Smartphone-Based Colorimetric Determination of Gamma-Butyrolactone and Gamma hydroxybutyrate in Alcoholic Beverage Samples

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GBL and GHB and Crime

Clockwise from left, serial rapist Reynhard Sinaga, Grindr serial killer Stephen Port, and robber and murderer Gerald Matovu all used 'G' on victims

Serial killer Stephen Port, responsible for the deaths of four men in London, used 'G' to murder victims he met on the gay dating App Grindr. His drug dealer, Gerald Matovu, went on to murder actor Eric Michels using the drug.

George Michael: GHB levels were found in blood on several occasions.

The Sun V & SHOWBIZ | NEWS | FABULOUS | MONEY | TECH | TRAVEL | MOTO

OVERDOSE IN BATH George Michael overdosed on party drug GHB and was rushed to hospital after collapsing in the bath

George Michael was found unconscious in a bath in 2014, and needed emergency treatment, after taking the Class-C muscle relaxing drug

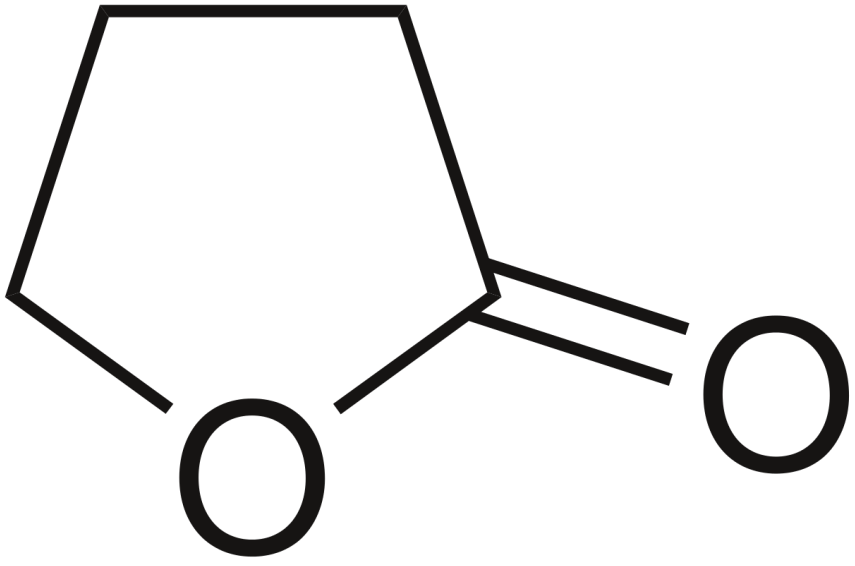
EXCLUSIVE

Ben Leo | Chris Pollard | Michael Hamilton
21 Jul 2018, 22:35 | Updated: 21 Jul 2018, 22:41

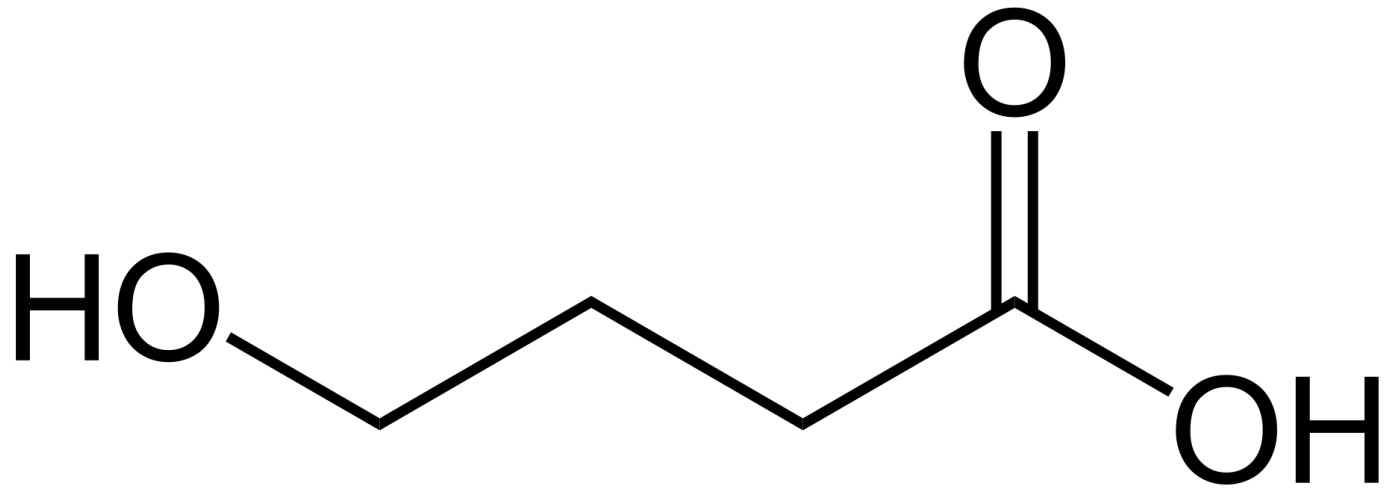
7 Comments

GEORGE MICHAEL once overdosed on party drug GHB, it has emerged.

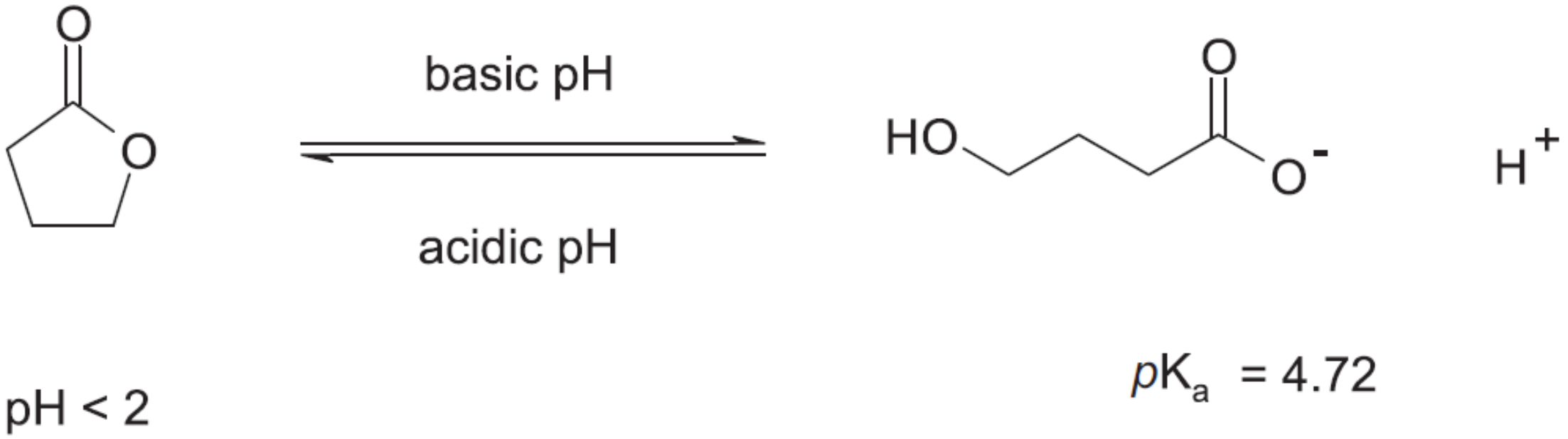
He was found unconscious in a bath in 2014 after taking the Class-C drug.



Gamma-Butyrolactone (GBL)



Gamma hydroxybutyrate (GHB)



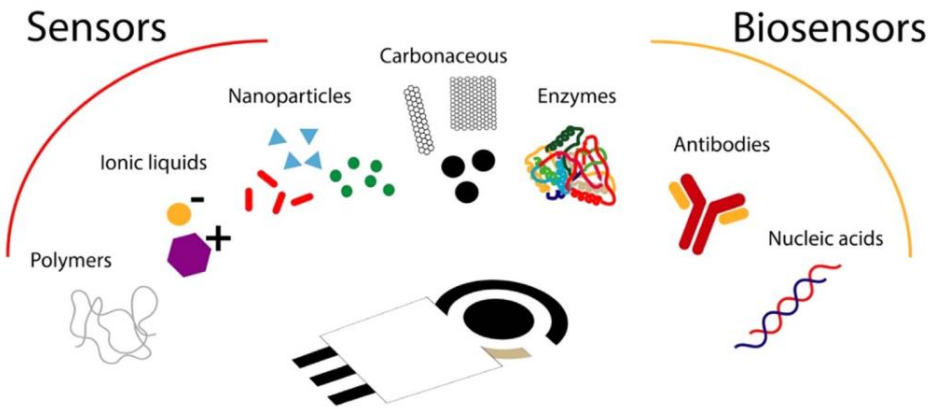
- GBL can be readily converted to GHB, either by relatively simple chemistry such as pH adjustment.
- Internal Fischer transesterification.
- GHB is the predominant species at pH values >12.
- Under acidic conditions, the particularly stable lactone, GBL is formed, playing a significant role in the solution chemistry of GHB.

Difficult to Detect

- **Not** looked for in standard drug screens.

- **No chromophores** – making UV-based detection difficult.

- **Biosensors** - detection based on the reduction of NAD^+ by a GHB-specific recombinant enzyme. Difficult to get specific enzymes.



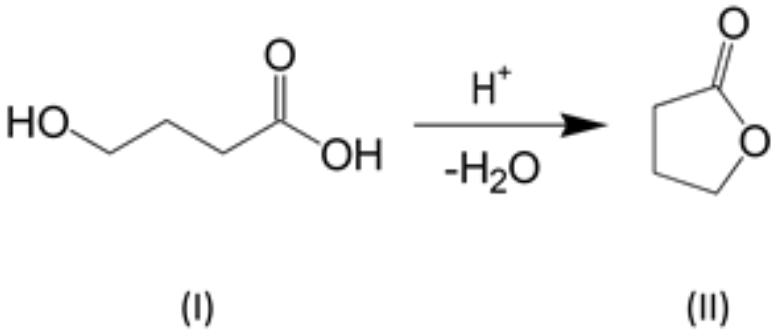
- **LC/MS** – the low molecular mass of GHB and GBL does not make them good target compounds for this approach.

- **Gas chromatography** - needs conversion of GHB to GBL or its conversion to the silyl derivative. Both processes are hampered by the polar nature of GHB and the difficulty of removing water for successful derivatization.

Our Colorimetric Method

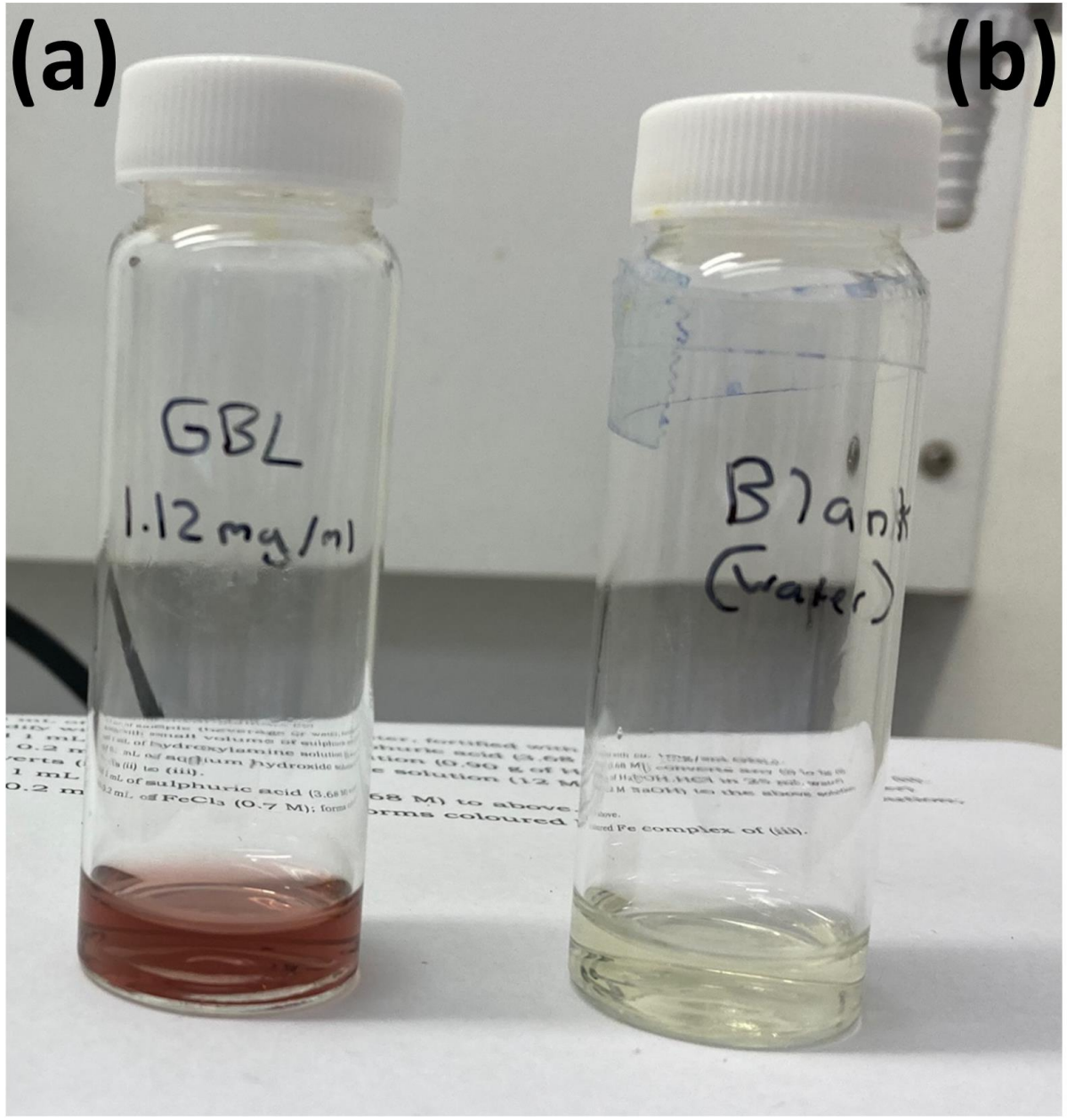
The addition of acid to the sample converts the **GHB** (I) present to its lactone, **GBL** (II).
Both the GHB and the GBL that could be present are now converted to be all GBL.

This can then be converted to a **Red-coloured complex** by the addition of hydroxylamine and ferric chloride.



(I) (II)

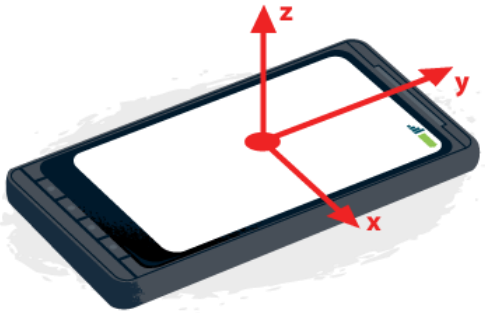
Normally be examined using laboratory-based spectrometry.

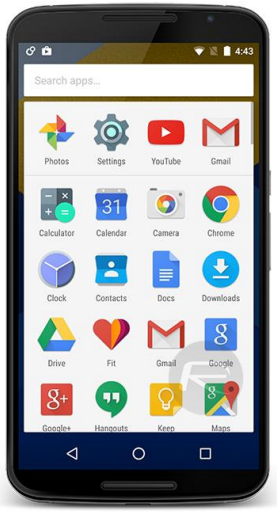


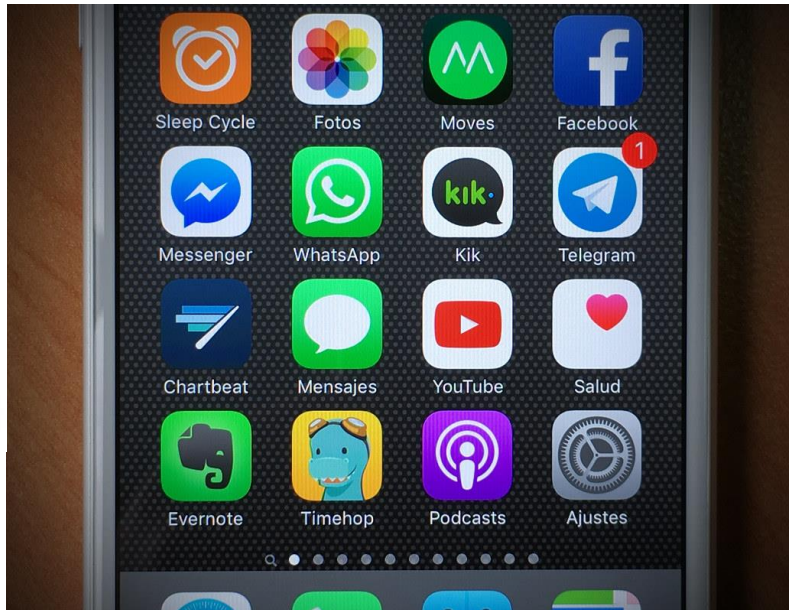
Colour developed in the presence of (a) GBL (b) absence of GBL

Smartphones

Numerous applications
Cameras
Compasses
Accelerometers
Gyroscopes
Lux meters
microphones
Even Geiger counters

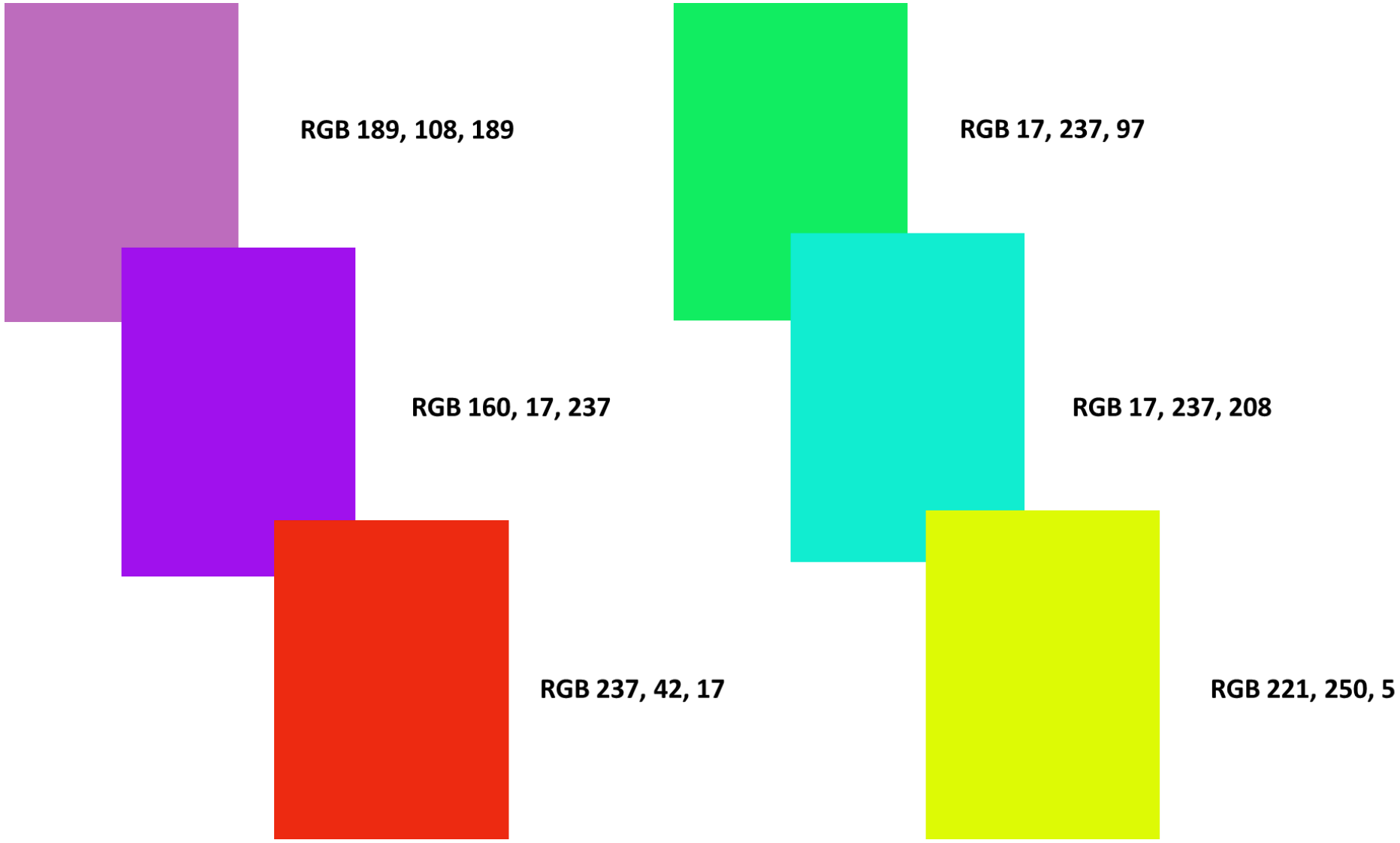






Digital Colour

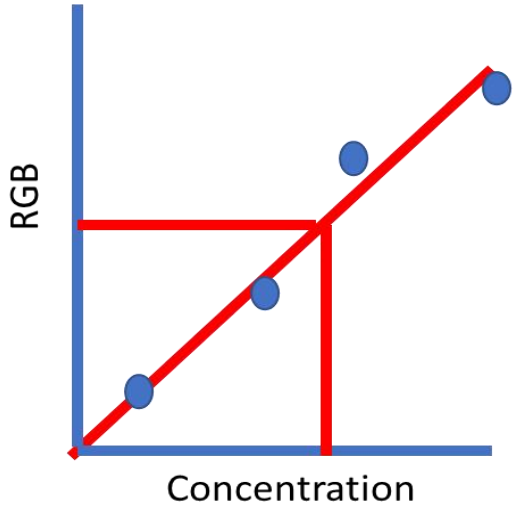
- Most phone cameras use an 8-bit jpeg image.
- The 8-bit picture provides 256 variations (2^8) for each colour channel (**red,** **green,** and **blue**) which can be expressed as a numerical value between 0 and 255 for each colour.
- Reflected colour.
- RGB for white 255, 255, 255
- Black 0, 0, 0
- Any colour in between can be expressed as an RGB ‘blend’ of the three numerical values.



Smart phone

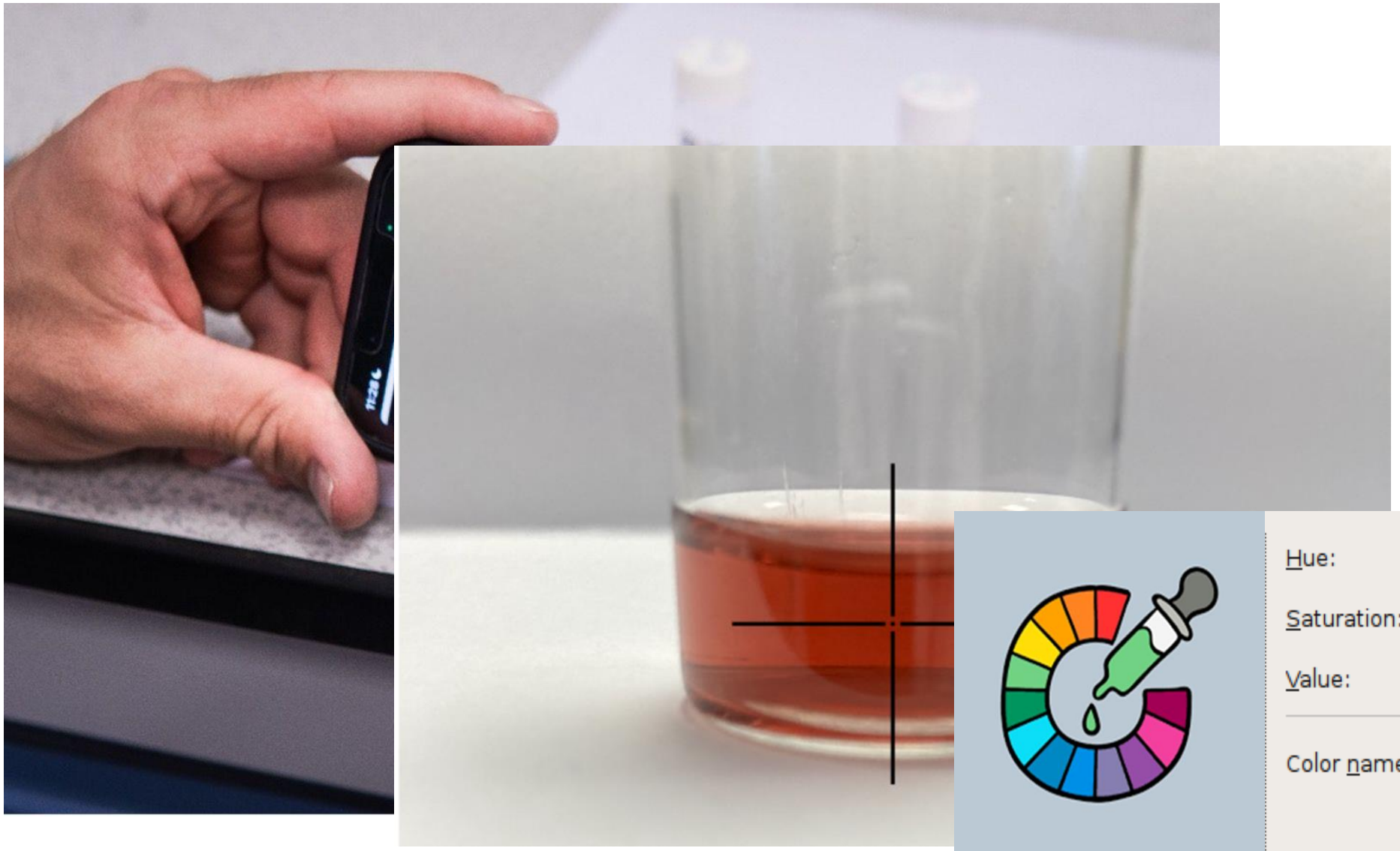
RGB App

Colour Picker and Helper

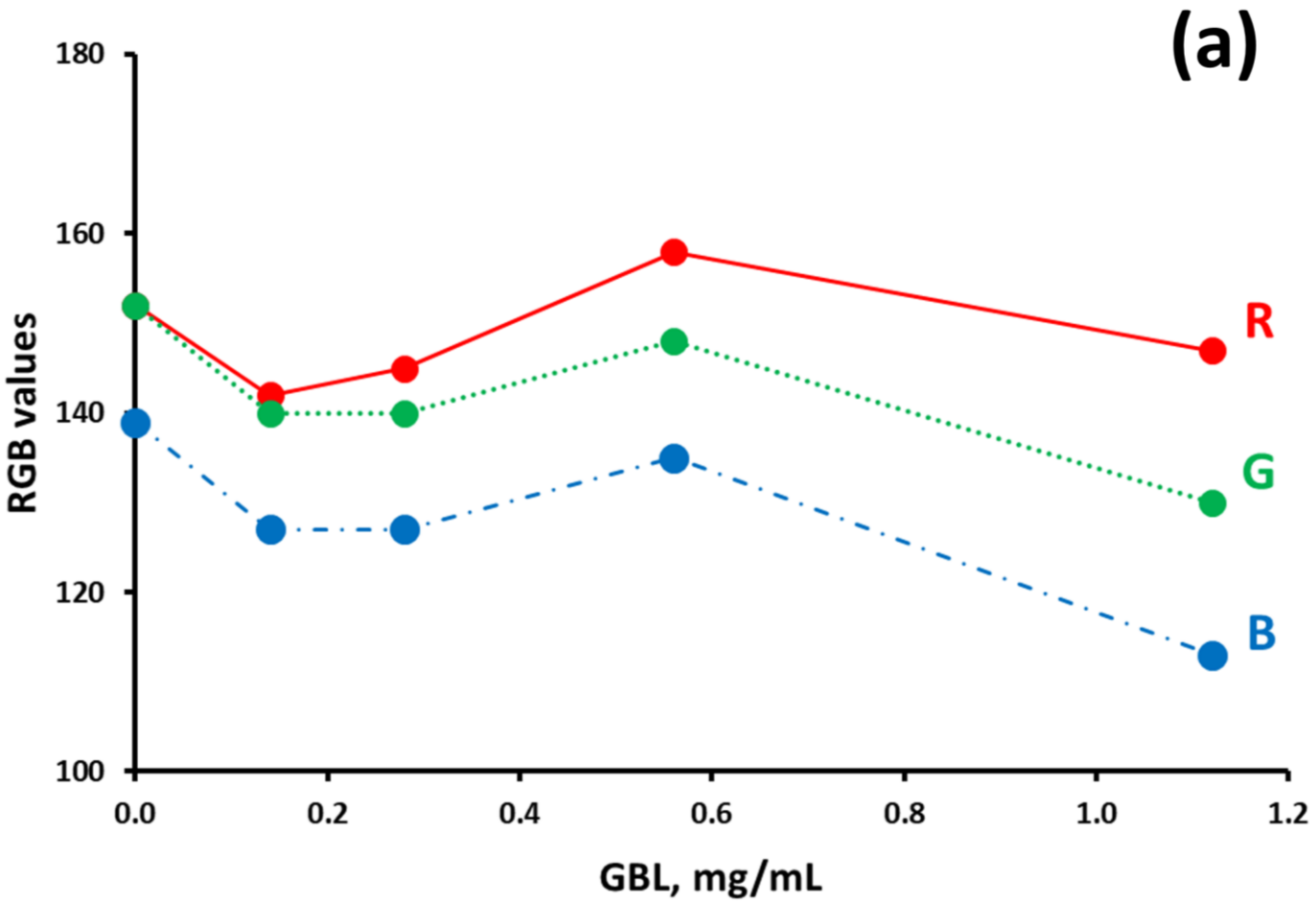


Concept

- Colorimetric reaction: greater the concentration of drug (GHB/GBL); the more colour developed.
- Image of colour developed taken with a Smartphone camera.
- Downloadable free App, to examine the **red**, **green**, and **blue** (RGB) colour and convert them to numerical values.
- RGB numerical values can be plotted against known concentrations of the analyte to construct a calibration curve.
- Sample concentrations can then be found by interpolation or rearrangement of y = mx + c.



Hue: 53
Saturation: 69
Value: 99
Red: 252
Green: 233
Blue: 79
Color name: #FCE94F
Cancel
OK



Initial Results

Little correlation with the concentration of the GBL colour product was observable for the raw RGB data collected.

$$\%R = \left(\frac{R}{R + G + B}\right) \times 100 \qquad \text{eq. 1}$$

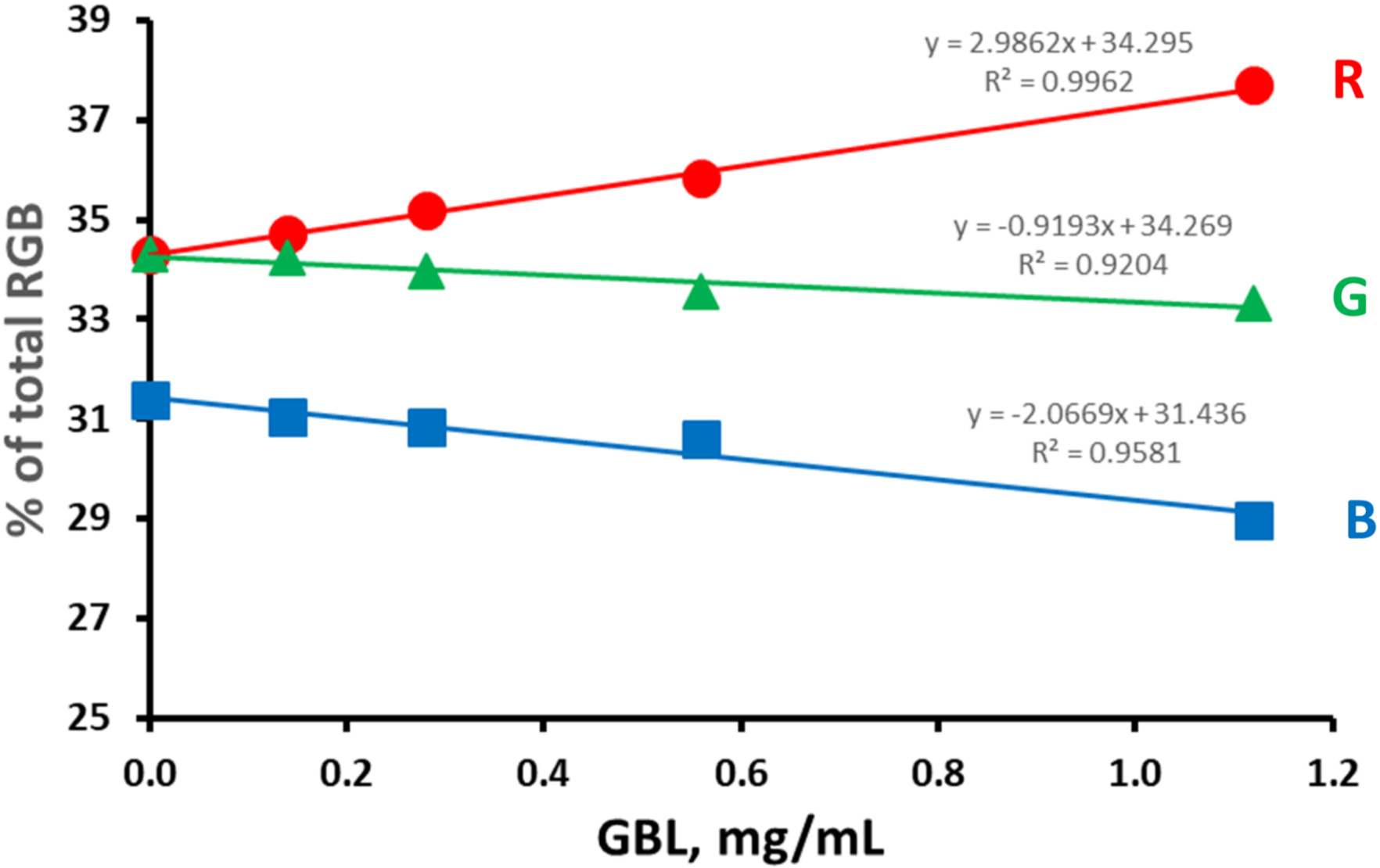
$$\%G = \left(\frac{G}{R + G + B}\right) \times 100 \qquad \text{eq. 2}$$

$$\%B = \left(\frac{B}{R + G + B}\right) \times 100 \qquad \text{eq. 3}$$

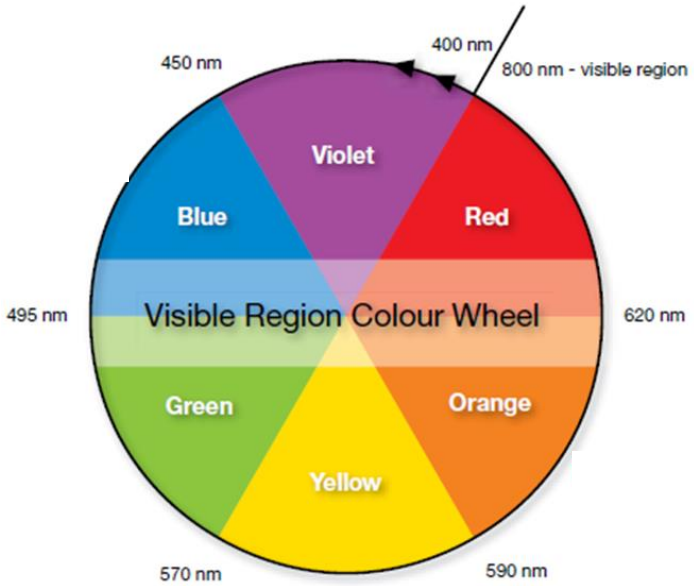
Simple processing:
The most readily achievable approach, which we have employed here, is to normalize the individual R, G, and B values as a percentage of the total RGB (equations 1, 2, and 3).

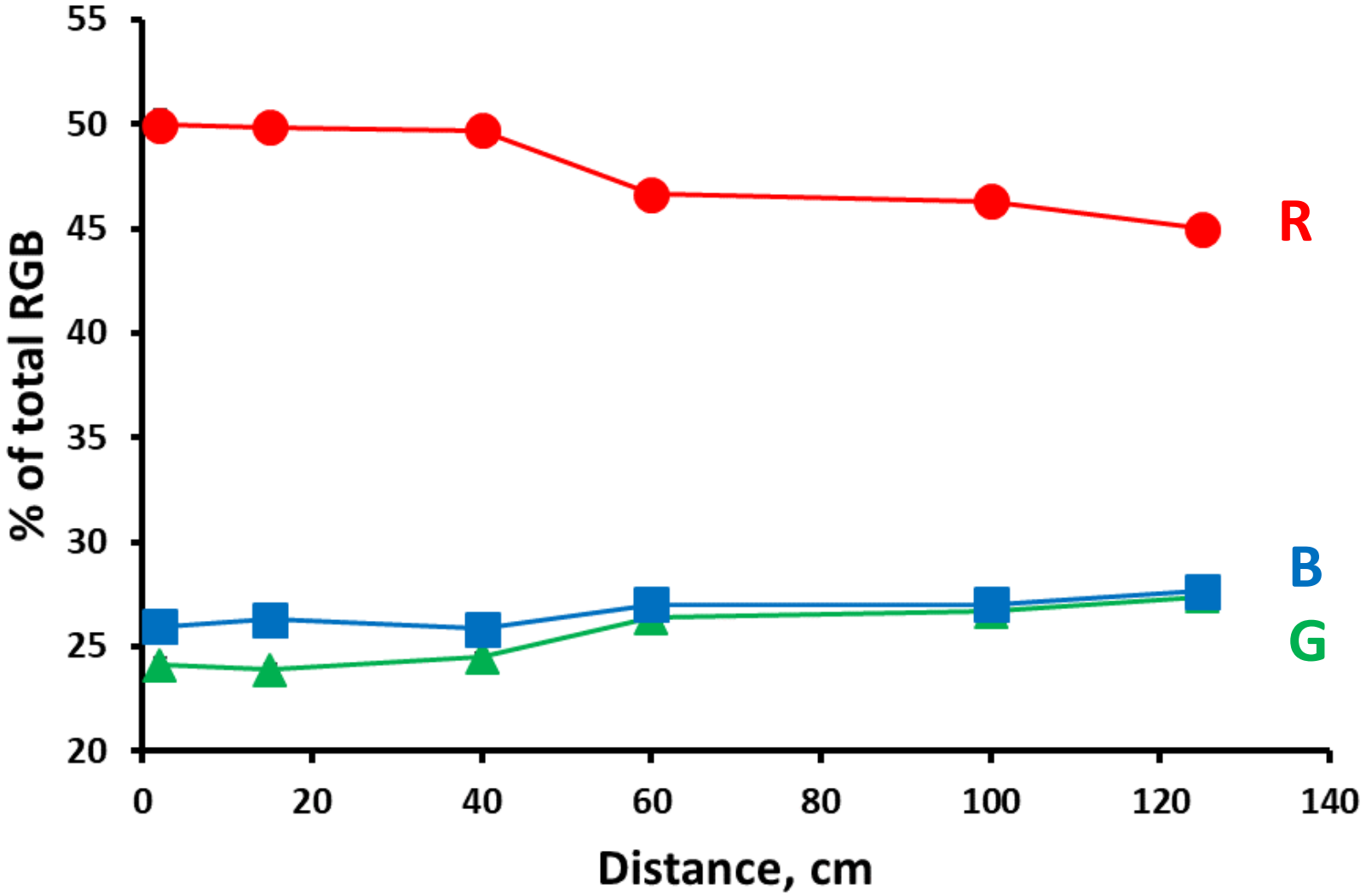
Normalising the RGB data in such a way corrects for variables such as local illumination, viewing angle, and distance.

Once corrected, as a percentage, plots of %R, %G, and %B all showed good linear relationships (R^2 of 0.996 for the % R) with the concentration of GBL over the entire range investigated.

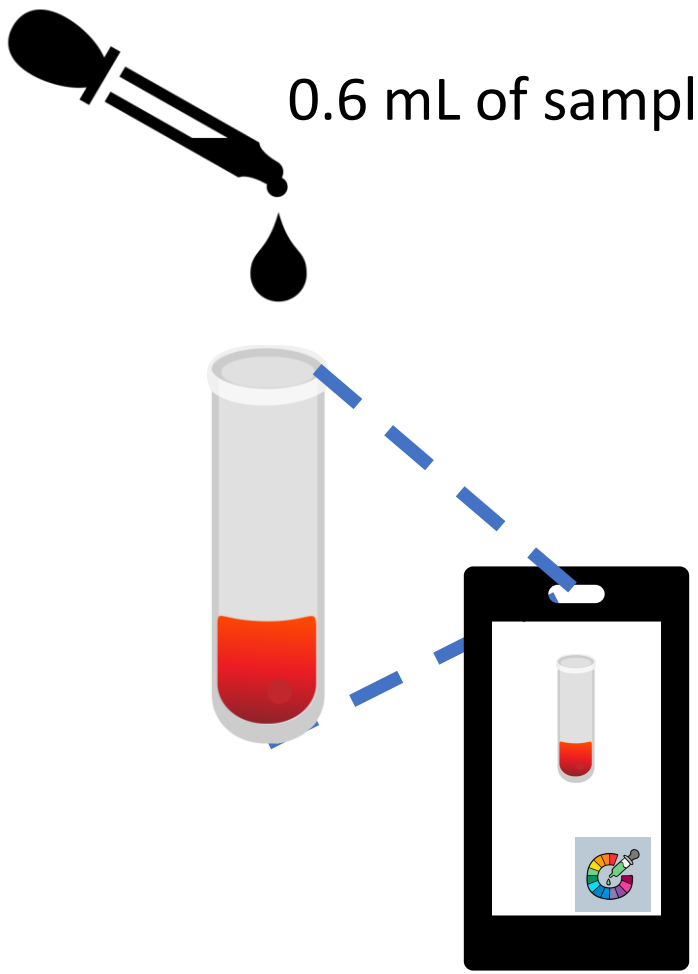


The colour wheel



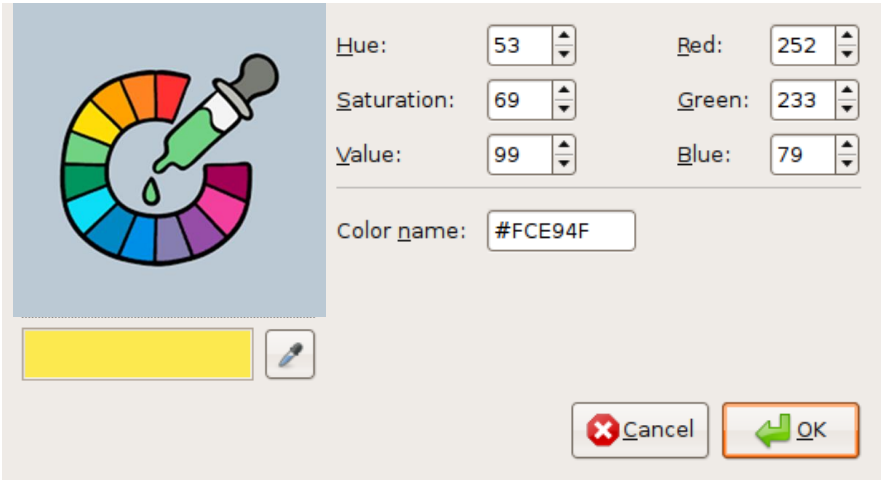


Plots of the relationship between the %red (%R), %green (%G), and %blue (%B) with distance of the smartphone camera from the colour source. Each point is a mean of three separate images.



GBL determinations on a sample of fortified lager beer

Mean recovery of 103% (%CV = 0.70%, n = 5) at a concentration of 0.56 mg/mL.

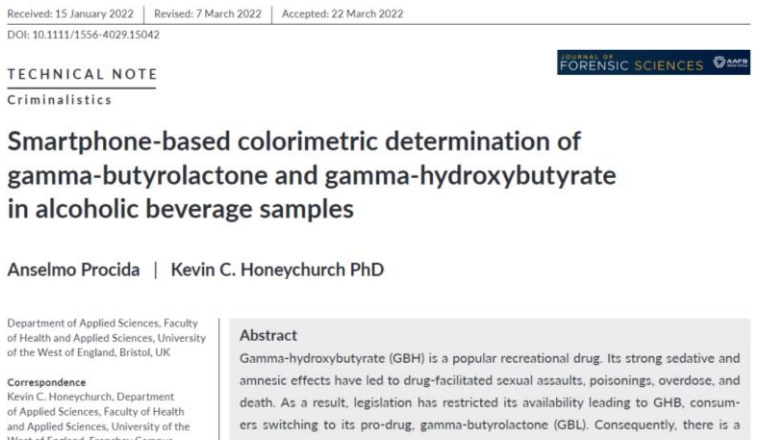


Conclusions

- Simple chemical reaction can be used to convert GHB and GBL to a coloured complex.
- Imagines of this can be taken with a smartphone camera.
- The **red, green,** and **blue** (RGB) colour values of these can be obtained using a downloadable free App.
- Following simple mathematical processing these RGB values can be used to give the concentration of the drug present.
- This research blends well-understood chemistry with new technology; theoretically limitless opportunities and impact.

References

- Procida, A., Honeychurch, K. C. (2022). Smartphone-based colorimetric determination of gamma-butyrolactone and gamma-hydroxybutyrate in alcoholic beverage samples. *Journal of Forensic Sciences*, 67(4), 1697-1703. https://doi.org/10.1111/1556-4029.15042



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TECHNICAL NOTE

Criminalistics

JOURNAL OF FORENSIC SCIENCES

Smartphone-based colorimetric determination of gamma-butyrolactone and gamma-hydroxybutyrate in alcoholic beverage samples

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Abstract

Gamma-hydroxybutyrate (GBH) is a popular recreational drug. Its strong sedative and amnesic effects have led to drug-facilitated sexual assaults, poisonings, overdose, and death. As a result, legislation has restricted its availability leading to GHB, consumers switching to its pro-drug, gamma-butyrolactone (GBL). Consequently, there is a

- https://epigram.org.uk/2023/01/19/a-new-app-is-being-developed-by-uwe-researchers-to-detect-spiked-drinks/

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