

## ABILITY OF COMMERCIALY AVAILABLE “DATE-RAPE” DRUG TEST KITS TO DETECT GAMMA- HYDROXYBUTYRATE IN POPULAR DRINKS<sup>1</sup>

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### ABSTRACT

Gamma-hydroxybutyrate (GHB) is one of the most widely-used drugs for drink adulteration in “date-rape” cases. Several test kits have been introduced to detect GHB in drinks. These include “DrinkSafe™” cards, “DrinkSafe™” coasters, and “Drink Detective™” test kits. This work was conducted to determine how well the available kits detect GHB in a variety of beverages. Using synthetic GHB in pure water, all three test kit types gave a positive blue response. No false negatives were observed. Gamma-butyrolactone and water gave no response on any of the kits. Experiments with beverages containing GHB focussed on the “DrinkSafe™” products because they provide two test areas on each card, allowing spiked and unspiked beverages to be compared directly. Using the original green colour of the “DrinkSafe™” products as a reference, seven of the eleven drinks gave an obvious blue reaction with the cards and nine of eleven with the coasters. In both cases, GHB-spiked Cosmopolitan and Margarita samples gave false negatives. With all beverages, however, the control drink changed the colour of the test spot. This reproducible difference in colour between the control and the spiked samples suggests that by putting an unadulterated sample of drink onto the test card, an individual could greatly increase their chances of detecting GHB in their beverage. Despite some limitations, the low cost of the kits and their apparent reliability suggest that they would be a useful screening tool for officials investigating rape cases.

### RÉSUMÉ

L'acide gamma-hydroxybutyrique (GHB) est une des drogues les plus souvent utilisées pour altérer les boissons dans les cas d'agressions sexuelles commises par une connaissance de la victime («date-rape»). Plusieurs trousseaux d'analyses ont été introduites pour détecter la présence de GHB dans les boissons dont : les cartes «DrinkSafe™», les sous-verres «DrinkSafe™» et les trousseaux «Drink Detective™». Cette étude a été réalisée pour déterminer l'efficacité de ces trousseaux dans plusieurs types de boissons. Toutes les trousseaux ont détecté la présence de GHB dans l'eau pure en tournant au bleu et indiquant ainsi un résultat positif. Aucun faux négatif n'a été observé. Le gamma-butyrolactone dans l'eau n'a été détecté par aucune de ces trousseaux. Les produits «DrinkSafe™» ont été utilisés pour effectuer les tests de GHB dans les boissons, car chaque carte comporte deux zones de tests permettant de placer un échantillon provenant d'une boisson dopée et un échantillon d'une boisson non dopée et de comparer directement les résultats. En utilisant la couleur verte originale des produits «DrinkSafe™» comme point de référence, sept des onze boissons ont provoqué une réaction évidente en tournant au bleu avec les cartes et neuf des onze avec les sous-verres. Dans les

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**deux cas, des faux négatifs ont été obtenus avec les échantillons de Cosmopolitan et les Margarita dopés au GHB. Cependant, dans tous les cas les échantillons de référence ont modifié la couleur de la pastille du test. La différence de coloration reproductible entre les échantillons contrôles et les échantillons dopés suggère qu'en plaçant un échantillon de boisson non altérée sur la carte de test, une personne peut grandement augmenter ses chances de détecter la présence de GHB dans ses boissons. Malgré quelques limitations, le faible coût de ces trousseaux et leur fiabilité apparente suggèrent qu'elles pourraient être utiles comme outil de détection pour les policiers enquêtant dans les dossiers d'agressions sexuelles.**

## INTRODUCTION

According to a recent study in Canada (1) more than 1 in 4 sexual assaults occur after a woman has been drugged by her assailant. The vast majority of these women are 15-19 years old. In 2004, researchers at the Department of Family Practice at the University of British Columbia conducted a study to measure the extent of drug induced "date-rape". Prior to 1998, 3.4 females in every 100,000 women were victims of "date-rape". By 2002 that number had increased to 10.7, a threefold increase in a span of approximately four years. The increase in numbers is more pronounced among teenagers where 59.3 per 100,000 teenaged girls were victimized in 2002 as opposed to 15 per 100,000 prior to 1998 (1). Researchers also examined 1,594 sexual assaults that were reported to the Sexual Assault Service between 1993 and 2002. In total, 246 or 15.4% of cases were considered to be sexual assaults facilitated by "date-rape" drugs (1).

One of the most widely used "date-rape" drugs is  $\gamma$ -hydroxybutyrate or GHB. It has become the rapist's drug of choice as it has no taste, colour or odour, making it hard to detect in a drink (2). It is a naturally occurring compound found in trace amounts throughout the human body and is, chemically, very similar to the neurotransmitter  $\gamma$ -amino butyric acid (GABA).

GHB has been used since the 1960's as a general anesthetic and a possible treatment for sleep disorders such as narcolepsy (2,3). It was also widely used in the body building community as an alternative to steroids (4,5). The American Food and Drug Administration (FDA) classified it as a controlled substance in November 1990. Since 1990 the Drug Enforcement Administration (DEA) has documented over 15,600 GHB overdoses, law enforcement encounters, and 72 deaths relating to GHB (6). In March of 1998  $\gamma$ -hydroxybutyric acid was added to the Canadian Controlled Drugs and Substances Act (CDSA) as a Schedule III controlled substance (5).

Available precursor chemicals can be converted chemically into GHB. Many individuals still synthesize this drug for personal and medicinal purposes (anti-aging remedy) using recipes found on the Internet (7). The most common synthesis converts  $\gamma$ -butyrolactone into GHB using sodium hydroxide. Consequently the lactone is regulated as a Class A Precursor in Schedule VI, Part 1 of the CDSA (8). Gamma-butyrolactone is also used as a "date-rape" drug. When it is ingested directly,  $\gamma$ -butyrolactone can be rapidly converted by the body into GHB (4). The effects of  $\gamma$ -butyrolactone are longer-acting and have a shorter onset, but are otherwise identical to GHB.

A key concern with GHB is that there is only a small difference between the dose which leaves the victim unconscious and a dose that may lead to death. A heavy dose is approximately 2.5 grams of GHB. An extra 0.25 grams could be the difference between euphoria and unconsciousness. A dangerous overdose can occur with as little as two grams depending on body weight and the individual's metabolism. Some GHB overdoses lead to unconsciousness, vomiting and a loss of the gag reflex, putting the victim in grave danger of aspiration and death.

The fear of date rape leads women to take many precautions to protect themselves against drink adulteration. They can no longer leave their drinks unattended. Open punch-bowls are now a source of suspicion among women, as a drug can easily be added. Even accepting a drink that has been purchased for them can be a risk.

Kits are now available which claim to detect date rape drugs in beverages. The “DrinkSafe™” cards, “DrinkSafe™” coasters, and “Drink Detective™” test kits are all available for purchase via the Internet (10,11). Another kit, The GHB Drug Card, allows the consumer to use it multiple times as it comes in the form of a plastic card, although at the time this research was conducted they did not appear to be available for purchase (12). GHB cannot be purchased legally in Canada and as a result there is no way for a consumer to test these kits to determine whether they actually work. This research was undertaken to fill this knowledge gap.

## MATERIALS AND METHODS

The following were used in the synthesis of  $\gamma$ -hydroxybutyrate (GHB) and confirmation of the synthesis:

- Gamma-butyrolactone, 99% (Sigma Aldrich, Oakville, Ontario)
- Sodium Hydroxide, 97% (Anachemia, Rouses Point, New York)
- Ferric Chloride ( $\text{FeCl}_3$ ), 99% (Sigma Aldrich, Oakville, Ontario)
- Silver Nitrate ( $\text{AgNO}_3$ ), 99% (Sigma Aldrich, Oakville, Ontario)
- Ethanol, 95% (Caledon Laboratories, Georgetown, Ontario)

The ingredients used for mixing the beverages were purchased from the Liquor Control Board of Ontario (LCBO) and local grocery stores.

The date rape detection kits and coasters were purchased from Test Medical Symptoms at Home Incorporated (10). The kits used in the experiments were:

- “DrinkSafe™” Date Rape Drug Test Cards (Drink Safe Technologies, Plantation, Florida, USA)
- “DrinkSafe™” Date Rape Drug Test Coasters (Drink Safe Technologies, Anderson, Alabama, USA)
- “Drink Detective™” Test Kits (WayPoint Biomedical, Inc., Huntington Beach, California, USA)

### *GHB Synthesis*

GHB was synthesized by base hydrolysis of  $\gamma$ -butyrolactone (7). The reaction employed sodium hydroxide in water to which gentle heat was applied. Assuming complete conversion, the aqueous solution of GHB contained 0.135 g/mL of GHB solution. The pH of the final solution was 9. The material gave a positive reaction with ferric chloride (13) and characteristic fine needle crystals of AgGHB in the presence of alcoholic silver nitrate (14). The crystals turned black with time as reported (14). Conversion of  $\gamma$ -butyrolactone to GHB was also confirmed by GC-MS employing a Hewlett Packard 5890 GC interfaced to a model 5971 mass selective detector (Hewlett Packard Company, Palo Alta, CA). The GC was equipped with a 30 m StabilWax DA capillary column (Restek Corporation, Bellefonte, PA) temperature programmed from 75 to 250 °C at 10 °C/minute. The injector was operated in split mode. The pH of the aqueous samples was adjusted to 3 and the samples injected directly without extraction. The analysis showed that GHB (m/z 55, 60, 74, 86) was the predominant product of the synthesis. Trace levels of  $\gamma$ -butyrolactone (m/z 56, 86) and butanoic acid (m/z 55, 60, 73, 88) were detected.

### *Preparation of Alcoholic Beverages and Testing the “Date-Rape” Detection Kits*

Eleven of the most popular beverages among club-goers were identified (15) for use in these experiments. The drinks included: margarita, martini, gin & tonic, Cosmopolitan, Bloody Mary, Blue Lagoon, rum & coke, Vex vodka cooler, beer (lager), red wine, and white wine. The drinks were prepared using standard ingredients and available recipes (15).

Each drink was first prepared in a 250 mL disposable beaker then spiked with GHB giving a final concentration of 0.014 g/mL; a concentration at the high end of the usual dose range according to the literature (6). The control beverages contained no GHB. The pH of all drink preparations was measured using pH paper. The treated and untreated drinks were applied to the GHB area of the detection cards using a Pasteur pipette.

## **RESULTS AND DISCUSSION**

Figure 1 shows the “DrinkSafe™” card, “Drink Detective™” test kit, and “DrinkSafe™” coaster. Each “DrinkSafe™” card and coaster can accommodate two drinks and each test is used to detect two different drugs: Ketamine in the pink area and GHB in the green. According to the manufacturer, if either spot turns to a darker blue, a possible date rape drug has been detected. The “Drink Detective™” test kit detects GHB, Ketamine, and Benzodiazepine but only accepts one sample per card.

### *Confirming the Response of the Test Cards in the Presence of GHB and its Precursors*

The three detection kits were tested with synthetic GHB solution (0.135 g/mL), the precursor  $\gamma$ -butyrolactone (0.136 g/mL) and water, which was used as a control.

Figures 2, 3, and 4 show that all of the kits gave a positive blue reaction when GHB was applied. This experiment was repeated six times with the “DrinkSafe™” Cards. A positive blue response was observed in each case. Gamma-butyrolactone and water gave no response. A negative reaction for the “Drink Detective™” test kit, shown in Figure 2, is pink while the “DrinkSafe™” cards or coasters, shown in Figures 3 and 4, give a green negative. The application of  $\gamma$ -butyrolactone was repeated five times with the “DrinkSafe™” Cards and four times with the coasters. A negative response was observed in each case.

### *Finding the Working Range of the “DrinkSafe™” Cards*

According to the literature (6), a GHB dose in the range of 2-4 grams will render a victim incapacitated, if ingested. Assuming a typical drink to be 250 mL, this converts to a concentration range of 0.008 to 0.016 g/mL. The manufacturer states (2,11) that the cards were designed to detect GHB in the 0.012 g/mL range. To find the working range of the test kits, GHB was diluted in water to give solutions ranging from 0.0033 g GHB/mL to 0.012 g GHB/mL, reflecting an actual dose of 0.83 to 3.1 grams in a 250 mL drink.

All the GHB solutions turned the test areas blue. Water did not give a positive reaction and did not change the original colour of the test area. As the concentration of GHB increased, the blue response became slightly darker. This shows that the cards satisfactorily work in the 0.0033 g/mL to 0.012 g/mL range, confirming the claims of the manufacturers (2,11).

### *Testing the Behaviour of “DrinkSafe™” Cards and Coasters Using a Variety of Alcoholic Beverages*

The drinks chosen for these experiments represented a series of the most widely consumed beverages but also covered a range of colours, composition and pH, as summarized in Table 1.

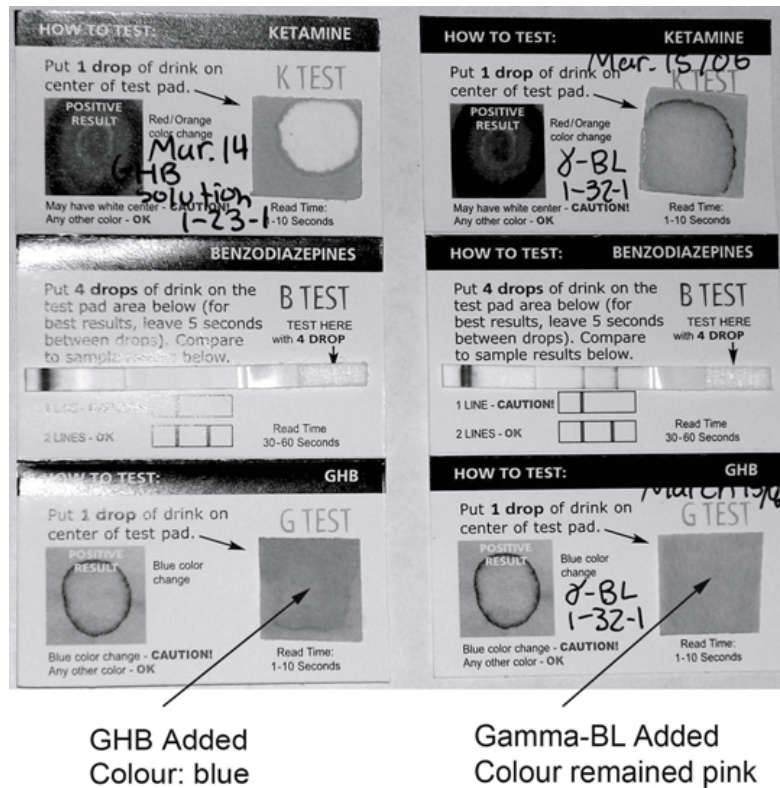


**Figure 1.** “DrinkSafe™” Coaster (top), “DrinkSafe™” Card (middle) and “Drink Detective™” Test Kit (bottom).

The following experiments were carried out using only the “DrinkSafe™” cards and coasters because unlike the “Drink Detective™” test kits, the cards and coasters had two test areas each. This allowed us to compare GHB-spiked and un-spiked beverages on the same card.

The results of our testing with the “DrinkSafe™” cards are summarized in Table 2 below. The results of the tests with the coasters are summarized in Table 3.

Using the original green colour as a reference, as suggested by the manufacturer, only seven of the eleven drinks gave an obvious blue reaction. These seven are: martini, gin & tonic, lager beer, white wine, Blue Lagoon, vodka cooler, and rum and coke. Two of the



**Figure 2.** Reaction of GHB preparation and  $\gamma$ -Butyrolactone (Gamma-BL) with the “Drink Detective™” Test Kit.

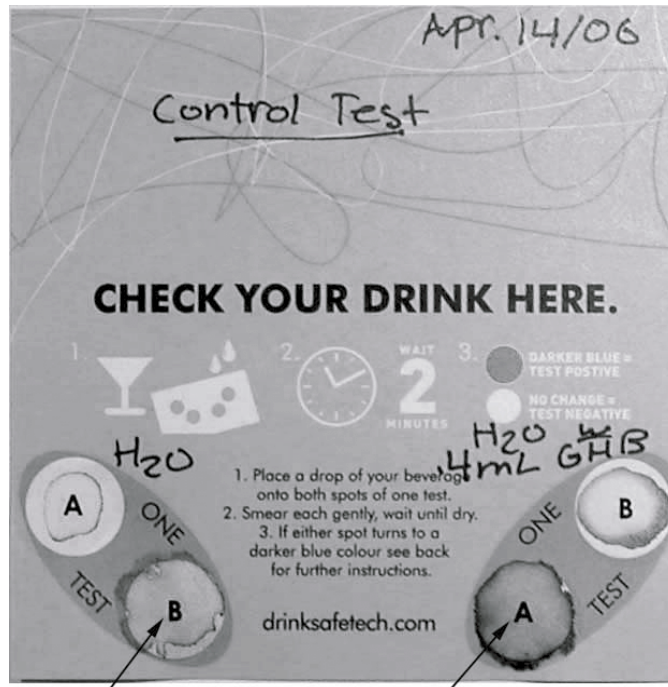
eleven drinks gave a less obvious blue response. These are: red wine and Bloody Mary. The Cosmopolitan and margarita samples did not noticeably change the colour from the original green. None of the control drinks (no GHB) gave a false positive even though one of the beverages was blue in colour.

Although the GHB-spiked test areas did not in all cases turn blue, there was still a noticeable difference in colour between the control sample and the GHB sample areas. In fact, the control colour changed from the original green of the cards in all cases and there was a dramatic difference in colour between the control and the spiked samples in all eleven cases.

By testing a sample of the drink after purchasing it to use as a reference, an individual could greatly increase their chances of detecting GHB in their beverage, particularly in a dim room such as a bar or club.

As shown in Table 3 nine of the eleven drinks that were tested on the coasters gave an obvious blue response. As with the “DrinkSafe™” cards, two of the eleven spiked drinks, the Cosmopolitan and margarita, did not give a positive blue response.

For the beverages that gave a clear positive response, the blue colour was darker and more obvious on the coasters than on the “DrinkSafe™” cards. Those that gave a less obvious response on the “DrinkSafe™” cards, red wine and Bloody Mary, gave a clear positive response on the coasters.



Water Control  
Colour: green

GHB Added  
Colour: blue

**Figure 3.** Reaction of GHB and water with a “DrinkSafe™” Coaster.



GHB-added  
Colour: blue

Control (no GHB)  
Colour: green

**Figure 4.** Reaction of GHB with a “DrinkSafe™” Card.

As with the cards, the un-spiked control was a different colour than the GHB test area every time. This confirms that by having a suitable reference colour, an individual would more likely be able to detect GHB in their beverage.

TABLE 1.  
CHARACTERISTICS OF THE BEVERAGES USED IN THE EXPERIMENTS

Beverage Name	Observations	
	Beverage Colour	pH
Cosmopolitan	Light translucent pink	3
Margarita	Light lime green	2-3
Bloody Mary	Red colour of tomato juice	2
Vodka Cooler	Dark pink	1.5
Rum & Coke	Dark colour of Coca Cola	1.5-2
Martini	Pale yellow	4
Gin & Tonic	Clear	3
Lakeport Beer	Amber	4-5
White Wine	Light amber	3
Blue Lagoon	Light blue	3
Red Wine	Red	5-6

TABLE 2.  
RESPONSE OF THE "DRINKSAFE™" CARDS TO GHB IN A RANGE OF BEVERAGES

Drink Name	Observations		Response Compared to Original Green Colour of GHB Test Area	Response Compared to Control-Treated Test Area
	Control Drink (no GHB) Green Area	Spiked Drink (0.0123 g/mL GHB) Green Area		
Cosmopolitan	bleached yellow-orange	perimeter tinged with blue but no obvious change in colour	negative	positive
Margarita	bleached light orange	stayed relatively the same colour	negative	positive
Bloody Mary	bleached yellow	bluish green	inconclusive	positive
Vodka Cooler	bleached bright orange	blue perimeter and light pink inside	positive	positive
Rum & Coke	very dull orange	dark greenish blue on outside. inside is a slightly lighter blue	positive	positive
Martini	green on the outside white on the inside	bright blue on the outside. Slightly lighter in the middle	positive	positive
Gin & Tonic	bright yellowish orange	dark blue around outside of droplet, lighter in the middle	positive	positive
Lager Beer	pale green	very dark blue	positive	positive
White Wine	bleached to an extremely light orange colour	lighter blue all the way through	positive	positive
Blue Lagoon	bleached to an extremely light orange	extremely light blue, almost undistinguishable from original colour of test area	positive	positive
Red Wine	rusty red colour	blue-grey with a purplish tinge.	inconclusive	positive

We noticed that on some coasters the green GHB detection chemical was on the top test area and on others it was on the bottom test area. Despite this inconsistency, the coasters generally performed well. We also noted that the instructions on the coasters state not to use them to test wine, tonic water or juice, however, our experiments showed that GHB was detectable in these beverages when an appropriate control was used.

The behaviours of the test strips and coasters in the presence of GHB did not appear to correlate with either the colour or pH of the drink

TABLE 3.  
RESPONSE OF THE “DRINKSAFE™” COASTERS TO GHB IN A RANGE OF BEVERAGES

Drink Name	Observations		Response Compared to Original Green Colour of GHB Test Area	Response Compared to Control-Treated Test Area
	Control Drink (no GHB) Green Area	Spiked Drink (0.0123 g/mL GHB) Green Area		
Cosmopolitan	pale yellow	forest green	negative	positive
Margarita	pale yellow	light forest green	negative	positive
Bloody Mary	bleached yellow with red residue from tomato juice	light blue with green tinge	positive	positive
Vodka Cooler	bleached bright orange with pink tinge	light blue with green tinge and light pink splotches	positive	positive
Rum & Coke	perimeter of droplet green, center is beige	dark blue	positive	positive
Martini	lime green perimeter with like green center	dark blue are outside, lighter in the middle	positive	positive
Gin & Tonic	light brownish- green	blue	positive	positive
Lakeport Beer	pale green	blue	positive	positive
White Wine	light lime green	blue	positive	positive
Blue Lagoon	bleached light yellow	light blue	positive	positive
Red Wine	light brown	grey-blue	positive	positive

*The Behaviour of  $\gamma$ -Butyrolactone-Spiked Drinks on the “DrinkSafe™” Cards and Coasters*

To test whether  $\gamma$ -butyrolactone would be converted into GHB in an acidic drink and lead to a positive test,  $\gamma$ -butyrolactone was spiked into the three most acidic beverages (Bloody Mary, vodka cooler, and rum and coke), then tested on the “DrinkSafe™” cards and coasters. All tests gave a negative response. This confirms the negative result obtained with diluted  $\gamma$ -butyrolactone in water and shows that  $\gamma$ -butyrolactone is not converted to GHB in an acidic drink.

We conclude from these observations that although  $\gamma$ -butyrolactone is closely related chemically to GHB, and can itself be used as a date rape drug, none of the commercially available test kits are able to detect it.

**CONCLUSIONS**

We conclude the following:

- All of the commercially-available test kits gave a positive response with GHB in water in the concentration range that could be found in a spiked beverage. The kits responded positively every time when authentic GHB in water was applied. No false negatives were observed with GHB in water. There were, however, some limitations with the detection of GHB in actual drinks.
- With the “DrinkSafe™” cards, using the original green colour as a reference as suggested by the manufacturer of the kits, only seven of the eleven spiked drinks tested gave an obvious positive result. Two of the eleven gave no noticeable colour change. These were the Cosmopolitan and margarita; two of the top four most popular cocktails. With the “DrinkSafe™” coasters, nine of the eleven drinks gave a clear positive result. As with the cards, the Cosmopolitan and margarita spiked with GHB gave no response.
- We observed that in no case did a drink not containing GHB give a false positive response.

- In all cases, the control drink changed the colour of the test spot. When this colour was used as a reference, GHB was detectable in all cases.
- This research shows that having an appropriate reference point (testing a sample of the drink right after purchase) greatly increases an individual's chances of detecting GHB in their beverage. This would be particularly true under dimly lit conditions such as a bar or club.
- The ability of the "DrinkSafe™" cards and coasters to detect GHB did not seem to be affected by the pH or colour of the beverage.
- Gamma-butyrolactone is closely related chemically to GHB and is used as a "date-rape" drug itself. However, none of the commercially available test kits are able to detect it either in water or in a beverage. It does not appear to be converted into GHB in acidic drinks.
- Due to the low cost of the test strips and coasters (less than one dollar per test) and their apparent reliability, these kits could be used by investigating officers in "date-rape" cases as a quick screen for the presence of GHB in beverages. The kits do not adulterate the beverage as a sample is withdrawn for testing leaving the remainder of the drink available for further examination.

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