to its primary effect. Caffeine is also a drug which affects every individual very differently. Although the LD_{50} is 175 mg/kg, individual cases have been able to exceed this quantity by many factors.

In both cases, drinking this quantity of fluid also puts the body at very high risk of hyponatremia. There is also a risk of reaching the LD_{50} of other substances within these drinks that are not modelled in this paper.

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